ORIGINAL ARTICLE

Knowledge, Attitude and Practices Regarding Antimicrobial Resistance among Undergraduate Students

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CITATION
Varshney S, Karthika P, Ahmad S, Mehnaz S. Knowledge, Attitude and Practices Regarding Antimicrobial Resistance among Undergraduate Students. Indian J Comm Health. 2024;36(4):556-564. https://doi.org/10.47203/IJCH.2024.v36i04.009

ARTICLE CYCLE
Received: 20/05/2024; Accepted: 08/07/2024; Published: 31/08/2024

ABSTRACT

Background: Antimicrobial resistance (AMR) poses a significant global health threat, driven by factors such as irrational antibiotic use and limited healthcare infrastructure. Addressing knowledge gaps and promoting responsible antibiotic use among medical professionals is crucial to combat this growing problem. **Objectives:** This study aimed to assess the knowledge, attitudes, and practices (KAP) regarding antibiotics and antimicrobial resistance among medical students at a medical college in North India. **Methods:** A cross-sectional study was conducted between October to December 2023, involving 201 medical students. Data was collected through a self-administered questionnaire covering demographic details, knowledge about antibiotics and antimicrobial resistance, attitudes toward antimicrobial resistance, and practices related to antibiotic use. Statistical analysis was performed using SPSS 20.0. **Results:** Participants demonstrated a mean knowledge score of 7.9±1.3, with 131 students exhibiting poor knowledge and 70 showing good knowledge regarding antibiotics and AMR. While positive attitudes towards prudent antibiotic use were prevalent, some risky behaviours such as keeping leftover antibiotics and self-medication were observed. Practices varied, with most participants completing full treatment courses but some discontinuing prematurely. **Conclusion:** The KAP assessment highlighted mixed findings among medical students regarding antibiotic use and AMR. While positive attitudes and practices were evident, knowledge gaps and risky behaviours persisted.

KEYWORDS

Antibiotic resistance; Antibiotic use; Medical education; Knowledge assessment; Attitude and practice

INTRODUCTION

Antimicrobial resistance (AMR) is a pressing global concern characterized by the ability of bacteria, viruses, parasites, and fungi to resist previously effective treatments (1). This phenomenon poses a substantial threat to public health, impacting individuals across diverse social and economic backgrounds, and jeopardising the management of once-treatable infections such as pneumonia, tuberculosis, gonorrhoea, and salmonellosis (2).

Recent studies have shed light on the escalating challenge of AMR, particularly

evident in the BRICS countries (Brazil, Russia, India, China, and South Africa), where antibiotic consumption surged by 76% between 2000 and 2010 (3). Globally, approximately 1.27 million deaths are directly attributed to antimicrobial resistance, surpassing the combined toll of cancer and road traffic accidents (4). Of particular concern is India, identified as a global hub for AMR due to its notably high rates of antibiotic consumption (5).

Several factors contribute to the rise of antimicrobial resistance, including irrational antibiotic use, limited healthcare infrastructure, patient non-compliance, and inadequate hand hygiene practices. Medical practitioners play a pivotal role in antibiotic consumption, yet national and international surveys reveal gaps in medical students' understanding of infectious diseases and confidence in prescribing antibiotics (6-12). Despite rigorous training, students may still lack proficiency in selecting appropriate antibiotics, providing instructions, and effectively communicating with patients.

This study aims to assess the understanding of medical undergraduates regarding antimicrobial resistance.

The objective of the present study is to assess the knowledge about antibiotics and AMR, evaluate the attitude towards AMR, and assess the practices (KAP) concerning antibiotic usage among medical students enrolled in the Faculty of Medicine at a medical college in North India.

Material & Methods

The cross-sectional study was conducted between October to December 2023. It included medical undergraduate students across three batches: third-year MBBS students, fourth-year MBBS students, and interns, with 201 students responding to the entire survey. The study participants were chosen from the third year and above as topics of Microbiology and Pharmacology are introduced at this stage. Before the administration of the survey, a pilot study was conducted through online distribution of questionnaires among medical students. 50 questionnaires to selected volunteer participants were distributed of which 40 participants responded to the disseminated survey. The collected data was then analysed for validity and reliability before being circulated among the medical students. The survey was conducted online via Google Forms, following ethical clearance from the Institutional Ethics Committee on 21st October 2023. Research team members approached potential participants, explained the study's purpose in their local language, assured confidentiality, and invited voluntary participation. Students who did not respond to the questionnaire even after three subsequent reminders at a 15-day gap were excluded from the study. For data collection, a self-administered questionnaire with four sections covering demographic details and informed consent, knowledge about antibiotics and antimicrobial resistance, attitude towards antimicrobial resistance, and practices related to antimicrobial resistance was distributed. The questionnaire was based on the literature review and was made after extensive peer discussion to cover all the essential aspects related to AMR.

