BMJ Public Health

Cross-sectional survey to explore knowledge, attitude, practices and impact of an intervention programme related to antibiotic misuse and self-medication among general population of Pakistan

Arifa Saif [1], Tahir Mehmood Khan [1], Allah Bukhsh [1], Muhammad Osama Yaseen [1], Alia Saif [2]

To cite: Saif A, Khan TM, Bukhsh A, *et al*. Cross-sectional survey to explore knowledge, attitude, practices and impact of an intervention programme related to antibiotic misuse and self-medication among general population of Pakistan. *BMJ Public Health* 2024;**2**:e000758. doi:10.1136/bmjph-2023-000758

► Additional supplemental material is published online only. To view, please visit the journal online (http://dx.doi.org/10.1136/bmjph-2023-000758).

Received 14 November 2023
Accepted 17 January 2024

[1]Institute of Pharmaceutical Sciences, University of Veterinary and Animal Sciences, Lahore, Pakistan
[2]Department of Pharmacology and Toxicology, University of Veterinary and Animal Sciences, Lahore, Pakistan

Correspondence to
Dr Arifa Saif;
arifa.saif@hotmail.com

ABSTRACT

Objective The objective of this study is to observe the knowledge, attitude and practices related to antibiotic use, the prevalence of self-medication and non-adherence to the prescribed course of antibiotics across Pakistan.

Method A cross-sectional quantitative study on knowledge, practices, attitude and adherence to antibiotic therapy was conducted from January 2021 to March 2022 among the adult population living in different areas across Pakistan. Individuals with poor knowledge were selected for video-based intervention programme. Video template produced by WHO to create antibiotic awareness was used for this purpose. A postintervention study was conducted to assess the improvement in their knowledge and practices regarding the use of antibiotics. Paired samples t-test was applied to assess the improvement in postintervention survey scores.

Results 68.9% (n=340/493) of the participants were female and the majority of the sample population was from urban areas. Our study revealed that 39.2% (n=196) of individuals have undergone self-medication with antibiotics in the last 6 months and 42% (n=207) of the total participants were non-adherent to antibiotic treatment plan. Lack of proper information from healthcare professionals was observed to be the most important barrier to antibiotic treatment adherence. The interventional video was shown to 31.64% (n=156/493) of participants who lack proper knowledge about antibiotic use and its associated problems. There appeared to be a significant improvement in the postintervention mean scores of knowledge, practices, attitude and adherence related to antibiotics.

Conclusion This study highlights the alarming situation of self-medication and non-adherence to antibiotic therapy. To cope with the situation, certain pertinent measures are direly needed before the precious lifesaving antibiotics become useless in eradicating various controllable microbial diseases.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Self-medication with antibiotics and non-adherence to antibiotic therapy are major causes of antibiotic resistance, which is an important public health concern around the globe.
⇒ In low-income and middle-income countries such as Pakistan, misuse of antibiotics is widespread due to limited healthcare access, lack of knowledge about antibiotics and ease of access to antibiotics without prescription.
⇒ Previous research highlights the positive outcomes of interventions in improving rational use of antibiotics and reducing healthcare costs among Pakistan population.

WHAT THIS STUDY ADDS

⇒ This study provides updated and comprehensive data on knowledge, attitude, practices and adherence to antibiotic therapy among Pakistani residents, as the extent of antibiotic self-medication and non-adherence practices may change over time.
⇒ This study highlights lack of adequate information from healthcare professionals and poor knowledge of people about antibiotics as the major factors towards non-compliance with prescribed use of antibiotics.
⇒ This study explores the impact of video-based intervention and reveals a significant improvement in knowledge and behaviour of Pakistani diaspora about proper use of antibiotics.

INTRODUCTION

Misuse of antibiotics and its consequence of antimicrobial resistance is an emerging public health problem worldwide. Proper use of antibiotics is crucial to assure treatment effectiveness and reduce the chances of antimicrobial resistance. However, misuse of antibiotics may

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ The findings of our study will guide further research, encouraging researchers to investigate and adapt interventions for combating self-medication and non-adherence.
⇒ Healthcare professionals will use these findings to develop targeted strategies for prescription management and patient education, ultimately improving antibiotic adherence and healthcare outcomes.
⇒ Policy-makers will use the insights from our study to formulate evidence-based policies and regulations aimed at reducing antibiotic misuse in this region.

result in a myriad of unfortunate incidents and increase the odds of antibiotic resistance which can usher high treatment costs with reduced effectiveness.[1] In recent years, microbes, which were previously susceptible to certain antimicrobial agents, have become resistant and this phenomenon has emerged or re-emerged in many regions of the world causing a global health threat and macroeconomic consequences.[2 3] Furthermore, the dwindling development and research in the field of antibiotics to combat the menace of antimicrobial resistance has created turbulent public health and economic challenges around the globe.[4]

It is believed that more than half of the antibiotics are obtained without a prescription and taken over the counter in most parts of the world.[5] In many Latin American countries, despite the restricted sale of over-the-counter medications, the policies are rarely enforced, and people tend to self-medicate frequently.[6] Furthermore, in Europe, where the sale of over-the-counter (OTC) antibiotics is outlawed, it occurs often in countries such as Spain and Greece.[7] According to WHO, 80% of antibiotics are used in the community in low-income and middle-income countries (LMICs), with 20%–50% of those being used incorrectly. It has also been reported that over half of all antibiotic prescriptions in the world are unnecessary, and two-thirds of antibiotics accessible in the pharmaceutical industry are used for self-medication.[8] Studies have shown increased prevalence of self-medication with antibiotics ranging from 8.1% to 93% in LMICs revealing a strong association with gender, education, knowledge of antibiotics and income of respondents. Self-medication appeared to be associated with various other factors such as lack of trust in healthcare providers, inaccessibility to healthcare facilities and high cost of treatment therapies.[9]

Antibiotic resistance is also one of the major healthcare problems in Pakistan and it poses a substantial cost to its healthcare system annually.[10] Lack of antibiotic treatment adherence, self-medication of antibiotics due to poor behaviour and limited knowledge of people of Pakistan are major determinants of antimicrobial resistance among many other factors.[11] The widespread trend of self-medication with antibiotics has been attributed to several factors such as inaccessibility to healthcare facilities, accessibility of antibiotics as over-the-counter (OTC) medicines and poor drug regulatory framework in Pakistan.[12 13] Despite much research on misuse of antibiotics and the development of national action plan on antimicrobial resistance in Pakistan, limited attention is given to implement this plan. Studies have indicated that strategies that mainly depend on enforcing strict regulations in LMICs generally fall short due to a combination of interconnected problems. These include inadequate funding of regulatory bodies, policies being challenged by private stakeholders, lack of technical capabilities and limited political support.[14 15]

The non-prescription use of antibiotics with ease of access at pharmacies creates the opportunities of bypassing expert opinion and promoting self-medication.[16] Self-medication with antibiotics associated with poor prognosis based on previous experiences and peer recommendations is endangering the populace on various grounds due to the development of antimicrobial resistance.[12] Non-adherence to prescribed antibiotic therapy can be attributed to dearth in public knowledge and negligent attitude or behaviour towards the prescribed treatment plan posing serious health issues in Pakistan in future.[17]

Knowledge and beliefs are cognitive factors that influence the health-related decision-making of an individual. Understanding the factors affecting behaviour change is necessary to identify the change, and therefore, models, which identify and strengthen such aspects of behaviour, are required to prevent self-treatment and improve the rational use of antibiotics.[18] In Pakistan, several studies have been carried out to assess the prevalence of antibiotic self-medication along with the factors that influence the behaviour, attitude and understanding of the populace towards antibiotic use. Many of these studies, however, are limited in scope, sample size and geographical coverage, and may not adequately portray the complexity and diversity of the issue. Moreover, the available data about antibiotic practices in Pakistan are neither comprehensive nor up to date.

In addition to the limitations in available data from Pakistan, it is vital to take into account the developing nature of the issue. Several social, economic, cultural and environmental factors—many of which are changing over time—have an impact on the use and misuse of antibiotics. Also, public attitudes and practices towards the use of antibiotics will likely shift as the global health community works to spread knowledge about the threat posed by antibiotic resistance. This highlights the significance of ongoing research to assess changes in behaviour over time and discover emerging problems and opportunities for intervention. Hence, it is pertinent to understand the recent perception and attitude of Pakistani diaspora towards antibiotic use. Investigation of such findings would help us better understand the factors influencing the rational use of antibiotics, which will ultimately help combat antibiotic resistance over time.

