



## KAP ASSESSMENT REGARDING ANTIFUNGAL RESISTANCE AND ANTIFUNGAL STEWARDSHIP AMONG MEDICAL UNDERGRADUATES: A CROSS-SECTIONAL QUESTIONNAIRE-BASED SURVEY

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### ABSTRACT

**Introduction:** As the antifungal resistance has taken a massive proportion in the present date, Antifungal resistance is increasing due to irrational prescribing, over-the-counter use, and lack of awareness, leading to reduced drug effectiveness. There is a need for antifungal stewardship; however, limited information is available on the knowledge, attitudes, and practices of health sciences students regarding antimicrobial resistance.

**Methods:** A cross-sectional survey was distributed to 1000 health sciences students, of which 752 completed the questionnaire and were included in the analysis.

**Results:** Out of all respondents, 80.3% had good knowledge, 82.4% showed favorable attitudes, and 67.95% demonstrated good practices. Knowledge and attitudes improved significantly with the year of study ( $p < 0.001$ ), and practices also showed a significant association ( $p = 0.032$ ). Female students had higher knowledge but lower practice levels. Urban residence was linked to better preventive practices but lower knowledge and attitudes.

**Conclusion:** Students showed good levels of knowledge and favorable attitudes toward antifungal resistance and stewardship, yet their practices were not always appropriate. Variations across gender, residence, and academic year underline the importance of early stewardship education, improved awareness, and stronger regulation of antifungal use to reduce resistance risks.

**Keywords:** Antifungal Resistance (AFR), Antifungal Stewardship (AFS), Antimicrobial Resistance (AMR).



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### INTRODUCTION

Antimicrobial resistance (AMR) is considered one of the most serious health problems of the twenty-first century. When a bacterium, virus, fungus or parasite changes in such a way that the medicine we are using to kill them, no longer works [1]. The

antifungal resistance (AFR) is gaining increasing attention among the different form of AMR. Fungal infections receive only a fraction of the attention and funding of bacterial diseases, yet cause millions of serious disease cases and deaths each year [2, 3]. The increasing prevalence of these resistant species of fungal infections adversely affects the outcomes for patients and causes extra economic burden to an already overwhelmed health system- in low- and middle-income countries [4].

A wide array of individuals experience fungal diseases, including superficial infections such as dermatophytes, oral thrush as well as invasive and life-threatening infections. The last one is especially dangerous to people with weak immunity like patients receiving chemotherapy, an organ transplant, prolonged use of corticosteroids or HIV/AIDS patients [5, 6]. When diagnosis and treatment are delayed, there is significant morbidity and mortality in these groups due to invasive infections [7]. Fungal infections, however, are still under recognised in global health strategies. More often than not, bacterial and viral infections receive the most focus historically [8].

The restricted choice of diagnostic and therapeutic options is one of the major barriers in treating fungal infections. Clinical presentation is often confused with one another, resulting in misdiagnosis and late treatment [9]. Due to the similarity in the general cellular structure and function of yeast and human cells, the antifungal drugs are limited and only a few classes of drugs available [10]. Resistance is alarmingly reported against important antifungal like *Candida auris* and azole resistant *Aspergillus* which have been reported as the major cause of hospital outbreaks [11,12] The aforementioned factors are also responsible for those diseases: Over-the-counter use of antifungals, irrational prescribing, poor adherence to therapy, and extensive use of agricultural fungicides having a chemical similarity to clinical antifungals [13, 14].

In India, the burden of fungal infections is substantial with estimates suggesting that annually greater than 57 million people harboured serious fungal diseases [15]. The spectrum comprises not only superficial infections like dermatophyte infections, but also invasive infections, including candidemia and aspergillosis, which have high morbidity and mortality [15, 16]. Resistance first-line antifungal agents have been increasingly reported. Studies indicate that almost 50% of the non-albicans *Candida* isolates and more than 20% of the *Candida albicans* isolates are resistant to the azoles, especially fluconazole [16].