Statistical analysis: The collected data was analysed in SPSS 20.0. The data was reported in the form of frequency tables in the case of qualitative variables, while the calculation of mean and standard deviation was done in the case of quantitative variables.

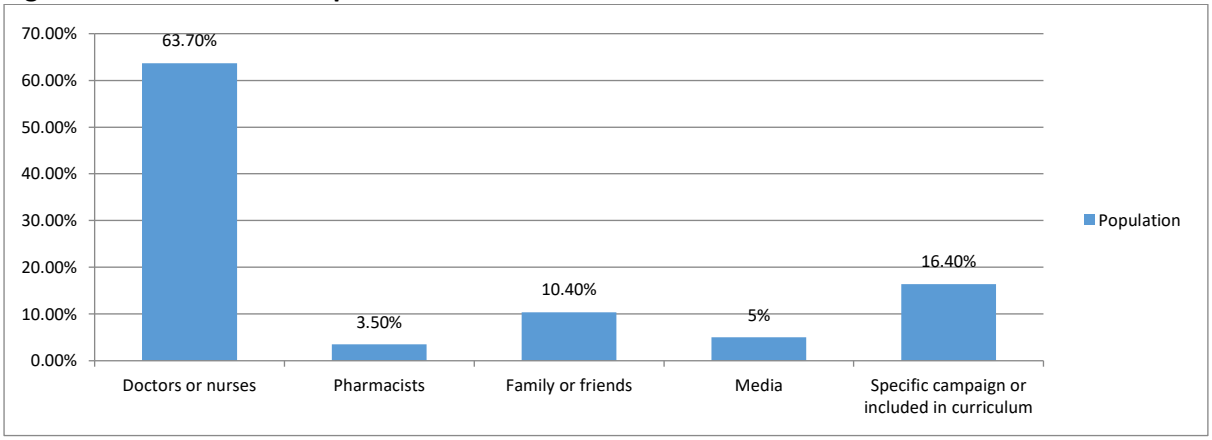
Results

Socio-demographic profile of the study respondents: Out of the total questionnaires circulated, 201 students responded to the entire survey. The mean age of participants was found to be 22 ± 1.21 years.(Table 1) The source of initial exposure to the term ‘antibiotic resistance’ for most of the participants has been the doctors or nurses followed by specific campaigns or as a part of the curriculum.(Figure 1)

Table 1 Demographic characteristics of the study participants

Characteristic	Frequency (n)	Percentage (%)
Gender		
· Male	117	58.2%
· Female	84	41.8%
Year of Study		
· Third	79	39.3%
· Fourth	66	32.8%
· Internship	56	27.9%
Place of residence		
● Urban – within a densely populated city/town	142	70.6%
● Suburban – in a suburb of a city/town	42	20.9%
● Rural – outside of a city/town, e.g. village/countryside/farming area	17	8.5%

Figure 1 Source of initial exposure to the term 'antibiotic resistance'



Knowledge of the participants regarding antimicrobial resistance

Table 2 shows the descriptive analysis of the responses received from the participants regarding knowledge. We employed a scoring methodology wherein participants were awarded 1 point for each accurate response and received no points for incorrect answers. According to the data, the mean knowledge score was found to be 7.9±1.3. Scores suggest that 131(65.1%) students had poor knowledge (score 0-8) and 70 (34.8%) students had good knowledge (score 9-10) about antibiotics and antimicrobial resistance.

