Original Article

Assessment of Antibiotics Adherence and Investigating the Targeted Interventions to Dwindle the Antibiotics Nonadherence

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Abstract

Introduction: Antibiotic resistance is a pressing global health concern, exacerbated by antibiotic nonadherence and misuse. Understanding the knowledge, attitude, and practice (KAP) regarding antibiotics among the general population is crucial for effective interventions. This study aims to assess antibiotic adherence behavior among adults in the Chennai population and validate potential interventions to improve adherence. **Materials and Methods:** This cross-sectional study was conducted in and around Thoraipakkam, Chennai, over 6 months. Data were collected using a specially designed form covering demographics, medication adherence, KAP related to antibiotics. Statistical analysis was performed using SPSS version 23. **Results:** Among 250 participants, the majority (64%) was nonadherent to antibiotics, with significant associations found between adherence and gender, education, and medication purchase practices. Knowledge scores indicated that 39% had good knowledge of antibiotic use. Attitudes were varied, with 56% holding positive attitudes toward antibiotics. Practices also varied, with 52% exhibiting good antibiotic use practices. Validation of potential interventions showed high acceptance rates among participants, indicating the effectiveness of targeted interventions in improving adherence. **Conclusion:** This study highlights the prevalence of antibiotic nonadherence and identifies factors associated with it among adults in Chennai. It underscores the importance of targeted interventions to improve adherence and mitigate antibiotic resistance.

Keywords: Antibiotic resistance, antibiotics, intervention, nonadherence

Introduction

Antibiotics are substances that specifically target bacteria with the goal of treating and preventing bacterial illnesses. These are typical agents seen in contemporary medicine. It did not always go like this. People have been looking for ways to cure illnesses since ancient times. Dyes, molds, and even heavy metals were considered to have therapeutic potential.[1] Numerous microorganisms, such as bacteria, viruses, fungi, and parasites, are important in medicine. At the time of their introduction, antibiotics were considered "wonder drugs" because the only treatments for serious bacterial infections were surgical drainage or natural healing. The golden age of discovering new antibiotic classes was undoubtedly the 1950s to 1970s; no new classes have been found subsequently.[2]

Although antibiotics cure many kinds of infections and save millions of people around the world, it has significant side effects, such as the development of resistance to antibiotics in environmental and human microbes. Several bacterial groups are showing signs of resistance to these antibiotics through a variety of mechanisms, possibly as a result of their irrational use.[3] It is still possible to treat the majority of bacterial infections today with readily accessible antibiotics, either by itself or in combination, however, a rising number of clinical failures with the current arsenal is to be expected. In some circumstances, minimizing the establishment of resistance may be possible through optimizing therapeutic dose and duration.[4]

The focus of current outpatient stewardship initiatives is on directing healthcare providers in safe antibiotic prescribing practices; however, little is known regarding patients' knowledge

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of antibiotics and how to properly dispose of unused medicines.[5] According to the World Health Organization (WHO), the causes of antibiotic resistance are overexploitation, misuse of antibiotics, and inadequate infection control which is the primary cause of death and burden in low-resource countries.[6,7] Antibiotic resistance was ranked by the WHO as among the 10 greatest hazards to world health. According to the 2022 global antimicrobial resistance (AMR) and Use Surveillance System report, the rates of resistance to common bacterial illnesses are concerning. The fact that 35% of methicillin-resistant *Staphylococcus aureus* cases and 42% of third-generation cephalosporin-resistant *Escherichia coli* cases are documented in 76 countries is highly alarming.[8] An estimated 1.27 million deaths globally in 2022 were directly attributable to bacterial AMR, accounting for 4.95 million deaths overall. AMR not only causes death and disability but also has significant financial ramifications. World Bank estimates suggest that by 2050, healthcare costs might rise by US$ 1 trillion, and by 2030, gross domestic product (GDP) losses could range from US$ 1 trillion to US$ 3.4 trillion annually.[9]

Antibiotics may become less effective in the near future due to improper and careless usage combined with the death of novel therapeutic options. One of the many steps needed to stop AMR is proper adherence to antibiotic medication.[10] Medication adherence frequently refers to a patient's capacity to take prescribed medications on time and according to instructions. Due to the complexity of AMR, a multidisciplinary, multisectoral approach is necessary. A One Health strategy is necessary to bring together sectors and stakeholders involved in food and feed production, the environment, and the health of people, animals, and plants because AMR has caused in many different areas.[11,12]