Keeping in view the aforementioned realities, the motivation behind this study is to assess the latest scenario

of antibiotic self-medication in Pakistan and to educate public about rational use of antibiotics. The primary objective of this study is to comprehensively examine the knowledge, attitudes, practices, adherence and barriers related to the use of antibiotics within the Pakistani diaspora. Additionally, the study aims to assess the impact of an innovative video-based intervention in addressing the issue of inappropriate antibiotic use among the general public of Pakistan. Although, there are different types of information media available, yet studies revealed video-based educational interventions to be more effective.[19] Through a detailed analysis, this research provides insights into the effectiveness of the video-based intervention and its applicability for promoting awareness about the proper use of antibiotics within the community.[20] The ultimate goal is to contribute to the development of targeted interventions and educational strategies to improve antibiotic stewardship and reduce the inappropriate use of antibiotics in Pakistan.

METHOD

A cross-sectional quantitative study was conducted from January 2021 to March 2022, among the adult population in different areas across Pakistan. The administrative structure of Islamic Republic of Pakistan is divided into four provinces, namely Punjab, Sindh, Khyber Pakhtunkhwa, Baluchistan, and two autonomous territories namely Azad Jammu and Kashmir and Gilgit-Baltistan. Individuals from all these areas participated in the study. Convenient sampling technique was used to collect data due to limitation of resources and time. The data were collected through an online questionnaire as the study was conducted during COVID-19 period when people were hesitant to interact in-person.

Participants

Inclusion criteria

1. Adult population aged 18 years or above.
2. Individuals with a history of antibiotic use or who are currently using antibiotics.
3. Pakistani nationals residing in Pakistan.
4. Only quantitatively collected data are used.

Exclusion criteria

1. Individuals aged less than 18 years.
2. Individuals who never used antibiotics.
3. Data from Pakistani nationals residing in foreign countries.

Study design

A questionnaire was developed for the study under consideration based on extensive literature review.[21–26] Other than demographics, the preintervention questionnaire was divided into sections to assess self-medication with antibiotics, knowledge about antibiotics, practices related to antibiotics, attitude towards antibiotic use, adherence to antibiotic therapy and barriers to antibiotic treatment adherence, as presented in online supplemental appendix 1. The respondents having poor knowledge about antibiotics were selected for follow-up with interventional video and post-intervention survey. Literature was explored in order to identify an appropriate interventional strategy to raise awareness about rational use of antibiotics. This intervention covered basic knowledge about the common uses of antibiotics, awareness about antibiotic resistance and general recommendations to tackle the problem of self-medication and non-adherence to prescribed antibiotic regimen. The video produced by WHO for use during World Antibiotic Awareness Week in 2017 was found suitable for this study and used as interventional video.[27] The questionnaire for postintervention survey was intended to assess improvement in knowledge, practices, attitude and adherence towards antibiotic therapy. The objectives of this study were explained to the respondents before taking their consent. To acquire the trust of participants, information about their national identity card, resident's name and postal address was avoided.

A panel of experts, including clinicians, academic staff and psychometricians, was consulted for face and content validity to finalise the 32-item questionnaire, excluding demographics. The scale was further tested by conducting a pilot study on 50 individuals from the target population. These individuals could give suggestions on readability, understanding and appropriateness of the items. The wording and format of items were slightly modified based on suggestions given by the individuals. The responses were then coded and subjected to reliability and validity testing using SPSS V.21 (IBM).

Patient and public involvement

Patients or the public were not involved in the design, or conduct, or reporting, or dissemination plans of our research.

Reliability

Internal consistency, inter-item correlation and item-total correlation were applied to assess the reliability of the items. The acceptable Cronbach's Alpha coefficient was considered greater than 0.7 for internal consistency of each subscale. Homogeneity of the scale was examined using inter-item correlation and item-total correlation. Acceptable limits for coefficient of inter-item correlation and item-total correlation were considered 0.3–0.7 and greater than 0.3, respectively. A coefficient greater than 0.7 stipulates redundancy, while coefficients less than a value of 0.3 mean that items have no contribution to the scale.

Validity

Exploratory factor analysis (EFA) was employed to confirm the validity of each subscale. Extraction method of principal component analysis with varimax

rotation was used to perform EFA. Scree plot, total variance explained and Eigenvalues greater than 1 were the benchmark for factor extraction. The cut-off point for characterising factor-associated variables was greater than 0.4. The study tool was mainly composed of seven sections, with first section aiming to explore demographic information while remaining six were aiming to explore knowledge about antibiotics, self-medication and previous experience with antibiotics, practices related to antibiotics, attitude towards antibiotic use, antibiotic adherence scale and barriers to antibiotic treatment adherence. The strategy used in each of these sections is discussed below:

Self-medication/previous experience

This subscale was made to assess the behaviour towards self-use of antibiotics. It includes four items, exploring previous illnesses, their treatment with antibiotics and the source of information about the use of antibiotics to treat the minor illness. These items were not scored and each item was assessed separately based on individual choices.

Knowledge

The purpose of this subscale was to evaluate the participants' understanding of antibiotics. The subscale consisted of seven items, each with three response options as 'yes', 'no' and 'do not know'. For all questions, 'do not know' responses were labelled as incorrect.[28] A correct answer was given a score of 1, while an incorrect answer received a score of 0. The total score for this subscale ranges from 0 to 7, with higher scores indicating greater knowledge of antibiotics, their use, and resistance, and lower scores indicating less understanding.

Practices

The purpose of this subscale was to examine self-reported behaviours related to the use of antibiotics. It consists of four items with Likert scale responses ranging from 'never' to 'always'. The total score for this subscale ranges from 0 to 16 for each item, with higher scores indicating good practices regarding antibiotics and lower scores indicating poor practices.

Attitude

The purpose of this subscale was to evaluate individuals' attitudes towards the self or prescribed use of antibiotics. It consists of five items with Likert scale responses ranging from 'strongly disagree' (score of 0) to 'strongly agree' (score of 4). The total score for this subscale ranges from 0 to 20 for each item, with higher scores indicating a positive attitude towards the rational use of antibiotics and lower scores indicating a negative attitude.

Adherence

The purpose of this subscale was to evaluate the participants' adherence to the rational use of antibiotics. It consisted of five items, each with three response options as 'yes', 'no' and 'may be'. For all questions, 'may be' responses were labelled as incorrect.[28] A correct answer was given a score of 1, while an incorrect answer received a score of 0. The total score for this subscale ranges from 0 to 5, with higher scores indicating better adherence to guidelines and lower scores indicating poor adherence.

Barriers

The purpose of this subscale was to assess potential barriers that prevent individuals from complying with the prescribed or rational use of antibiotics. It consisted of seven items, each with response options ranging from 'very important barrier' to 'unimportant barrier.' These items were not scored, and each item was assessed separately based on individual choices.

Postintervention

After the initial survey, mean scores were set as a cut-off value to classify individuals as those having poor knowledge and those having better knowledge regarding antibiotics; having satisfactory or unsatisfactory practices related to antibiotics; having positive or negative attitude towards antibiotic use and are adherent or non-adherent to antibiotic therapy.[29 30] Individuals with poor knowledge were focused for intervention since they are more likely to use antibiotics inappropriately, putting them at risk of undesirable effects, such as antibiotic resistance, adverse drug reactions and treatment failure. The postinterventional survey was done following 9 months gap after intervention, to assess the sustainability of intervention and its impact on knowledge, practices, attitude and adherence related to rational use of antibiotics over time.[31]

Sample size

The sample size of this study was calculated by using sample size calculator at Raosoft website.[32] The parameters that were considered include the margin of error, confidence level, population size, response distribution and critical value for the confidence level of this study. In this study, the margin of error and CI were 5% and 95%, respectively. The minimum estimated sample size was n=384 to achieve 95% confidence level, yet 502 respondents were surveyed to make the findings more precise.

Data analysis

All the responses were coded and collected data was processed using IBM SPSS Statistics software V.21.0. The data were subjected to normality test with a cut-off significant value of 0.05. Quantitative analysis of the data was performed using descriptive analysis. For the variables that were not normally distributed on independent factors, Kruskal-Wallis test and Mann-Whitney U test were applied to estimate the association among variables. Paired samples t-test was performed to check the association of preintervention and postintervention survey scores. Regression model was used to assess the association among different variables.

RESULTS

Demographic details of participants

A total of 502 individuals were contacted randomly through social media, for participation in this study. Out of the total participants, only nine individuals did not give consent. Hence, the response rate for this study was 98.2%. Mean age of the participants was 25.92±6.72 years. 69% of participants were female and majority of the sample population was from urban areas of Pakistan. The demographic details of 493 individuals are shown in table 1.