Table 2 Knowledge of the participants regarding antimicrobial resistance

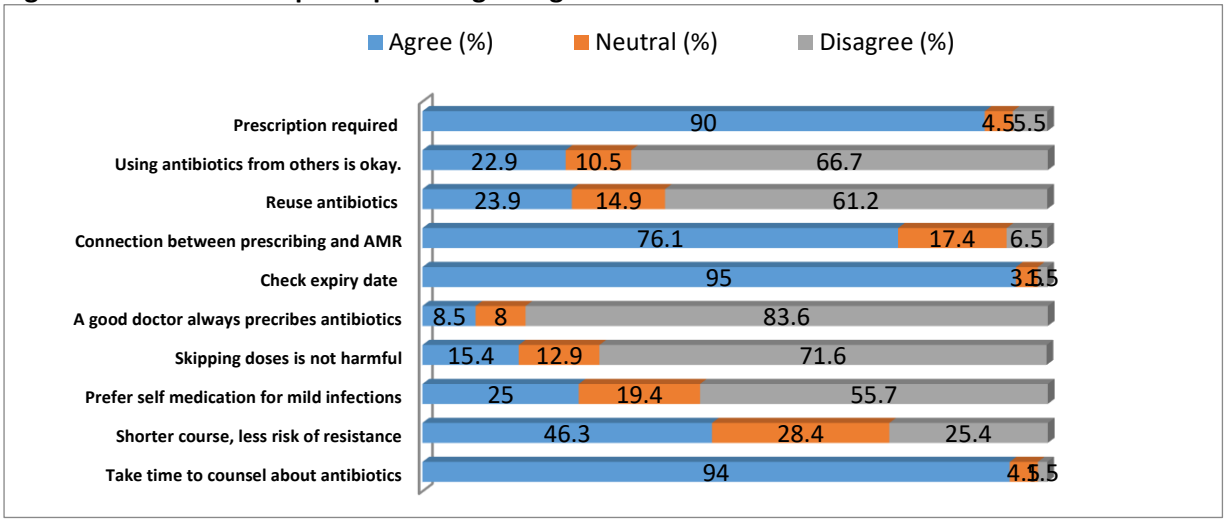
Questions to assess knowledge	Frequency (n)	Percentage (%)
Antibiotics are effective against		
● Bacteria	190	94.5%
● Viruses	11	5.5%
● Both	N/A	N/A
● I don't know	N/A	N/A
Paracetamol falls in which class of drugs?		
● Antibiotic	19	9.5%
● Antiviral	12	6%
● NSAID	170	84.6%
● Anti-fungal	N/A	N/A
As a future prescriber, I know what information to give to the individuals about prudent use of antibiotics and Antibiotic resistance.		
● Yes	175	87.1%
● No	3	1.5%
● Not confident	23	11.4%
Can antibiotic resistance spread from one person to another?		

Questions to assess knowledge	Frequency (n)	Percentage (%)
● Yes	69	34.3%
● No	91	45.3%
● In some cases	41	20.4%
Antibiotic resistance can increase because of		
● Unnecessarily prescribing the drugs	16	8%
● Non-compliance of the patient	1	0.5%
● Low production of new antibiotics by pharmaceutical companies	2	1%
● Self-medication	1	0.5%
● All of the above	181	90%
Antibiotic resistance is a problem at		
● Global level	186	92.5%
● National level	14	7%
● State level	N/A	N/A
● Your hospital level	1	0.5%
Which type of antibiotics can lead to more increase in antibiotic resistance?		
● Broad spectrum	149	74.1%
● Narrow spectrum	19	9.5%
● Both are equally responsible	20	10%
● I don't know	13	6.5%
Lack of hand hygiene by healthcare workers cause the spread of Antibiotic Resistance? Is this statement true or false?		
● True	103	51.2%
● False	64	31.8%
● Can't say	34	16.9%
Bacteria develop resistance because of		
● Lack or the inaccessibility of target structures for certain antimicrobial agents	5	2.5%
● Production of species-specific inactivating enzymes in certain bacteria	6	3%
● Genus- or species-specific property of bacteria	3	1.5%
● Acquisition of foreign resistance genes or mutational modification of chromosomal target genes.	6	3%
● All of the above	181	90%
Antibiotic resistance leads to		
● Low medical costs	7	3.5%
● Prolonged hospital stays	189	94%
● Decreased mortality	3	1.5%
● positive impact on veterinary and agricultural industries	2	1%