Adherence to antibiotics has been a significant concern over time, as it greatly affects the overall outcomes of treatment. Nonadherence to antibiotic regimens contributes to the emergence of AMR, leading to detrimental health outcomes.[13] The primary factors for noncompliance with antibiotic therapy were lack of knowledge and social support, low education status, poor attitude, adverse effects of drugs, and so on. Hence, the present study was conducted to assess the antibiotic adherence behavior of the general population to evaluate their knowledge, attitude, and practice (KAP) of antibiotic use. In addition, the potential barriers that lead to antibiotic nonadherence were assessed and identified the possible methods to overcome those barriers.

Materials and Methods

Study design

This cross-sectional study was conducted over 6 months (August 2023–January 2024) in and around Thoraipakkam (Chennai). The study protocol was approved by the Institutional Human Ethics Committee (Ethical Clearance No.: IEC/2023/017) and the research was performed in conformance with the Helsinki Declaration. Written informed consent was obtained from all participants before they were included in the study. The STROBE guideline has been followed for this study design, and the flow chart is shown in Figure 1.

Study population

This study included the general population aged 18 and above of either gender those residing in Chennai and excluded subjects who had medical and paramedical qualifications and who were not willing to participate in the study.

Sample size calculation

The sample size was estimated using the $n = Z^2P\ (1 - P)/d^2$ formula, resulting in a sample size of 250. Based on a pilot study, the standard normal variate (Z) at 5% is 1.96, the estimated population proportion (P) is 0.205, and the absolute error (d) is 5%.

Data collection and study procedure

Data were collected through direct interviews using a data collection form. This form contains demographic details and questions to assess the medication adherence behavior, KAP of antibiotics and validate interventions to minimize antibiotic nonadherence. The medication adherence assessment questions are given as the

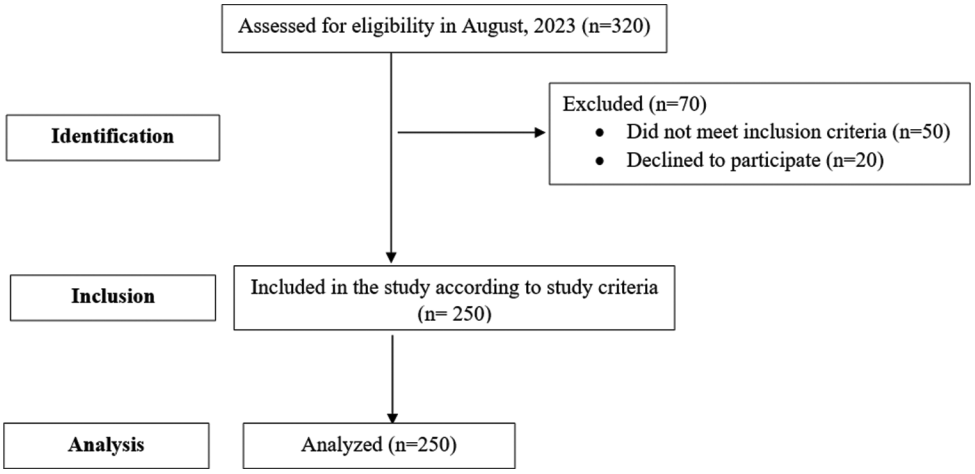

Figure 1: STROBE flow chart

close-ended questions. The knowledge assessment consists of 6 yes/no questions. The attitude assessment consists of 5 Likert scale questions. The practice section consists of 4 Likert scale questions. In the knowledge section, subjects who scored below 3 were considered poor knowledge, 3 were considered average knowledge, and more than 3 were considered good knowledge. In the attitude and practice sections, the score of 1–2 were considered as negative attitude/bad practice, 3 was neutral or no opinion/sometimes bad, and 4–5 were positive attitude/good practice.

Development and validation of the questionnaire

The questionnaire was formulated by referring to various primary, secondary, and tertiary resources of information. Following its creation, it was cross-verified by the research advisor and subjected to content validation by a team of experts from the Department of Pharmacy for critical appraisal and inputs. Minor revisions were made to the questionnaire in response to their comments. A pilot study was carried out to validate the questionnaire. Internal consistency and reliability were assessed using Cronbach's α coefficient. A coefficient of 0.8 was obtained.