Instrument reliability and validity

The reliability analysis showed that Cronbach's alpha for each of the subscales was above 0.7, indicating acceptable internal consistency. The inter-item correlations ranged from 0.3 to 0.7, while all item-total correlations were greater than 0.3. The scale consisted of 32 items, which were grouped into 6 subscales based on EFA. To assess the sustainability of the scale, a correlation matrix (determinant>0.00001), Kaiser Meyer-Oklin test (0.783) and Bartlett's test of sphericity (p<0.01) were performed before conducting principal component analysis. The results supported the factorability of the scale, and further analysis was conducted using principal component analysis. The scree plot (figure 1), eigenvalues of greater than 1 and total variance explained were used to determine the number of factors to be extracted. Using the varimax rotation technique, six factors were identified and named self-medication/previous use of antibiotics, knowledge, practices, attitude, adherence and barriers based on conceptual considerations.

Self-medication/previous experience with antibiotics

A total of 50.7% participants (n=250/493) got sick in the last 6 months. Among these participants, 16.4% (n=41) suffered from more than one disease and 78.4% (n=196) individuals have taken antibiotics to treat their illness in the past 6 months (table 2). The details of symptoms or infections from which individuals suffered in the past 6 months are presented in figure 2. Among the 196 participants who used antibiotics to treat their illness, 60.2% (n=118) used prescribed antibiotics by a regular physician while the remaining 39.79% (n=78) used antibiotics without any prescription as summarised in figure 3.

Knowledge, practices and attitude regarding use of antibiotics

Out of 493 individuals, 68.4% (n=337) had better knowledge about antibiotics, 50.7% (n=250) participants showed a 'positive' attitude and practices of 54.76% (n=270) individuals were found satisfactory concerning the use of antibiotics. The remaining 31.6% (n=156) participants having poor knowledge, were selected for follow-up with the interventional video and postinterventional survey to assess the impact of intervention on knowledge, practices and attitude towards antibiotic use and also on adherence to antibiotic therapy. Detailed

Table 1 Demographic details of respondents

Demographics	N (%)	
	Preintervention (N=493)	Postintervention (N=156)
Age		
18–25 years	299 (60.6)	94 (60.3)
26–33 years	154 (31.2)	44 (28.2)
34–41 years	28 (5.7)	12 (7.7)
42–49 years	5 (1)	2 (1.3)
≥50 years	7 (1.4)	4 (2.6)
Gender		
Male	149 (30.2)	62 (39.7)
Female	340 (69)	90 (57.7)
Prefer not to say	4 (0.8)	4 (2.6)
Province		
Punjab	454 (92.1)	141 (90.4)
Sindh	17 (3.4)	5 (3.2)
Baluchistan	1 (0.2)	1 (0.6)
Khyber Pakhtunkhwa	5 (1)	0
Federal	8 (1.6)	3 (1.9)
Other	8 (1.6)	6 (3.8)
Area		
Rural	114 (23.1)	51 (32.7)
Urban	379 (76.9)	105 (67.3)
Education level		
No certificate but can read/write	1 (0.2)	0
Matriculation	5 (1)	3 (1.9)
Intermediate	56 (11.4)	28 (17.9)
University graduate	341 (69.2)	104 (66.7)
Above	90 (18.3)	21 (13.5)
Marital status		
Married	153 (31)	44 (28.2)
Single	336 (68.2)	110 (70.5)
Divorced	2 (0.4)	0
Widowed	2 (0.4)	2 (1.3)
Employment		
Employed	171 (34.7)	50 (32.1)
Unemployed	317 (64.3)	104 (66.7)
Retired	5 (1)	2 (1.3)
Presence of comorbidities		
No	464 (94.1)	145 (92.9)
Yes	29 (5.9)	11 (7.1)
If yes, which comorbidities (N=29)		
Skin infection/allergy	5 (1)	1 (1.1)
Asthma	1 (0.2)	1 (1.1)
Depression	3 (0.6)	1 (1.1)
Pain in joints	3 (0.6)	1 (1.1)
Backbone issues	1 (0.2)	1 (1.1)
Diabetes and blood pressure	4 (0.8)	4 (4.5)

Continued

Table 1 Continued

Demographics	N (%)	
	Preintervention (N=493)	Postintervention (N=156)
Gastrointestinal issues	7 (1.4)	0
Common cold/influenza	1 (0.2)	0
Hepatitis	1 (0.2)	0
Kidney stones	1 (0.2)	0
Kidney failure	1 (0.2)	0
Muscles issue	2 (0.4)	0
Ovary stones	1 (0.2)	0
PCOS	2 (0.4)	0
Urinary tract infection	1 (0.2)	0
Vitiligo	1 (0.2)	0
Anxiety	1 (0.2)	0
Anaemia	1 (0.2)	0
High cholesterol	1 (0.2)	0
Thrombocytopenia	1 (0.2)	0
COVID-19	1 (0.2)	0
Throat infection	1 (0.2)	0
Thyroid issue	1 (0.2)	0
Others	7 (1.4)	0

*18–70 years. Mean=25.92 ± 6.72 years (pre), 26.21±8.76 years (post)
PCOS, polycystic ovary syndrome.

mean scores of knowledge, practices and attitude of different groups are given in table 3.

People with lower education had lower mean scores with respect to their knowledge about antibiotics and attitude towards the use of antibiotics. There was a significant difference in area-based knowledge (p<0.01) and attitude (p=0.015) when the data were subjected to Mann-Whitney U test. A statistically significant difference was also noticed regarding knowledge (p=0.003) and attitude (p=0.022) among participants of different provinces when Kruskal-Wallis test was applied to abnormally distributed data. Different age groups had difference (p=0.022) in knowledge regarding the antibiotics, their use and resistance. People with higher level of education had better attitudes towards the use of antibiotics as compared with those having less education. The results of regression analysis revealed that females were more likely to have better knowledge (β=0.108, 95% CI=0.061 to 0.697, p=0.020) and satisfactory practices (β=0.098, 95% CI=0.022 to 1.229, p=0.042) related to antibiotic use. Moreover, there was a significant association of practices (β=0.212, 95% CI=0.229 to 0.547, p<0.01) and attitude (β=0.247, 95% CI=0.331 to 0.685, p<0.01) of people with their knowledge. Details of regression analysis are shown in table 4.

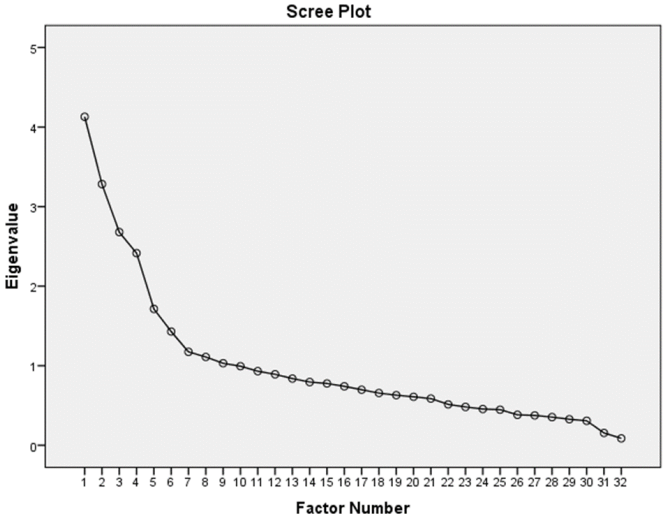

Figure 1 Scree plot authenticating factorability of the scale.

Adherence to antibiotic therapy

58% (n=286) participants were adherent to the antibiotic therapy while 42% (n=207) participants appeared to be non-adherent to the antibiotic treatment. There was a significant difference in age-based (p=0.022) and area-based (p=0.000) adherence to antibiotic therapy (table 3). Regression model revealed that people in urban areas were more adherent (β=0.176, 95% CI=0.295 to 0.885, p<0.01) to the antibiotic treatment plan as compared with those in rural areas. There was a significant association (β=0.321, 95% CI=0.202 to 0.346, p<0.01) between participants' knowledge and adherence scores. 46.65% (n=230) participants forget to take their antibiotics, 64.71% (n=319) take antibiotics out of their prescribed schedule, 38.53% (n=190) stop taking antibiotics when the disease symptoms disappear, 48.88% (n=241) stop taking antibiotics when the symptoms worsen and 80.93% (n=399) take antibiotics more than what they are prescribed for their illness.

Barriers to antibiotic treatment adherence

When asked about the barriers to antibiotic treatment adherence, 44.4% of participants said that they did not receive any proper information from healthcare professionals regarding antibiotic use. It was perceived by 39.4% individuals that once they get better, they do not find any reason to continue their medication and would stop taking antibiotics. 26.2% individuals find it difficult to adhere to a prescribed treatment plan due to multiple dosing of antibiotics per day, while 25.8% individuals simply forget to take their antibiotics on the prescribed schedule. Female participants had most of the reasons not to comply with the optimal antibiotic treatment plan. Figure 4 highlights different barriers in view of the participants who may interfere with their compliance to rational use of antibiotics.