Attitude of the participants regarding antibiotic use and AMR

In Figure 2, respondents' perspectives on antibiotic use and antimicrobial resistance are outlined. The findings suggest a widespread recognition among respondents of the importance of obtaining antibiotics from pharmacies with a prescription. Additionally, there is a notable reluctance towards the informal sharing of antibiotics, indicating a general understanding of the risks associated with such practices. The acceptance of purchasing previously effective antibiotics for recurring symptoms may reflect a perceived convenience or lack of awareness regarding antibiotic resistance. Furthermore, the high percentage of participants prioritising the checking of antibiotic expiry dates indicates a commendable level of awareness regarding antibiotic safety. However, the small percentage associating good medical practice with doctors' willingness to prescribe requested medications reveals a potential gap in understanding or expectations between patients and healthcare providers. Lastly, the overwhelming support for healthcare providers to educate patients on antibiotic usage underscores the importance of patient education in fostering responsible antibiotic use and combating antibiotic resistance.

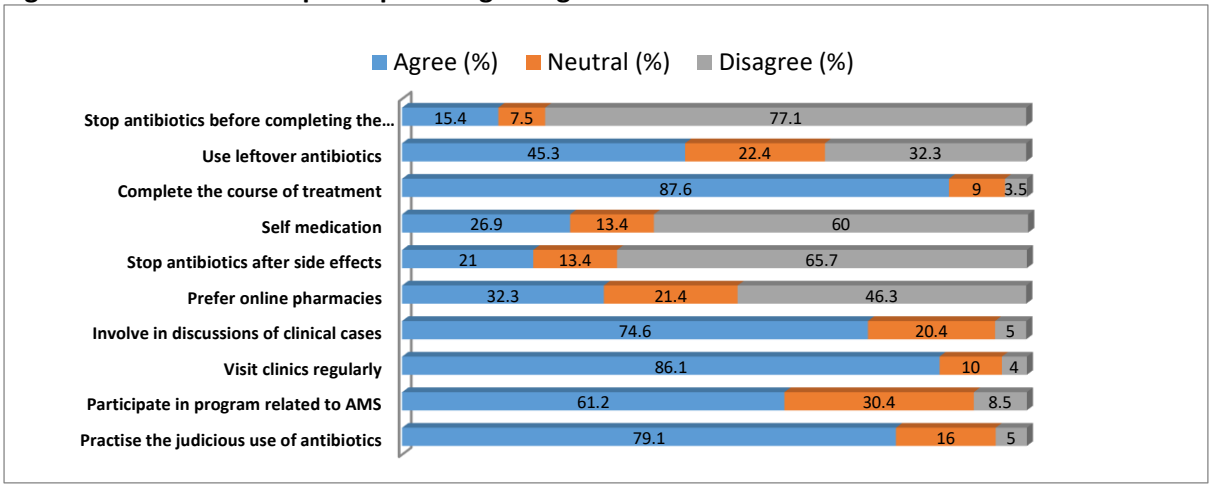
Figure 2 Attitude of the participants regarding antibiotics and AMR



Practices of the participants regarding antibiotics and AMR

Figure 3 presents the diverse antibiotic-related practices of participants highlighting a generally responsible approach to antibiotic usage among respondents. Most (77.1%) prioritise completing their regimen, though 45.3% keep leftover antibiotics, potentially raising concerns about stewardship. The majority (87.6%) consistently finish their treatment, but 21% stop upon side effects without consulting a professional. Many (60%) avoid self-administration for prolonged symptoms. Reluctance (46.3%) towards online pharmacies suggests cautious medication practices. Active engagement (74.6%) in discussions and stewardship programs in college demonstrates a proactive stance towards responsible antibiotic use.

Figure 3 Practices of the participants regarding antibiotics and AMR



DISCUSSION

Antimicrobial resistance (AMR) is a well-known global health concern, and physicians' incorrect prescribing practices have been identified as a significant cause (13). The primary objective of this study was to evaluate the knowledge, attitudes, and practices of medical students concerning antibiotics and antimicrobial resistance among medical undergraduate students.

Socio-demographic profile of respondents:

According to the present study, males comprised 58.2% of participants, with females making up 41.8%. This aligns with previous research (14), which also noted a higher proportion of male respondents. However, other studies (15) reported a different gender distribution, with more female participants compared to males. Moreover, 63.7% of respondents identified healthcare

professionals as their primary source of information on antimicrobial resistance, contrasting with the 5% who relied on social media channels. This differs from a study where only 4% cited healthcare professionals, with a notably higher percentage (18%) turning to social media for information on antimicrobial resistance(15).