The Eastern India data provide fresh evidence of rising resistance to amphotericin B, as well as an increasing predominance of non-albicans *Candida*

species. This strongly emphasises the need for a national plan for surveillance along with enhanced diagnostic infrastructure and stewardship programs relevant to India [17].

Antifungal resistance (AFR) is not just a problem for the individual patient as it poses risks to public health. The emergence of resistant fungal pathogens can take place in the healthcare setting and the community that is not easy to contain an outbreak [18]. The application of antifungal agents in agriculture also promotes the development and spread of resistant strains [19]. Furthermore, it is expected that climate change will alter environmental conditions leading to the spatial expansion of disease causing fungi and hence a growing human exposure to them [20]. The complexity and severity of the challenges presented calls for targeted integrated interventions including better diagnostics, rational antifungal use, public health messaging and systematic antifungal stewardship policy implementation. If such measures are not implemented, Africa can considerably hinder progress related to infectious diseases and pose a serious global public health threat [21, 22].

## MATERIALS AND METHODS

**Study Design and Participants:** This cross-sectional study was conducted among undergraduate health science students to evaluate their knowledge, attitudes, and practices (KAP) regarding antifungal resistance and antifungal stewardship. A total of 752 students consented and participated. All of whom consented and participated.

**Data Collection:** For the study, data were collected using a well-structured questionnaire adopted from previously published literature assessing knowledge, attitude and practice of antifungal resistance and stewardship [23]. The instrument was categorized into three segments. The section that tests Knowledge included, in this case, ten items testing knowledge of antifungal medicines, resistance mechanisms, diagnostic requirements and treatment adherence. The attitude section included ten items that evaluated views on stewardship programmes, adequacy of training and preventive measures. Covered in the practice section were ten items addressing actual behaviors like use of guidelines, participation in an awareness initiative, self-medication or recommendation informally. Responses were given using multiple-choice, and a scoring construct was framed for categorizing the results as good/poor for the three domains. Before the main survey, the questionnaire was pre-tested with twenty students to check for clarity and cultural appropriateness. Minor

modifications were done based on their feedback. According to the study, all the domains' Cronbach's alpha value is greater than 0.70 which explains the reliability of the instrument. Students filled the questionnaires individually in supervised settings to minimize peer influence.

**Study Measures:** The main outcomes of this study that were assessed included knowledge, attitudes, and practices regarding both antifungal resistance and antifungal stewardship, all of which fell under good and poor. The answers to the knowledge section were coded one for correct and zero for incorrect or "don't know" replies for the analysis. Attitude and practice items were given codes in a similar binary fashion. Those with favourable choices were given one and those with unfavourable choices were assigned zero. Subsequently, composite scores were calculated for each domain through summation. Those participants who scored was classified as good if their score was  $\geq 80\%$  and it was coded as 1. Those scoring  $< 80\%$  was classified as poor and it was coded as 0. The aforementioned system provided a standard measurement of KAP in the study population.

**Ethics:** The study was conducted following approval from the Institutional Ethics Committee.

**Statistical Analysis:** The Statistical Package for Social Science (SPSS) was used for data analysis. The first application of descriptive statistics was to describe participants' socio demographic profiles as well as distributions of knowledge, attitude, and practice (KAP) levels on antifungal resistance and stewardship. The normality of quantitative variables was assessed using Kolmogorov-Smirnov test. All variables with their p-value  $< 0.05$  were considered non-normal. As a result of the distributional assumptions of the data was violated the Kruskal-Wallis test was used for multiple comparisons across groups. The Chi-square test was used to examine the relationships between various KAP levels and demographic characteristics. A p-value test with a two-sided  $< 0.05$  was noted to be significant. AOR and 95% CI were derived from univariate and multivariate logistic regression analyses of factors associated with KAP outcomes. Skewed variables were appropriately transformed to satisfy the assumptions of logistic regression.