Postintervention study

A total of 156 individuals with poor knowledge according to the preintervention survey were contacted for the postintervention survey. The mean age of the participants was 26.21±8.76 years 57.7% (n=90) of the participants were female and the majority of population was

Table 2 Previous illness and experience of participants regarding antibiotic use

Demographics	Suffered from any illness in the past 6 months (N=250)	Illnesses suffered from in the past 6 months		Taken any antibiotics to treat illness (N=196)
		Only one disease (N=209)	More than one disease (N=41)	
Age				
18–25 years	146	120	26	115
26–33 years	84	73	11	64
34–41 years	14	10	4	12
42–49 years	4	4	0	4
≥50 years	2	2	0	1
Gender				
Male	76	72	4	55
Female	172	136	36	139
Prefer not to say	2	1	1	2
Province				
Punjab	231	191	40	184
Sindh	7	7	0	4
Baluchistan	0	0	0	0
Khyber Pakhtunkhwa	4	4	0	4
Federal	5	5	0	3
Other	3	2	1	1
Area				
Rural	55	45	10	42
Urban	195	164	31	154
Education level				
No certificate but can read/ write	1	1	0	1
Matriculation	4	4	0	2
Intermediate	18	12	6	14
University graduate	178	153	25	140
Above	49	39	10	39
Marital status				
Married	81	66	15	70
Single	166	141	25	124
Divorced	1	0	1	1
Widowed	2	2	0	1
Employment				
Employed	92	77	15	73
Unemployed	157	131	26	122
Retired	1	1	0	1
Presence of comorbidities				
No	227	193	34	175
Yes	23	16	7	21

from urban areas of the country. Most participants (n=130, 83.3%) considered interventional video helpful in improving their knowledge, practices, attitude and adherence to antibiotics. Demographic details of these 156 individuals are shown in table 1.

Comparison of the mean scores of preintervention and postintervention surveys showed significant improvement ($p<0.05$) in the knowledge of individuals and subsequently their practices, attitude and adherence to the antibiotic treatment plan were also improved. The results from paired sample t-test analysis suggest that video-based intervention does influence knowledge, attitude, practices and adherence to the antibiotic regimen of an individual. The mean scores of different groups

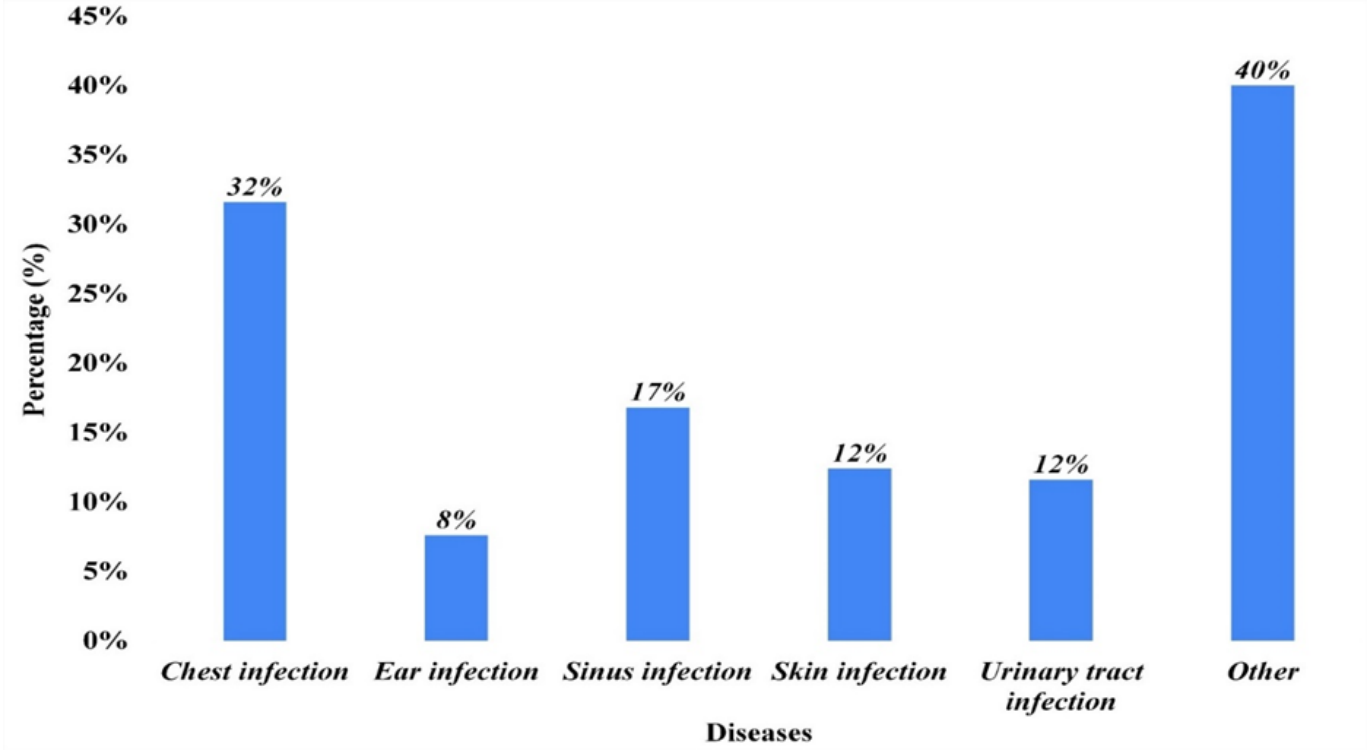

Figure 2 Illnesses from which participants suffered in the past 6 months.

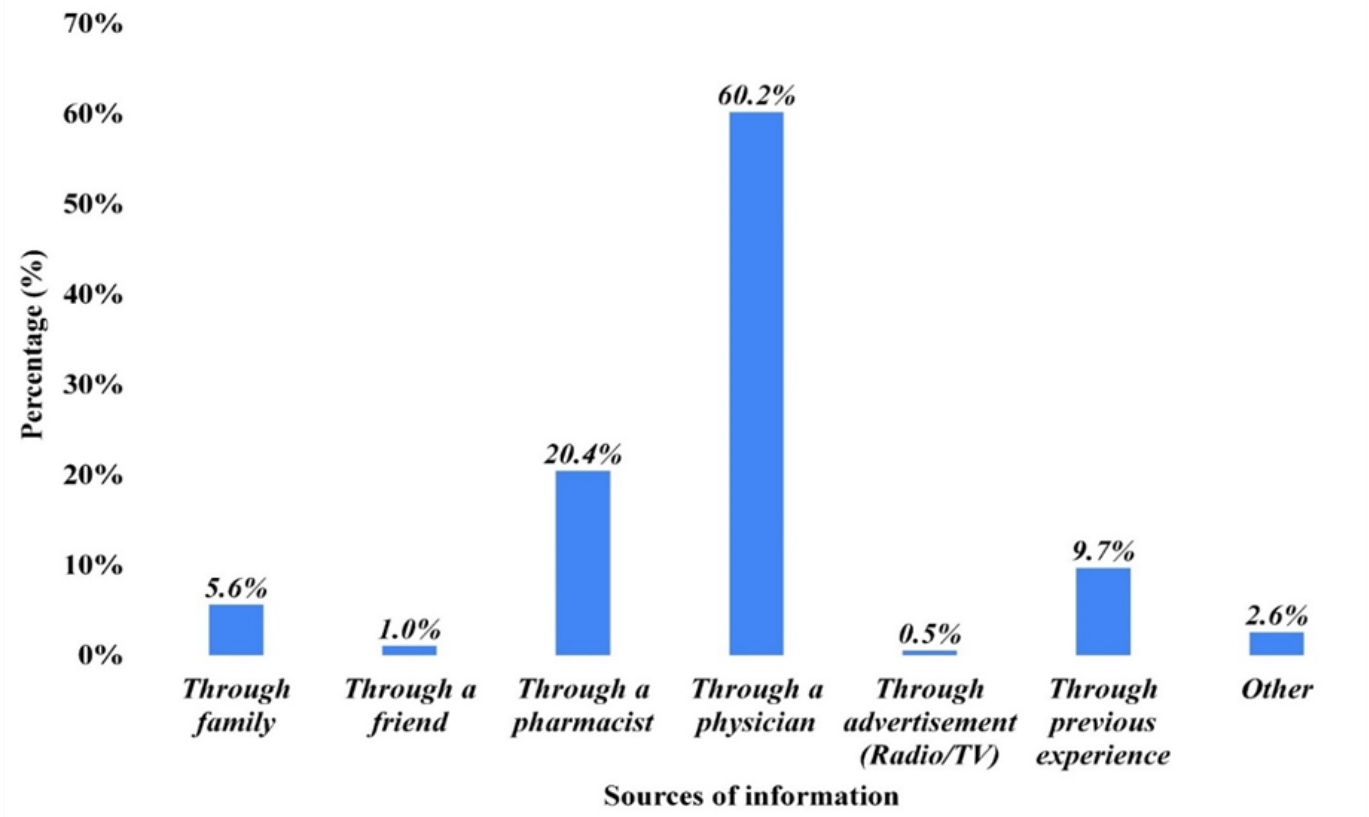

Figure 3 Sources through which participants came to know about the antibiotics they used to treat their illness. TV, television.