Statistical analysis

The collected data were analyzed using SPSS version 23 (SPSS Inc., Chicago, IL, USA). Demographic variables and responses to the KAP questions were presented using descriptive statistics. A Chi-square test and Pearson's correlation coefficient were used to find out the significance and association. A $P < 0.05$ was considered statistically significant at a 5% level of significance to the confidence interval of 95%.

Results

A total of 250 subjects were included in this study. The mean age of the study participants was 22.5 ± 4.5 years. Majority of the subjects (84%) fall under the age interval of 18–27 years. The demographic details are shown in Table 1.

Antibiotics adherence

Our study results showed that among the study participants, 64% were found to be nonadherent to antibiotics. Table 2 exhibits the antibiotic adherence behavior of the study population. The association of demographic variables with adherence behavior is shown in Table 3. A statistically significant difference was found in the adherence based on gender alone ($P < 0.05$). Figure 2 represents the factors associated with nonadherence.

Table 1: Demographic details

Variable	*n* (%)
Age (years)	
18–27	210 (84)
28–37	18 (7)
>37	22 (9)
Gender	
Male	120 (48)
Female	130 (52)
Education	
Illiterate	2 (1)
SSLC/HSC	90 (36)
Degree	158 (63)
Socioeconomic status	
Lower	17 (7)
Middle	213 (85)
Upper	20 (8)

Knowledge, attitude, and practice of antibiotics

Table 4 represents the responses of the study population to KAP questions on antibiotics. The mean scores of KAP were 3.37 ± 1.79, 3.68 ± 1.18, and 3.20 ± 1.01. A notable significant correlation was observed at the 0.01 level between the score of knowledge and attitude ($r = 0.482$**), knowledge and practice ($r = 0.709$**), and attitude and practice ($r = 0.619$**), as shown in Figures 3–5.

Validation of interventions to minimize nonadherence

Response to the targeted interventions is shown in Table 5. Study population have shown more positive responses to the interventions to improve their adherence behavior.

Discussion

This is the first study to assess antibiotic adherence behavior as well as to evaluate the factors associated with antibiotic nonadherence in the general population. In this study, the

Table 2: Antibiotics adherence

Question	Response		*P*
	Yes, *n* (%)	No, *n* (%)	
Do you complete the whole course of medication prescribed for fever by the doctor?	90 (36)	160 (64)	<0.0001
Do you buy the whole course of medications prescribed by the physician?	143 (57)	107 (43)	

Table 3: Association of demographic variables with adherence behavior

Variable	Adherence		*P*
	Yes	No	
Age			
18–27	79	131	0.1887
28–37	7	11	
>37	4	18	
Gender			
Male	34	86	0.0177*
Female	56	74	
Education			
Illiterate	0	2	0.4611
SSLC/HSC	35	55	
Degree	55	103	
Socioeconomic status			
Lower	7	10	0.3370
Middle	73	140	
Upper	10	10	

*P value is less than 0.05

overall prevalence of antibiotic drug nonadherence was found to be 64%. Respondent's sex status was found to have a statistically significant association with the adherence. The overall prevalence of drug nonadherence was found to be 67.3%. The study findings are consistent with a study done in Bangladesh (50%),[14] India (69%),[15] Lisbon, and Portugal (57.7%).[16] Females are likely to be more antibiotic adherent, this finding is also consistent with the study in Ethiopia.[17] The most important finding of this study is that the people who are not completing their medication do not buy the whole course of medicine. Only 56% of people buy their complete course of antibiotics, this indicates the level of nonadherence starts with attitude in buying medication itself.