## RESULTS

**Characteristics of Study Participants:** The total number of student involved in the study was 752. Most of them were age between 18 to 25 years (86.7 %), aged 26 -33 years was in 12.8 % and only

0.5 percent were older than 33 years. The sample consisted of 61.2 percent male students and 38.8 percent female students. Just over half of the subjects came from urban backgrounds (52.7 %), with the balance being from rural backgrounds (47.3 %). As illustrated in table1, the highest number of students involved in this study was second year (66.0 %), followed by third year (23.4 %), fourth year (7.4 %), and finally, first year with only (3.2 %). (Table 1)

Table 1: Socio Demographic Characteristics of Participants

		Frequency	(%) Percentage
<b>Total</b>		<b>752</b>	
<b>Age (years)</b>	<b>18-25</b>	652	86.7
	<b>26-33</b>	96	12.8
	<b>&gt;33</b>	4	0.5
<b>Sex</b>	<b>Male</b>	460	61.2
	<b>Female</b>	292	38.8
<b>Residence</b>	<b>Rural</b>	356	47.3
	<b>Urban</b>	396	52.7
<b>Year of study</b>	<b>First</b>	24	3.2
	<b>Second</b>	496	66.0
	<b>Third</b>	176	23.4
	<b>Fourth</b>	56	7.4

**Knowledge, Attitude, and Practice (KAP) Towards Antifungals and Antifungal Resistance:** As shown in Table 2, in a present study, most of the participants showed satisfactory knowledge, attitude, and practices towards antifungal agents and resistance. In general, 80.32% of the students had good knowledge, 82.45% had good attitudes, and 67.95% had good practices. The results of the analysis show that there was a strong academic progression effect in the knowledge of the students as it was found that the first year students had 58.3% good knowledge which increased to 85.48% in second year students, to 63.64% in third year students and to 96.43% in fourth year students ( $p < 0.001$ ). Similar trends were seen in the attitudes of first-year students. Indeed, 62.5% of the first-year students had a positive attitude compared to 84.7% in the second year, 80.1% in the third year and 78.6% in the fourth year.  $p < 0.001$ . Correspondingly, practices experienced an improvement from 54.2% in the first year to 66.1% in the second year, 75.0% in the third year, and 67.9% in the fourth year ( $p = 0.032$ ). In-depth evaluation of the knowledge responses revealed that most students were aware of the antifungal resistance concept. 93.6% of the

Table 2: Association of Knowledge, Attitude, and Practice (KAP) Levels with Year of Study among the Study Population

		Years of Study				Total	Chi Square	P Value
		First (n=24)	Second (n=496)	Third (n=176)	Fourth (n=56)			
Knowledge	Poor	10 (41.7%)	72 (14.52%)	64 (36.36%)	2 (3.57%)	148 (19.68%)	67.03	<0.001
	Good	14 (58.3%)	424 (85.48%)	112 (63.64%)	54 (96.43%)	604 (80.32%)		
Attitude	Poor	9 (37.5%)	75 (15.12%)	34 (19.32%)	12 (21.4%)	132 (17.55%)	20.035	<0.001
	Good	15 (62.5%)	421 (84.88%)	142 (80.68%)	44 (78.6%)	620 (82.45%)		
Practice	Poor	11 (45.8%)	169 (34.11%)	44 (25.00%)	18 (32.1%)	241 (32.05%)	8.811	0.032
	Good	13 (54.2%)	327 (65.89%)	132 (75.00%)	38 (67.9%)	511 (67.95%)		

Chi square test,  $p < 0.05$  (Significant)

students correctly identified it as less effective treatment against fungi.

Similarly, 94.7% identified misuse of antifungals as a cause of resistance and stress the completion of all courses. It can be seen from Table 3 that there were some persistent misconceptions. For instance, 17.6% responded that diagnostic tests are not really necessary; while 8.5% erroneously thinks that resistance is only in bacteria.