Table 3 Association between participants' demographics and mean scores of knowledge, practices, attitude and adherence to antibiotics

	Knowledge score		Practice score		Attitude score		Adherence score	
Demographics	**Mean±SD**	**P value**	**Mean±SD**	**P value**	**Mean±SD**	**P value**	**Mean±SD**	**P value**
Age								
18–25 years	5.68±1.525		14.55±2.981		18.97±3.454		2.65±1.344	
26–33 years	5.71±1.748		15.07±3.183		19.81±3.306		3.10±1.468	
34–41 years	5.11±1.771		15.39±2.753		20.00±3.139		2.89±1.474	
42–49 years	5.40±2.074		13.80±2.588		18.60±2.302		2.20±1.789	
≥50 years	3.43±2.760˜	0.022*	13.00±2.828	0.133	18.29±4.608	0.084	2.71±1.890	0.022*
Gender								
Male	5.28±1.841		14.29±3.184		19.21±3.531		2.72±1.428	
Female	5.80±1.533		14.92±2.958		19.30±3.384		2.84±1.409	
Prefer not to say	3.75±1.893	0.000*	15.50±3.317	0.095	19.50±1.915	0.962	1.75±0.957	0.233
Province								
Punjab	5.65±1.637		14.73±3.052		19.35±3.332		2.79±1.395	
Sindh	5.18±2.325		14.35±2.691		18.71±4.120		3.06±1.886	
Baluchistan	5.00		16.00		19.00		2.00	
Khyber Pakhtunkhwa	7.00±0.000		18.20±2.490		18.60±7.797		3.40±1.949	
Federal	5.63±1.408		13.88±3.482		19.50±3.338		2.75±1.282	
Other	4.50±1.414	0.022*	14.38±1.923	0.173	16.13±1.959	0.033*	2.50±1.414	0.824
Area								
Rural	5.11±1.866		14.33±2.862		18.39±4.193		2.31±1.470	
Urban	5.78±1.560	0.000*	14.85±3.083	0.110	19.54±3.101	0.015*	2.94±1.365	0.000*
Education level								
No certificate but can read/write	6.00		13.00		20.00		1.00	
Matriculation	3.80±2.049		13.80±3.421		17.00±4.000		1.80±1.304	
Intermediate	5.11±1.875		13.95±2.844		18.20±3.283		2.54±1.348	
University graduate	5.62±1.666		14.74±3.070		19.21±3.474		2.79±1.422	
Above	6.03±1.302	0.002*	15.24±2.962	0.130	20.31±2.978	0.002*	3.04±1.389	0.066
Marital status								
Married	5.67±1.713		14.95±3.092		19.87±3.134		3.02±1.467	
Single	5.63±1.584		14.65±3.003		19.01±3.499		2.70±1.370	
Divorced	6.50±0.707		16.00±1.414		20.50±4.950		4.50±0.707	
Widowed	0.00±0.000	0.000*	10.00±2.828	0.103	16.00±4.243	0.033*	0.50±0.707	0.003*
Employment								
Employed	5.80±1.458		14.72±3.051		19.65±3.417		2.87±1.422	
Unemployed	5.55±1.722		14.74±3.043		19.10±3.380		2.76±1.407	
Retired	4.20±3.033	0.287	14.60±2.881	0.992	17.40±4.775	0.106	2.80±1.789	0.736
Presence of comorbidities								
No	5.64±1.639		14.80±2.987		19.31±3.341		2.81±1.424	
Yes	5.28±1.925	0.246	13.72±3.683	0.065	18.72±4.479	0.372	2.55±1.242	0.336
Overall	5.62±1.658	–	14.73±3.039	–	19.27±3.415	–	2.80±1.414	–

*p<0.05=significant association.

of independent variables for the preintervention and postintervention survey are given in table 5.

DISCUSSION

Antibiotic misuse causes many personal and societal issues, the most serious of which is antimicrobial resistance. Despite efforts to curtail practices of antibiotic self-medication, it is, nevertheless, highly common in developing countries. This study aimed to assess knowledge, practices, attitude towards antibiotics and adherence to antibiotic treatment. In this study, 39.2% of the participants used antibiotics to treat their illness in

Table 4 Regression analysis for predicting influence of independent variables on dependent variables

Factors	B	T	Sig.	95% CI for β	
				Lower bound	Upper bound
Knowledge					
Age	–0.184	–3.825	0.000	–0.599	–0.192
Gender	0.108	2.341	0.020	0.061	0.697
Area	0.156	3.560	0.000	0.274	0.950
Education level	0.115	2.563	0.011	0.073	0.556
Marital status	–0.116	–2.432	0.015	–0.706	–0.075
Employment	–0.112	–2.454	0.014	–0.678	–0.075
Practice					
Gender	0.098	2.036	0.042	0.022	1.229
Knowledge	0.212	4.796	0.000	0.229	0.547
Attitude					
Area	0.116	2.607	0.009	0.232	1.652
Education level	0.125	2.722	0.007	0.195	1.210
Knowledge	0.247	5.640	0.000	0.331	0.685
Adherence					
Area	0.176	3.934	0.000	0.295	0.885
Knowledge	0.321	7.513	0.000	0.202	0.346

Negative sign (–) depicts decrease in mean scores down the groups in independent variable.

the past 6 months, of which 60.2% came to know about the use of antibiotics for the treatment of their disease through a physician. Although a variety of approaches have recently been devised to reduce self-use of antibiotics and to address the issue of antibiotic resistance, yet their implementation is unsatisfactory. As a result,

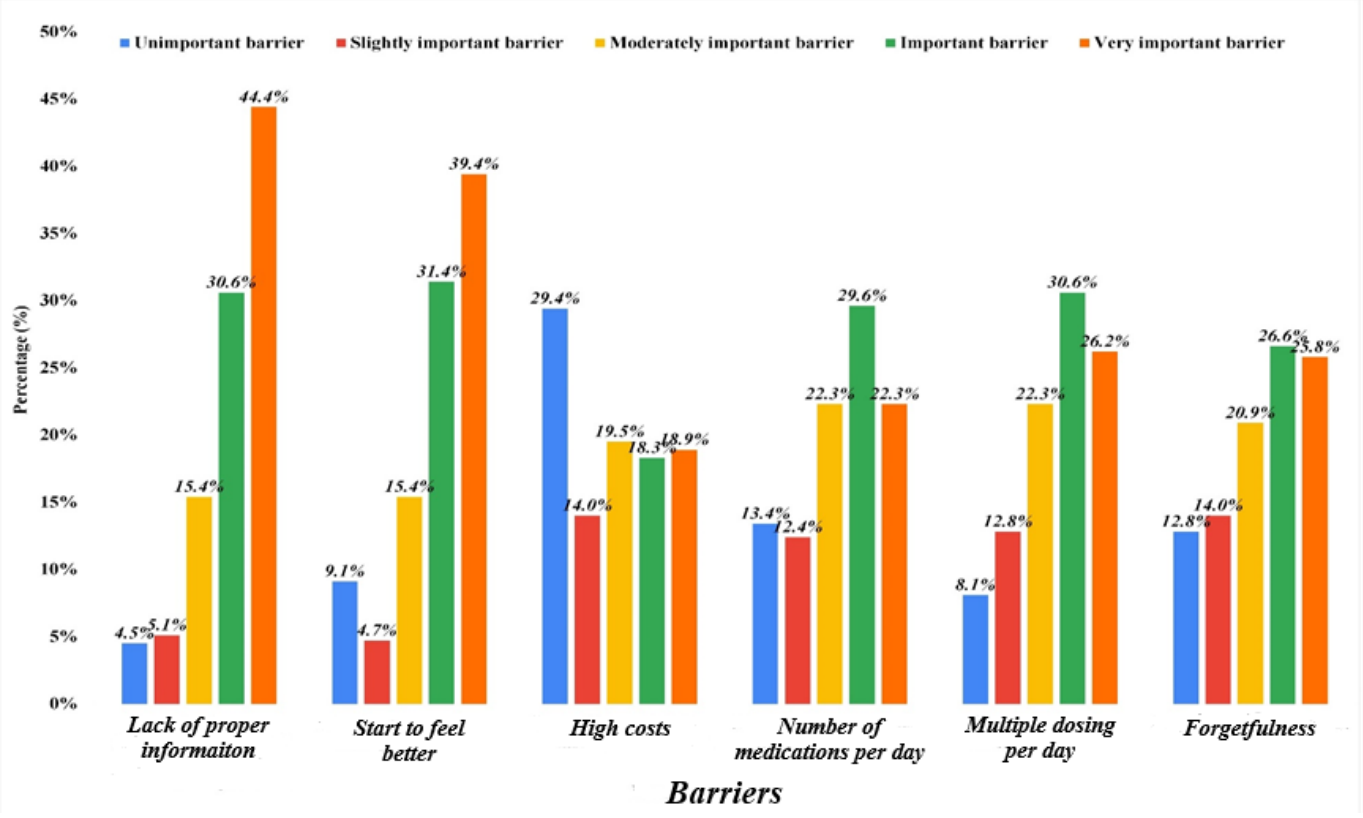

Figure 4 Barriers and their importance to antibiotic treatment adherence.