Table 4: Knowledge, attitude, and practice of antibiotics

Variable	*n* (%)
Knowledge	
Average	60 (24)
Good	98 (39)
Poor	92 (37)
Attitude	
Negative	67 (27)
Neutral	44 (18)
Positive	139 (56)
Practice	
Bad	48 (19)
Good	129 (52)
Sometimes bad	73 (29)

While assessing the KAP of antibiotics, 37% of participants have poor knowledge and around 63% have appropriate knowledge (24%-average and 39% good knowledge) of antibiotic use. Females have more knowledge about antibiotic use than males which correlates with studies in Nepal.[16] In our study, 78% of participants know about the antibiotics and 57% of people can identify the antibiotics correctly. This attitude will develop into practice with increased support from over-the-counter (OTC) sales of antibiotics. Our study

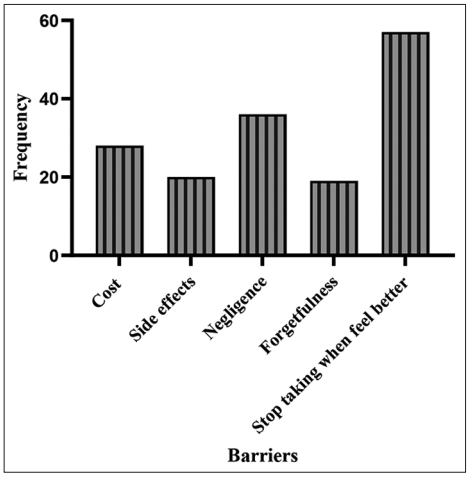

Figure 2: Barries to antibiotics adherence

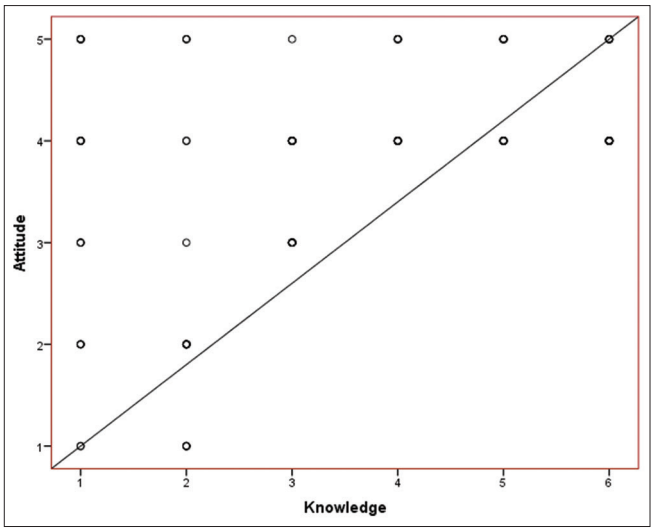

Figure 3: Association of knowledge with attitude

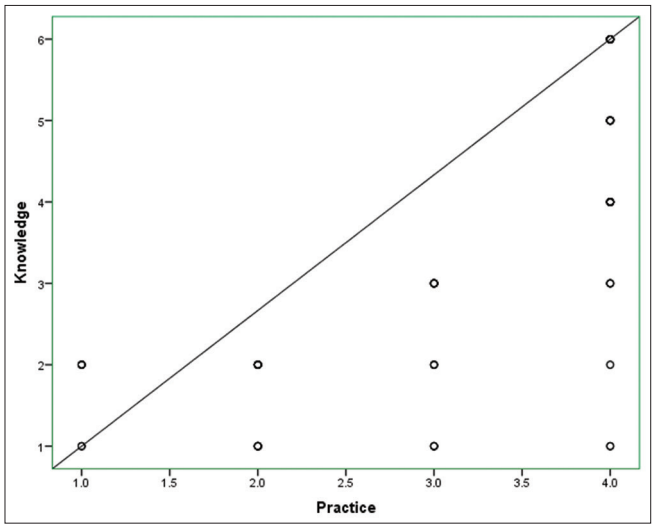

Figure 4: Association of knowledge with practice

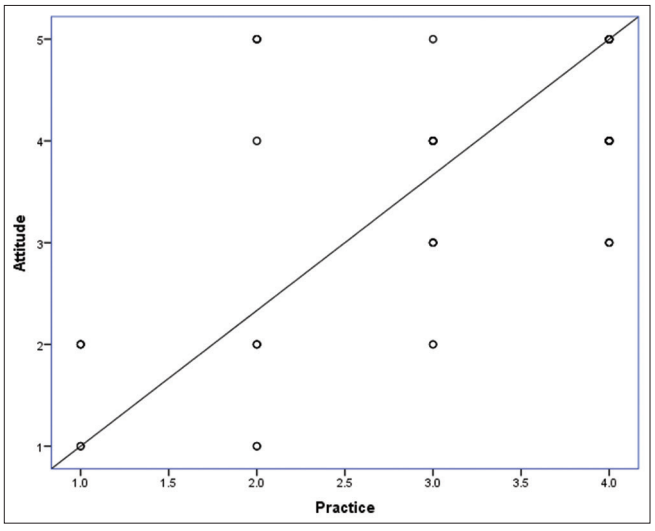

Figure 5: Association of attitude with practice

Table 5: Response to interventions

Targeted intervention	Definitely, *n* (%)	Probably, *n* (%)	Possibly, *n* (%)	Probably not, *n* (%)	Definitely not, *n* (%)
If the information about the importance of antibiotics is printed on the medication cover, will you be more adherent to the medication?	110 (44)	75 (30)	38 (15)	20 (8)	7 (3)
If you know that side effects are not experienced by everyone. Will your misconception about side effects change?	80 (32)	83 (33)	40 (16)	32 (13)	15 (6)
If your medications are given in highlighted attractive colors, will your chance of forgetting to take them decrease?	85 (34)	48 (19)	55 (22)	45 (18)	17 (7)
If the medication cost is reduced by 5–10 times by purchasing generic medicines, will you complete the full course of the treatment regimen?	105 (42)	48 (19)	32 (13)	43 (17)	22 (9)
Will you adhere to the regimen if any reminder is set in mobile phone for taking the drug?	115 (46)	63 (25)	22 (9)	20 (8)	30 (12)

found that in addition to inappropriate attitude regarding the use of antibiotics, 20% of people do not like antibiotics, and 27% of participants believe that their immunity itself cure infection without antibiotics which is similar to the findings Fernandes *et al*.[17] According to our study, common factors that contribute to the inappropriate of antibiotics is people's lack of knowledge and attitude that antibiotics can cure a common cold and flu and support of this attitude by OTC sale of antibiotic in pharmacy, although more than half of participant know the importance of completing antibiotics and have a good attitude. The most common sources of self-medication of antibiotics are the OTC sale of antibiotics in community pharmacies and leftover antibiotics. Similar to a study by Shet *et al*. on the pharmacy-based dispensing of antimicrobial agents without a prescription in India, we found that amoxicillin and azithromycin are the most common antibiotics sold OTC. She reported that amoxicillin (51.2%) and azithromycin (51.2%) were the most common antimicrobial drugs dispensed by the pharmacist.[18,19]