It was encouraging regarding antifungal stewardship. Almost all respondents (96.3%) agree that stewardship initiatives should be implemented, while 96.8% agreed that the rational use of antifungals is an important component of patient safety and treatment outcomes. Nonetheless, a gap

in professional preparedness was observed with only 21.3% of participants picking that their current training equips them sufficiently to deal with resistance to antifungals in practice (Table 3).

According to practices, learners reported much good behaviour. A large proportion of them sought further training (81.9%), attended awareness programs (68.6%) and regularly used updated clinical guidelines (70.2%). Nonetheless, there were unsafe practices as well. Approximately one-fifth (20.7%) reportedly bought antifungals without prescriptions while 13.8% stated recommending these medicines to others. This highlights the need for more educational interventions in these areas (Table 3).

Table (3.1): Students' Knowledge Regarding Antifungal Resistance

	Yes (n %)	No (n %)	Don't know (n %)
<b>Knowledge statements</b>			
Antifungal resistance is a phenomenon where fungi become less responsive to antifungal medications	704 (93.6%)	28 (3.7%)	20 (2.7%)
Fluconazole, amphotericin B, and itraconazole are examples of common antifungal medications	720 (95.7%)	16 (2.1%)	16 (2.1%)
Misuse or overuse of antifungal medications contributes to the development of antifungal resistance	712 (94.7%)	28 (3.7%)	12 (1.6%)
Antifungal resistance could lead to prolonged illnesses and higher mortality rates	624 (83%)	76 (10.1%)	52 (6.9%)
Only bacterial infections can develop resistance; fungal infections cannot.	64 (8.5%)	648 (86.2%)	40 (5.3%)
It is important to complete the full course of prescribed antifungal treatment, even if symptoms improve earlier.	712 (94.7%)	16 (2.1%)	24 (3.2%)
Antifungal stewardship programs aim to improve the use of these drugs	712 (94.7%)	24 (3.2%)	16 (2.1%)
Over-the-counter antifungal medications cannot lead to antifungal resistance.	140 (8.6%)	540 (71.8%)	72 (9.6%)
Patient adherence to the prescribed antifungal regimen is crucial	700	20	32

for effective treatment.	(93.1%)	(2.7%)	(4.3%)
Regular diagnostics are not necessary when prescribing antifungal treatment.	132 (17.6%)	576 (76.6%)	44 (5.9%)

Table (3.2): Students' Attitudes, Regarding Antifungal Resistance

	Yes (n %)	No (n %)	Don't know (n %)
<b>Attitude statements</b>			
Antifungal resistance is a significant public health concern.	652 (86.7%)	56 (7.4%)	44 (5.9%)
The current training and education about the proper use of antifungals and antimicrobial resistance are sufficient	160 (21.3%)	536 (71.3%)	56 (7.1%)
It is okay to prescribe antifungal medication even without a confirmed fungal infection	64 (8.5%)	676 (89.9%)	12 (1.6%)
All healthcare students should participate in antifungal stewardship programs.	724 (96.3%)	16 (2.1%)	12 (1.6%)
Patient non-compliance to antifungal medicines contributes to the occurrence of antifungal resistance.	600 (79.8%)	72 (9.6%)	80 (10.6%)
Overuse or misuse of antifungal medications in healthcare practices is a public health concern	704 (93.6%)	32 (4.3%)	16 (2.1%)
The proper use of antifungal medicines is a critical part of effective patient care.	728 (96.8%)	8 (1.1%)	16 (2.1%)
It is necessary to discuss antifungal resistance and its implications with patients.	700 (93.1%)	24 (3.2%)	28 (3.7%)
I believe that more research is needed in the field of antifungal resistance.	720 (95.7%)	0 (0.0%)	32 (4.3%)
Preventive measures, such as infection control and prophylaxis are important in managing antifungal resistance.	700 (93.1%)	16 (2.1%)	36 (4.8%)