Table 5 Mean scores of preintervention and postintervention survey and analysis of change in scores by paired samples t-test

	Knowledge score (mean±SD)		Practice score (mean±SD)		Attitude score (mean±SD)		Adherence score (mean±SD)	
Demographics	**Preintervention**	**Postintervention**	**Preintervention**	**Postintervention**	**Preintervention**	**Postintervention**	**Preintervention**	**Postintervention**
Age								
18–25 years	3.82±1.344	4.97±1.448	14.05±3.003	16.54±2.734	17.56±3.004	20.29±4.466	2.35±1.293	3.09±1.427
26–33 years	3.55±1.873	5.14±1.488	13.64±3.458	16.43±2.519	19.20±3.239	20.52±3.586	2.34±1.524	3.11±1.262
34–41 years	3.42±1.379	4.42±1.621	15.75±2.768	16.50±2.153	19.00±4.880	19.08±3.147	2.25±1.485	3.17±1.337
42–49 years	3.50±2.121	3.50±0.707	13.50±0.707	18.50±0.707	17.00±0.000	20.50±0.707	1.00±0.000	4.00±0.000
≥50 years	1.50±1.915	4.75±1.500	11.75±2.630	17.00±1.633	16.75±5.188	20.75±1.258	1.50±1.291	2.75±1.258
Gender								
Male	3.53±1.607	4.87±1.552	13.79±3.359	16.77±2.871	18.23±3.117	20.19±4.817	2.32±1.400	3.27±1.381
Female	3.72±1.529	5.02±1.382	14.08±2.976	16.48±2.314	17.98±3.298	20.32±3.762	2.31±1.371	2.98±1.349
Prefer not to say	3.75±1.893	4.50±2.380	14.50±3.512	15.50±3.317	19.50±1.915	20.25±2.754	1.75±0.957	3.25±0.957
Province								
Punjab	3.67±1.561	4.99±1.464	14.00±3.171	16.46±2.623	18.29±3.070	20.31±4.130	2.33±1.391	3.09±1.346
Sindh	2.20±2.280	5.80±1.304	13.60±3.362	17.80±2.168	16.20±6.686	17.80±7.294	1.60±1.817	3.60±1.140
Baluchistan	3.00	5.00	16.00	19.00	19.00	23.00	2.00	4.00
Khyber Pakhtunkhwa	–	–	–	–	–	–	–	–
Federal	4.00±0.000	4.33±0.577	14.00±4.583	18.33±2.082	17.67±1.155	22.00±2.646	2.00±1.000	3.67±1.528
Other	3.83±0.753	4.00±1.673	14.00±2.098	16.17±2.041	15.67±2.066	20.00±2.683	2.50±1.761	2.50±0.548
Area								
Rural	3.47±1.604	4.98±1.581	14.02±2.846	16.63±2.623	17.61±4.015	20.88±4.038	2.00±1.311	3.29±1.375
Urban	3.73±1.540	4.93±1.423	13.99±3.277	16.50±2.580	18.36±2.697	19.97±4.223	2.45±1.389	3.01±1.341
Education level								
No certificate but can read/write	–	–	–	–	–	–	–	–
Matriculation	2.33±0.577	6.00±0.000	13.67±4.726	17.33±1.528	15.67±4.933	17.33±10.786	1.67±1.528	2.67±2.309
Intermediate	3.68±1.634	4.71±1.740	13.68±3.056	16.21±2.298	17.21±3.095	19.71±3.809	2.18±1.249	3.25±1.266
University graduate	3.59±1.599	5.00±1.455	13.96±3.150	16.53±2.651	18.13±3.262	20.54±4.062	2.34±1.398	3.06±1.371
Above	4.10±1.261	4.86±1.236	14.67±3.088	16.95±1.910	19.57±2.158	20.10±4.073	2.38±1.431	3.19±1.327
Marital status								
Married	3.48±1.691	5.02±1.532	14.02±3.605	16.09±2.467	19.41±3.294	19.61±4.178	2.11±1.418	3.18±1.147
Single	3.78±1.436	4.92±1.460	14.06±2.909	16.72±2.644	17.64±3.013	20.51±4.196	2.41±1.336	3.09±1.431
Divorced	–	–	–	–	–	–	–	–
Widowed	0.00±0.00	5.00±1.414	10.00±2.828	17.00±0.000	16.00±4.243	21.50±0.707	0.50±0.707	2.00±1.414
Employment								
Employed	4.00±1.443	4.80±1.485	13.53±3.333	16.86±2.483	18.28±2.914	21.20±2.373	2.38±1.413	3.26±1.352

Continued

Table 5 Continued

Demographics	Knowledge score (mean±SD)		Practice score (mean±SD)		Attitude score (mean±SD)		Adherence score (mean±SD)	
	Preintervention	Postintervention	Preintervention	Postintervention	Preintervention	Postintervention	Preintervention	Postintervention
Unemployed	3.53±1.564	5.06±1.454	14.26±3.027	16.35±2.632	18.13±3.283	19.79±4.774	2.28±1.347	3.01±1.362
Retired	1.00±1.414	3.00±0.000	12.00±2.828	19.00±0.000	13.00±1.414	22.00±1.414	1.50±2.121	4.00±0.000
Presence of comorbidities								
No	3.67±1.541	4.98±1.441	14.19±3.018	16.67±2.483	18.19±3.060	20.32±4.226	2.30±1.371	3.13±1.376
Yes	3.36±1.859	4.55±1.864	11.55±2.725	14.91±3.419	17.09±4.700	19.64±3.501	2.27±1.421	2.73±1.009
Paired sample t-test								
Difference in means scores of preintervention and postintervention surveys	−1.301±2.135		−2.545±4.304		−2.154±5.209		−0.801±1.946	
P value	0.000*		0.000*		0.000*		0.000*	

*p<0.05=significant association.

antibiotics are still widely used irrationally in many countries including Pakistan.[33]

Even though most participants had better knowledge about antibiotics, there were considerable disparities in understanding antibiotics, their resistance and use depending on the participants' age, gender, area, level of education, marital status and employment. These results were consistent with a previous study from Nepal, which reported better knowledge among younger population with higher level of education and among those who were living in urban areas.[34] Similarly, a previous study from Pakistan indicated significant association of knowledge with the level of education and age of the individuals; however, only 44.4% of community participants were observed to have sufficient knowledge about antibiotics.[35] In contrast to a study from Indonesia, this study showed a better understanding among females about the consequences of antibiotic misuse and resistance.[22] Likewise, a Malaysian survey demonstrated that almost half of the local hospital-visiting population did not believe in the side effects of antibiotics, while only a few participants in this research were observed to have such views.[36]

More than half of the total participants were observed to have better practices of antibiotic use with a mean score of 14.73±3.04. These results were in line with those from a previous study conducted among non-medical students from South Punjab, Pakistan but less than those reported among university students of biological sciences in Pakistan.[37 38] The fact that a considerable number of participants still prefer to take antibiotics on their own is attributed to lack of knowledge or misconceptions about antibiotic use among less educated and non-medical individuals.[35 39] Other possible reasons for self-medication with antibiotics in developing countries such as Pakistan could be the high costs of healthcare facilities, and inability of primary, secondary and tertiary healthcare systems to fulfil individuals' healthcare needs due to overburdened capacity and underutilisation of resources.[40 41]

Almost half of the participants showed a positive attitude towards antibiotic use, with a mean score of 19.27±3.415. Majority of participants believed that irresponsible use of antibiotics would lead to antibiotic resistance and demonstrated 'wait-and-see' behaviour towards the use of antibiotics to treat their illness. This behaviour may be attributed to their misconception of the nature of illness.[42] Even though most participants acknowledged the importance of prescribed use of antibiotics and completed the course of prescribed antibiotic treatment, yet few of them did not understand why they were prescribed antibiotic for their illness. This would result in increased chances of ineffective treatment, health deterioration, increased healthcare cost and antibiotic resistance. These findings were corroborated by the outcomes of another research which revealed that poor communication and lack of information provided by clinicians about appropriate use of antibiotics contributed to this issue.[43]