Knowledge of the participants regarding Antimicrobial resistance:

The study participants displayed a slightly low level of knowledge, as indicated by their mean scores. In line with previous research, a small subset of our participants (5.5%) believed antibiotics were suitable for viral infections, echoing findings from a Malaysian study (34.3%) (9). Additionally, a 2020 systematic review found that a significant majority (69%) perceived antibiotics could help with colds and coughs, contributing to antimicrobial resistance and necessitating mitigation strategies (16).

Our study revealed a noteworthy consensus, with 74.1% expressing the belief that broad-spectrum antibiotics play a prominent role in antimicrobial resistance. This finding resonates with a study conducted in Iran, which reported that a considerable proportion (36%) of healthcare workers prescribe broad-spectrum antibiotics without consulting infectious disease experts (17).

Most participants (87%) in our setup felt confident in educating patients about the appropriate use of antibiotics and antibiotic resistance. However, another study revealed a notable lack of confidence among medical students regarding antibiotic prescriptions (18). These differing findings emphasise the need for focused educational interventions to improve healthcare professionals' proficiency in antibiotic stewardship and encourage responsible antibiotic use.

In our setting, around 90% of students acknowledge antimicrobial resistance as a global issue. Similarly, another study (19) found nearly all participants were aware of antimicrobial resistance as a significant concern globally. These parallel findings highlight the widespread recognition of antimicrobial resistance as a critical issue beyond national borders.

Half of the participants in our research demonstrated an understanding of the importance of hand hygiene in mitigating the spread of antimicrobial resistance, mirroring findings from other studies (20). This alignment highlights the beneficial impact of collegiate education in raising awareness and promoting responsible practices in public health.

Attitude towards antibiotic use and AMR:

In the context of antibiotic use and antimicrobial resistance (AMR), our study revealed that 90% of respondents affirmed the necessity of obtaining a prescription to acquire antibiotics from pharmacies, aligning with findings from Lebanon where 73.1% declared adherence to this practice (7). These consistent results underscore the widespread acknowledgment of prescription-based access to antibiotics as a crucial measure in mitigating antibiotic misuse and combating antimicrobial resistance. This global consensus highlights the universal recognition of regulatory protocols aimed at promoting responsible antibiotic use and safeguarding public health. However, it's noteworthy that a Canadian study reported a significant proportion (28.0%) of participants admitting to taking antibiotics without a prescription. This finding suggests a deviation from recommended practices and underscores the need for heightened awareness and enforcement of prescription regulations to address antibiotic misuse and mitigate the spread of AMR (19).

In our study, most participants (66.7%) opposed using antibiotics from friends or family, emphasizing the importance of tailored medical care. Surprisingly, some (23.9%) felt confident in reusing antibiotics based on past experiences. To address these complexities, interventions could include: enhanced patient education, healthcare provider training, public awareness campaigns, and implementing regulations to restrict the sale of antibiotics without a prescription

Also, a significant majority (76.1%) acknowledged the direct correlation between their antibiotic-related actions and the rise of antibiotic-resistant bacteria. These findings resonate with a study conducted in Galicia, Spain (10), which uncovered students'

profound awareness of antibiotic misuse and its repercussions on resistance, attributing responsibility to both prescribers and patients. In this study, almost all participants (95%) regularly checked the expiry dates of antibiotics before use, showing a proactive approach. This matches findings from another study (21), where an even higher percentage (97.8%) did the same. These consistent behaviours indicate a shared awareness of the importance of following medication guidelines to stay safe and achieve better health outcomes.

It was found that most students (71.6%) understood the importance of taking antibiotics on schedule to fight antimicrobial resistance (AMR). In a study conducted in South India (6), 31% of the participants believed that skipping a dose or two doesn't affect AMR. Therefore, educational interventions are necessary to correct misunderstandings and promote accurate understanding of antibiotic adherence in preventing AMR.

In our setup, 25% of respondents agreed that self-medication could be appropriate for mild infections. Similarly, other studies have found a significant number of students engaging in self-medication practices (22, 23). It needs to be understood that self-medication fosters incorrect antibiotic use, including inappropriate selection and dosing, delay in seeking proper medical advice, and exacerbating the problem of AMR, emphasising the need to discourage self-medication and promote responsible antibiotic use.