Table (3.3): Students' Practices (KAP) Regarding Antifungal Resistance

	Yes (n %)	No (n %)	Don't know (n %)
<b>Practice statements</b>			
I bought antifungal medicines without a prescription.	156 (20.7%)	584 (77.7%)	12 (1.6%)
When my family/friend is sick, I recommend buying antifungals.	104 (13.8%)	616 (81.9%)	32 (4.3%)
I use antifungals because of advice from friends and family	124 (16.5%)	608 (8.9)	20 (2.7%)
I use antifungals when I have a urinary tract infection.	124(16.5%)	600(79.8 %)	28(3.7%)
I use antifungal medicines when I have a cold.	48 (6.4%)	696 (92.6%)	8 (1.1%)
I seek additional education or training on antifungal medications and resistance.	616 (81.9%)	100 (13.3%)	36 (4.8%)
Prescribing physicians and students are the only professionals who need to understand antifungal stewardship.	236 (31.4%)	500 (66.5%)	16 (2.1%)
I participate in antifungal stewardship and awareness programs.	516 (68.6%)	212 (28.2%)	24 (3.2%)
I keep myself updated about the latest research and guidelines regarding antifungal medications and antimicrobial resistance.	528 (70.2%)	176 (23.4%)	48 (6.4%)
Formal teaching on the proper usage of antifungals among healthcare students is an intervention that may minimize the phenomena of antifungal resistance.	696 (92.5%)	20 (2.7%)	36 (4.8%)

**Factors Associated with KAP towards AFR and AFS:** Regression analysis showed compared to males, females tend to have good knowledge (AOR

= 1.631, p = 0.018) while less likely to have good practices (AOR = 0.582, p = 0.002). Urban students have lower (AOR = 0.590, p = 0.011) but better

attitude (AOR = 0.548, p = 0.005) but better practice (AOR = 1.613, p = 0.005) than rural students. Although the academic year had a limited effect, the second-year students displayed a significantly poorer attitude (AOR = 0.170, p =

0.001) when compared to first years. It was found that gender, residence and stage of study were important KAP determinants towards antifungal resistance and stewardship (Table 4).

Table 4: Multivariate Logistic Regression Analysis of Factors Associated with Knowledge, Attitude, and Practice Regarding Antifungal Resistance

Variable		Knowledge		Attitude		Practice	
		AOR	P- value	AOR	P- value	AOR	P- value
Sex	Male	Reference	-	Reference	-	Reference	-
	Female	1.631	0.018	21.035	0.873	0.582	0.002
Residence	Rural	Reference	-	Reference	-	Reference	-
	Urban	0.590	0.11	0.548	0.005	1.613	0.005
Year of study	First	Reference	-	Reference	-	Reference	-
	Second	0.36	0.99	0.170	0.001	0.485	0.161
	Third	0.40	0.97	1.286	0.490	0.725	0.309
	Fourth	0.20	0.96	1.036	0.928	1.146	0.649

Multivariate logistic regression, p<0.05 (Significant)

Abbreviations: C (confidence interval), AOR (adjusted odds ratio)

## DISCUSSION

The knowledge, attitudes, and practices (KAP) of students based on antifungal resistance (AFR) and antifungal stewardship (AFS). In general, most students were knowledgeable with positive attitude and understood what stewardship is about. However, there is a misconception regarding the limited role of diagnostics [15]. Although students were willing to participate in stewardship activities, few of them thought that the training they received was adequate [22]. Different practices were followed by many by adhering to guidelines and attending awareness programmes. Risky practices like self-medication were also reported. Similarly, recommending antifungal to peers was noticed [16, 17].

The sample consisted of 752 students, 86.7% of whom had an age of 18–25 years and 61.2% of male gender. Over half of the participants were from urban areas (52.7 %), and most participants were from the second year (66.0 %), showing uneven distribution by academic year. Earlier studies in India regarding antifungal resistance showed similar demographics. Younger students were more often represented [15–17]. To some practice-related trends, the greater proportion of urban students may account. The easier access to antifungal medicines without prescription is one such a challenge noted earlier by Ocan et al. [13]. Based on the demographic profile, it was expected that age, sex, place of residence and academic level will influence knowledge, attitude and practices about antifungal resistance.