Non-compliance with antibiotic regimens is a well-known issue that contributes considerably to the development of antibiotic resistance. In this study, 58.02% participants were found to be adherent to antibiotic treatment regimens which is consistent with the results of a study conducted among medical students in Muzaffarabad, Pakistan.[44] Research conducted in other LMICs showed varying results regarding adherence to antibiotic treatment. A study from Southern Ethiopia reported 60.1% non-adherence while only 32.1% individuals were found to be non-adherent to antibiotic treatment in Jordan.[45 46]

It is also important to identify and address any practical barriers that may prevent compliance with antibiotic treatment plans, such as medicine cost, its availability or accessibility. In this study, non-adherence towards treatment with antibiotics was majorly attributed to the lack of proper information from healthcare professionals on antibiotic use, improvement in disease symptoms, frequency of antibiotic schedule and forgetfulness to take antibiotics on the patient's end. These issues could increase the challenges associated with misuse of antibiotics in the near future. To address these issues, clear and comprehensive information should be provided by the healthcare professional and antibiotic stewardship programmes should be implemented in letter and spirit.[47 48] When favourable, a short-course of prescribed antibiotics and scheduled follow-up may lower the likelihood of non-adherence due to symptom relief.[49] Dosage regimens should be simplified and patients should be encouraged to consult healthcare professionals for advice on proper medication administration and timing.[50] Provision of medication aids such as pill organisers or reminder apps and alarms could also improve adherence to antibiotic schedule.[51] Synchronised medication schedules, especially when the patient is taking multiple medications, may also help in reducing complexity and improving compliance to prescribed medication.

Literature underscores the significance of educational programmes in enhancing knowledge, practices, attitude and adherence to antibiotics. Various studies have demonstrated the usefulness of different types of interventions including leaflet, video, text-messages and in-person counselling in improving public knowledge and attitude towards rational use of medication.[52–54] Studies comparing different methods of intervention revealed that videos are more successful than either verbal or written form of education.[53 55] In this research, video-based intervention was used and it showed significant improvement in individuals' knowledge and behaviour. Consistent with these results, a study conducted among parents of children with respiratory tract infection reported prominent decline in parents' interest in receiving antibiotics for their child following 90s video intervention.[56] Various studies outlined the improvement in understanding and comprehension of information shared with the patient in the form of animated videos by healthcare providers.[19 20 57] This might be because video-based approach has advantages of speed, affordability and accessibility. Because of their engaging multimedia format, visual demonstrations, potential to simplify complicated concepts, emotional appeal and accessibility, videos are more effective than any other form in educating individuals about correct antibiotic use.[53] As the use of mobile phone is common nowadays, video-based interventional approach can target individuals with a variety of socioeconomic backgrounds. This is specifically true for the individuals who are illiterate or have low health literacy as they solely rely on their healthcare provider for information related to their medication.

Despite the development of various guidelines and protocols to control the misuse of antibiotics, self-medication remains a significant contributor to antibiotic resistance.[58] In Pakistan, rules and laws have been devised to restrict non-prescribed sale of antibiotics in the country. However, enforcement of such rules has been inadequate, and unrestricted access to antimicrobials, along with high prevalence of antibiotic administration without a prescription, remains a serious public health concern.[14] Drug Regulatory Authority of Pakistan should devise necessary measures to strictly implement drug regulatory laws and launch national campaigns on self-medication awareness in collaboration with Ministry of National Health Services, Regulations and Coordination, Pakistan Medical Association, Pharmacy Council of Pakistan, pharmaceutical industry associations, educational institutes and non-governmental organisations. The use of mass media should be encouraged to educate the public about common illnesses and to urge people to question the irrational prescribing and sale of antibiotics. To supplement existing programmes for antimicrobial resistance prevention, approaches such as improvement in self-hygiene to reduce the need for antibiotics; enhancement of antibiotic stewardship and nosocomial infection control; reducing and eventually eliminating the use of subtherapeutic antibiotics in agriculture; urging health professionals, policy-makers and general public to use antibiotics properly; and ensuring political commitment to deal with the threat posed by antibiotic resistance could help in controlling the misuse of antibiotics. It is, therefore, crucial to identify the factors that encourage misuse of antibiotics and to investigate, design and implement practical interventions that address these identified issues permanently.

Limitations

Like various other studies, this research also has some limitations. The study relied on self-reporting by individuals, which opens the door to both over-reporting and under-reporting. The type of technique used for sampling (convenience sampling) may result in under-representation or over-representation of the population. Additionally, there are chances of recall bias as the responses relied on individuals' memories about use of antibiotics in the past few months.

CONCLUSION

Self-medication with antibiotics is the leading cause of antibiotic resistance and is a problem of concern in the health sector all around the globe. Our study found that a significant number of individuals did not have adequate knowledge about antibiotics and hence, showed poor practices, attitudes, and adherence to antibiotic regimens. Improper information by healthcare professionals about the use of medications appeared as a major contributor to the irrational use of antibiotics. The use of educational video showed improvement in understanding and awareness of individuals about antibiotics. Regular airing of such educational videos may help combat the menace of antibiotic resistance. However, the significance of adapting such videos to meet the needs of various societal sectors cannot be overlooked.

Twitter Muhammad Osama Yaseen @Oyeosamayyy

Contributors All authors contributed to the study's conception and design. ArS was responsible for the overall content as the guarantor. Material preparation was done by MOY and ArS. Data collection and analysis were performed by ArS and AIS. The first draft of the manuscript was written by ArS, TMK and AB. All authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval This study involves human participants and ethical approval for this study was obtained from the Institutional Review Committee for Biomedical Research, University of Veterinary and Animal Sciences Lahore, Pakistan (No. 142/IRC/BMR). Participants gave informed consent to participate in the study before taking part.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data sharing not applicable as no datasets generated and/or analysed for this study. No data are available.

ORCID iDs

Arifa Saif http://orcid.org/0000-0002-6020-1037
Tahir Mehmood Khan http://orcid.org/0000-0003-0081-1957
Allah Bukhsh http://orcid.org/0000-0003-4285-0102
Muhammad Osama Yaseen http://orcid.org/0000-0003-2698-8830
Alia Saif http://orcid.org/0000-0002-9172-5802

REFERENCES

1 Prestinaci F, Pezzotti P, Pantosti A. Antimicrobial resistance: a global multifaceted phenomenon. *Pathog Glob Health* 2015;109:309–18.
2 Hofer U. The cost of antimicrobial resistance. *Nat Rev Microbiol* 2019;17:0125.
3 McEwen SA, Collignon PJ. Antimicrobial resistance: a one health perspective. In: *Antimicrobial Resistance in Bacteria from Livestock and Companion Animals*. 2018: 521–47.
4 Luepke KH, Mohr JF. The antibiotic pipeline: reviving research and development and speeding drugs to market. *Expert Rev Anti Infect Ther* 2017;15:425–33.
5 Alhomoud F, Aljamea Z, Almahasnah R, *et al*. Self-medication and self-prescription with antibiotics in the Middle East-do they really happen? A systematic review of the prevalence, possible reasons, and outcomes. *Int J Infect Dis* 2017;57:3–12.
6 Santa-Ana-Tellez Y, Mantel-Teeuwisse AK, Dreser A, *et al*. Impact of over-the-counter restrictions on antibiotic consumption in Brazil and Mexico. *PLoS One* 2013;8:e75550.
7 Lescure D, Paget J, Schellevis F, *et al*. Determinants of self-medication with antibiotics in European and Anglo-Saxon countries: a systematic review of the literature. *Front Public Health* 2018;6:370.
8 World Health Organization. Global action plan on antimicrobial resistance. 2015. Available: https://www.who.int/publications/i/item/9789241509763
9 Torres NF, Chibi B, Middleton LE, *et al*. Evidence of factors influencing self-medication with antibiotics in low and middle-income countries: a systematic scoping review. *Public Health* 2019;168:92–101.
10 WHO. Government of Pakistan, antimicrobial resistance national action plan Pakistan. In: *Ministry of National Health Services Regulations & Coordination, Editor*. 2017.
11 Akhund R, Jamshed F, Jaffry HA, *et al*. Knowledge and attitude of General Pakistani population towards antibiotic resistance. *Cureus* 2019;11:e4266.
12 Nazir S, Azim M. Assessment of antibiotic self-medication practice among public in the Northwestern region of Pakistan. *Eur J Hosp Pharm* 2017;24:200–3.
13 Haseeb A, Bilal M. Prevalence of using non prescribed medications in economically deprived rural population of Pakistan. *Arch Public Health* 2016;74:0113-9.
14 Saleem Z, Sono TM, Godman B. Concerns with current Drug Laws regarding the purchasing antibiotics without a prescription in Pakistan; ways forward to assist the national action plan. *Expert Review of Anti-Infective Therapy* 2023;21:1163–5.
15 Khan MS, Durrance-Bagale A, Mateus A, *et al*. What are the barriers to implementing national antimicrobial resistance action plans? A novel mixed-methods policy analysis in Pakistan. *Health Policy Plan* 2020;35:973–82.
16 Atif M, Asghar S, Mushtaq I, *et al*. What drives inappropriate use of antibiotics? A mixed methods study from Bahawalpur, Pakistan. *Infect Drug Resist* 2019;12:687–99.
17 Gillani AH, Chang J, Aslam F, *et al*. Public knowledge, attitude, and practice regarding antibiotics use in Punjab, Pakistan: a cross-sectional study. *Expert Rev Anti Infect Ther* 2021;19:399–411.
18 Niksadat N, Zavare MA-, Gohari MR, *et al*. Effectiveness of a health promotion intervention and education based on health belief model on improving the preventive behaviors of self-medication among women in Tehran, Iran. *In Review* [Preprint] 2021.
19 Dahodwala M, Geransar R, Babion J, *et al*. The impact of the use of video-based educational interventions on patient outcomes in hospital settings: a scoping review. *Patient Educ Couns* 2018;101:2116–24.
20 Herawati F, Yulia R, Arifin B, *et al*. Educational video improves knowledge about outpatients' usage of antibiotics in two public hospitals in Indonesia. *Antibiotics (Basel)* 2021;10:606.
21 Biswas M, Roy MN, Manik MIN, *et al*. Self medicated antibiotics in Bangladesh: a cross-sectional health survey conducted in the Rajshahi City. *BMC Public Health* 2014;14:847.
22 Widayati A, Suryawati S, de Crespigny C, *et al*. Knowledge and beliefs about antibiotics among people in Yogyakarta City Indonesia: a cross sectional population-based survey. *Antimicrob Resist Infect Control* 2012;1:38.
23 Dambrava PG, Torres A, Vallès X, *et al*. Adherence to guidelines' empirical antibiotic recommendations and community-acquired pneumonia outcome. *Eur Respir J* 2008;32:892–901.
24 Chan Y-H, Fan MM, Fok C-M, *et al*. Antibiotics nonadherence and knowledge in a community with the world's leading prevalence of antibiotics resistance: implications for public health intervention. *Am J Infect Control* 2012;40:113–7.