Our research revealed a strong agreement (95%) on the importance of healthcare providers dedicating consultation time to educate patients on antibiotic usage. However, another study highlighted variations in the effectiveness of healthcare professionals in providing accurate advice on antimicrobial use. Nurses demonstrated the highest accuracy, followed by pharmacists and doctors(24). This requires interdisciplinary collaboration to ensure comprehensive and accurate guidance on responsible antibiotic use, thus combating the escalating threat of antimicrobial resistance effectively.

Practices of respondents regarding antibiotic usage and AMR:

In our study, most participants (87.6%) completed their entire antibiotic course with 12.4% leaving the antibiotics once the symptoms are relieved. Therefore, targeted education campaigns emphasising the importance of completing prescribed antibiotic courses are crucial to address this behaviour and safeguard effective treatment.

45.3% of our participants kept leftover antibiotics at home, contrasting with a higher rate of 64% in a Chinese study (22). These practices raise concerns about antimicrobial resistance (AMR). Storing antibiotics without medical oversight may lead to inappropriate use and resistance. Hence, educating individuals on proper disposal and discouraging unnecessary stockpiling are essential to prevent AMR spread.

While nearly 60% of our respondents abstain from self-medicating with antibiotics when experiencing signs of infection for over a week, a cross-sectional study conducted in the United Arab Emirates found that 38.2% of participants had engaged in self-medication with antibiotics within the preceding six months (25).

In our study, a noteworthy portion of participants (74.6%) actively partake in clinical case discussions. Moreover, a majority of students (86.1%) regularly attend clinics, with 61.2% actively engaging in discussions and programs on antimicrobial stewardship (AMS). They demonstrate an understanding of the significance of prudent antibiotic use and consistently inquire about past prescriptions.

In Jordan, it was observed that clinical vignettes, coupled with small group teachings, proved effective in fostering understanding regarding antimicrobial resistance (AMR) (8). However, students elsewhere noted theoretical training lacked practical application and highlighted deficits in essential social and communication skills for clinical management (10). Similarly, our study found 11.4% lacked confidence in these areas, suggesting potential gaps in practical training and communication skills among students.

Integrating antimicrobial resistance (AMR) education into medical training is essential for

enhancing doctors' awareness. This involves incorporating AMR and antimicrobial stewardship into hospital rounds and revising undergraduate pharmacology/microbiology courses. Currently, there's a notable absence of dedicated AMR courses, emphasising the urgent need for curriculum updates. By integrating AMR education, medical students will be better equipped for future prescribing practices, leading to meaningful behavioural changes.

Conclusion

Overall, the KAP of the respondents highlights a mixed picture, with generally positive attitudes and practices but some areas of concern regarding knowledge gaps and potentially risky behaviors. Addressing these nuances through targeted education and interventions is vital in promoting responsible antibiotic use and combating the threat of AMR.

Recommendation

Antimicrobial resistance is a growing public health threat that requires urgent attention. To effectively address this issue, interventions should begin during undergraduate education, where students must be made aware and educated about the seriousness of antimicrobial resistance.

Limitation of the Study

While the study provides valuable insights into medical students' perspectives on antimicrobial resistance (AMR), several limitations must be considered. Firstly, its single-site focus may restrict the applicability of findings to broader populations. Additionally, reliance on self-administered questionnaires introduces the potential for self-report bias, and the exclusion of non-responders may skew results. Furthermore, the use of an online survey platform may exclude participants with limited internet access or proficiency. Despite efforts to ensure questionnaire validity and coverage of essential aspects, nuances or emerging issues in the field could be overlooked.

Relevance of the Study

This study enhances the existing literature on antimicrobial resistance (AMR) by identifying key risky behaviors, such as self-medication and improper antibiotic disposal, the study highlights critical areas for targeted educational efforts. The comprehensive KAP assessment presented in this research serves as a benchmark for future studies.

Authors Contribution

All authors have contributed equally.

Financial Support and Sponsorship

No financial support and sponsorship.

Conflict of Interest

There is no conflict of interest

Acknowledgement

We extend our heartfelt thanks to all the participants for their valuable contributions to this study on antimicrobial resistance (AMR). Your participation has been immensely appreciated.

Declaration of Generative AI and AI Assisted Technologies in the Writing Process

During the preparation of this work, the authors used Chat gpt and Quillbot in order to paraphrase and edit the content. After using the tool/service, the authors reviewed and edited the content as needed and takes full responsibility for the content of the publication.

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