According to our study, over half of the participants do not take their antibiotics as prescribed. This might result in bacterial resistance, re-infection, and therapeutic failure.[20] We developed some novel methods to improve antibiotic adherence based on the Indian environment and affordability factors. Overall, 88% of participants reported that the implementation of this method would change their practice. Oral patient counseling barriers can be overcome by information leaflets, or patient information sheets containing images and information in regional language for easy understanding of patients, and also counsel the general population by keeping banners regarding the rational use of antibiotics.

Although forgetfulness of medicine is less chance of nonadherence, 76% of participant agrees that when medication is cover in highlighted form the chance of forgetting will be less. Seventy-four percent of people accept that generic medicine will improve adherence due to reduced cost, this implies physicians have to prescribe bioequivalent generic formulations. If the medicine is prescribed according to the patient's lifestyle will improve adherence of 82.7% of participants, this section makes a stand for future research and should focus on formulating sustained-release antibiotics.

Our study found that the implementation of an effective and targeted intervention will improve antibiotic adherence and step toward appropriate antibiotic use and eliminate antibiotic resistance. The limitation of the study is unable to develop the intervention for some inappropriate antibiotic practices such as OTC use and saving remaining antibiotics for later use, this can be solved by developing strict regulations on antibiotic use and policies for returning unused medication at the community pharmacy level.

Conclusion

This research represents a significant milestone in enhancing the comprehension of antibiotic adherence and the assessment of KAPs on antibiotic use. This study discovered that by implementing the interventional strategies, antibiotic nonadherence can be reduced. Furthermore, our study findings can serve as a starting point for upcoming research projects concentrating on the establishment of hospital inventories comprising generic medications, and innovation in antibiotic packaging. Our discoveries hold significance for future endeavors. It is essential for upcoming research initiatives to address prevailing issues in antibiotic utilization, such as preserving the remaining antibiotics for later use, OTC acquisition of antibiotics, and the implementation of awareness campaigns to enhance rational antibiotic usage among the general public.

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Conflicts of interest

There are no conflicts of interest.

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