25 Wu J-R, Chung M, Lennie TA, *et al*. Testing the psychometric properties of the medication adherence scale in patients with heart failure. *Heart Lung* 2008;37:334–43.
26 Muñoz EB, Dorado MF, Guerrero JE, *et al*. The effect of an educational intervention to improve patient antibiotic adherence during dispensing in a community pharmacy. *Aten Primaria* 2014;46:367–75.
27 World Health Organization. Antibiotics - handle with care. 2017. Available: http://www.emro.who.int/world-antibiotic-awareness-week/2017/campaign-material.html
28 Hansen MB, Rasmussen IS, Marloth T, *et al*. A pre-post intervention study: knowledge among parents about child infections and antibiotic use facilitated by maternal and child health nurses. *Nurs Open* 2023;10:641–8.
29 Geta K, Kibret M. Knowledge, attitudes and practices of animal farm owners/workers on antibiotic use and resistance in Amhara region, north western Ethiopia. *Sci Rep* 2021;11:21211.
30 Health measurement scales: a practical guide to their development and use (5th edition). *Aust N Z J Public Health* 2016;40:294–5.
31 Kandeel A, Palms DL, Afifi S, *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(Suppl 3):498.
32 Rasosoft. Sample size calculator, Available: http://www.raosoft.com/samplesize.html
33 Bennadi D. Self-medication: a current challenge. *J Basic Clin Pharm* 2013;5:19–23.
34 Nepal A, Hendrie D, Robinson S, *et al*. Knowledge, attitudes and practices relating to antibiotic use among community members of the Rupandehi District in Nepal. *BMC Public Health* 2019;19:1558.
35 Cambaco O, Alonso Menendez Y, Kinsman J, *et al*. Community knowledge and practices regarding antibiotic use in rural Mozambique: where is the starting point for prevention of antibiotic resistance? *BMC Public Health* 2020;20:1183.
36 Lim KK, Teh CC. A cross sectional study of public knowledge and attitude towards antibiotics in Putrajaya, Malaysia. *South Med Rev* 2012;5:26–33.
37 Gillani AH, Ji W, Hussain W, *et al*. Antibiotic self-medication among non-medical university students in Punjab, Pakistan: a cross-sectional survey. *Int J Environ Res Public Health* 2017;14:1152.
38 Yousaf MA, Zahid H, Khalid Z, *et al*. Knowledge, attitude and practices of university students towards antibiotic use and resistance: questionnaire based assessment. *BioSci Rev* 2021;3:63–82.
39 El-Hawy RM, Ashmawy MI, Kamal MM, *et al*. Studying the knowledge, attitude and practice of antibiotic misuse among Alexandria population. *Eur J Hosp Pharm* 2017;24:349–54.
40 Aslam A, Zin CS, Jamshed S, *et al*. Self-medication with antibiotics: prevalence, practices and related factors among the Pakistani public. *Antibiotics (Basel)* 2022;11:795.
41 Sachdev C, Anjankar A, Agrawal J. Self-medication with antibiotics: an element increasing Resistance. *Cureus* 2022;14:e30844.
42 Bagnulo A, Muñoz Sastre M-T, Kpanake L, *et al*. Why patients want to take or refuse to take antibiotics: an inventory of motives. *BMC Public Health* 2019;19:441.
43 Davis ME, Liu T-L, Taylor YJ, *et al*. Exploring patient awareness and perceptions of the appropriate use of antibiotics: a mixed-methods study. *Antibiotics (Basel)* 2017;6:23.
44 Khan MM, Ijaz R, Khan MA. Compliance and adherence to short course of antibiotics in children and factors affecting the compliance. 2017;93:4.
45 Endashaw Hareru H, Sisay D, Kassaw C, *et al*. Antibiotics non-adherence and its associated factors among households in southern Ethiopia. *SAGE Open Med* 2022;10:20503121221090472.
46 Almomani BA, Hijazi BM, Awwad O, *et al*. Prevalence and predictors of non-adherence to short-term antibiotics: a population-based survey. *PLoS One* 2022;17:e0268285.
47 Jimmy B, Jose J. Patient medication adherence: measures in daily practice. *Oman Med J* 2011;26:155–9.
48 Ratna H. The Importance of effective communication in healthcare practice. *HPHR* 2019;23:1–6.
49 Snidal SJ, Barnard G, Atuhairwe E, *et al*. Use of eCompliance, an innovative biometric system for monitoring of tuberculosis treatment in rural Uganda. *Am J Trop Med Hyg* 2015;92:1271–9.
50 Patel DV, Acharya UK, Shinde MK, *et al*. Compliance to antibiotic therapy at paediatric out-patient clinic. *J Family Med Prim Care* 2022;11:1012–8.
51 Brinker DL Jr, Foley KA, Zhou Y, *et al*. Use of a smartphone medication reminder application to support emerging adult adherence to non-antibiotic treatment for viral upper respiratory tract infection. *J Prim Care Community Health* 2022;13:21501319221129732.
52 Axtell S, Haines S, Fairclough J. Effectiveness of various methods of teaching proper inhaler technique:the importance of pharmacist counseling. 2017;30:195–201.
53 Salimi NT, Ezbarami ZT, Tabari-Khomeiran R, *et al*. Comparing the effects of mobile-based education and booklet-based education on Iranian mothers' perception on antibiotics: a quasi-experimental study. *J Pediatr Nurs* 2021;61:S0882-5963(21)00156-1:122–9.:.
54 Nepal P, Subedee A, Shakya H, *et al*. Protocol for a randomized controlled trial on community education and surveillance on antibiotics use among young children in Nepal. *Contemp Clin Trials Commun* 2023;34:101177.
55 Schnellinger M, Finkelstein M, Thygeson MV, *et al*. Animated video vs pamphlet: comparing the success of educating parents about proper antibiotic use. *Pediatrics* 2010;125:990–6.
56 Goggin K, Hurley EA, Bradley-Ewing A, *et al*. Reductions in parent interest in receiving antibiotics following a 90-second video intervention in outpatient pediatric clinics. *J Pediatr* 2020;225:138–45.
57 van Rijn M, Haverkate M, Achterberg P, *et al*. The public uptake of information about antibiotic resistance in the Netherlands. *Public Underst Sci* 2019;28:486–503.
58 Chokshi A, Sifri Z, Cennimo D, *et al*. Global contributors to antibiotic resistance. *J Glob Infect Dis* 2019;11:36–42.