There were distinct differences between classes. Although most (80.32%) of the total sample had a good overall knowledge, the knowledge varied in the years which was first year (58.3%), second year (85.48%), third year (63.64%) and final year (96.43%) which was found to be significant at (p < 0.001). Similar patterns were reported regarding attitudes as well. Overall, the figures were 82.45%, accounting for the total of the years 1 (62.5 %), year 2 (84.7%), year 3 (80.1%) year 4 (78.6%) (p < 0.001). The practices had 67.95% overall which has improved—first year (54.2%), second year (66.1%), third year (75.0%), and fourth year (67.9%) (p=0.032). Curricular exposure and clinical training enhance residents' readiness to engage in antimicrobial stewardship. Similar findings have been noticed in other Indian cohorts where knowledge and attitudes improved with seniority [15, 22]. The importance of including antifungal stewardship modules for early learners on a regular basis to avoid disparity and enhance preparedness among students.

Around 90% of the students were aware that misuse is a key element of the AFR. Moreover, over 90% of students were aware that treatment adherence is a crucial element of the AFR. However, 17.6% of them considered the diagnostics incorrect, while 8.5% believed resistances were limited to bacteria. A majority (more than 96%) of the poultry stakeholders had a positive attitude towards these stewards but only 21.3% of them found the training adequate. The patterns of practise revealed that 81.9% of the respondents sought further training, while 70.2% of

them kept themselves updated. However, a concerning 20.7% admitted that they purchase antifungals at the chemist without a prescription. These results mirror earlier evidence that although Indian students increasingly understand AFR, unsafe practices such as self-medication remain prevalent [13,16, 17].

Table 5 shows being a female student was predictive of being knowledgeable (AOR = 1.631,  $p = 0.018$ ) but not following the recommended practices (AOR = 0.582,  $p = 0.002$ ). As per past Indian studies women show more awareness but less action undertaken, similar patterns have been observed earlier [15–17]. Students residing in the urban areas have lower odds of good knowledge (AOR = 0.590,  $p = 0.011$ ) and attitudes (AOR = 0.548,  $p = 0.005$ ) but better practices (AOR = 1.613,  $p = 0.005$ ). This coincides with previous evidence that urban residence offers a higher opportunity for stewardship activities but exposes students to a higher risk of self-medication [13, 16]. Academic year showed limited influence, except for second-year students who were less likely to express favorable attitudes (AOR = 0.170,  $p = 0.001$ ), a trend contrasting with earlier reports of steady improvements with academic progression [15, 17].

These results demonstrate that while students have good knowledge and attitude toward AFR, nevertheless there are significant training gaps and unsafe practices. Differences by gender, residence and demographic variations should be tackled by targeting. According to earlier studies from India and around the world [13,15–17,22] similar issues like self-medication, lesser emphasis on diagnostics, less incorporation of curriculum are common. Future strategies should therefore combine knowledge-based interventions with attitudinal training, stronger stewardship curricula, and policy-level measures to restrict over-the-counter antifungal availability.

## CONCLUSION

The study found that the students showed a fairly good level of knowledge as well as positive attitudes towards antifungal resistance as well as antifungal stewardship. Yet, not everyone practiced this, as some continued self-medication or informal use of antifungals. The KAP outcomes of gender, area of residence and year of study were significantly influenced. Female and urban students showed a mixed pattern of knowledge, attitude and practice. Although we're becoming increasingly conscious; we still have practical gaps. To close these gaps, it is important to strengthen the training of undergraduates, promote responsible use of antifungals, and improve awareness of stewardship principles. Through education and training of

future healthcare professionals, we can prevent the rise of AFR. In addition, we can preserve the efficacy of antifungal therapy.

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