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on

Use of digital interventions in promoting antimicrobial resistance awareness (AMRA) in the community: A scoping review

A Report by

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(PG/21/088)

Under the guidance of

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PGDM (Hospital and Health Management)

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International Institute of Health Management Research, New Delhi

(Completion of Dissertation from respective organization)

Ms. Ruchi Babra

in recognition of having successfully completed her internship in the department of

ERNST & YOUNG LLP GOVERNMENT & PUBLIC SECTOR

and has successfully completed her Project on

Use of digital interventions in promoting antimicrobial resistance awareness (AMRA) in the community: A scoping review

Date - 02-05-2023

Organization - ERNST & YOUNG

She comes across as a committed, sincere & diligent person who has a strong drive & zeal for learning.

We wish her all the best for future endeavors.

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This is to certify that **Ms. Ruchi Babra** of PGDM (Hospital & Health Management) from International Institute of Health Management Research, New Delhi has undergone internship training at from **01-02-2023 to 02-05-2023**.The Candidate has successfully carried out the study designated to him during internship training and her approach to the study has been sincere, scientific, and analytical. The internship is fulfilment of the course requirements. I wish her all success in all her future endeavors.

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Associate Dean, Academic
and Student Affairs
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Professor
IIHMR, New Delhi

Certificate of Approval

The following dissertation titled **"USE OF DIGITAL INTERVENTION IN PROMOTING ANTIMICROBIAL RESISTANCE AWARENESS IN THE COMMUNITY: A SCOPING REVIEW"** is hereby approved as a certified study in management carried out and presented in a manner satisfactory to warrant its acceptance as a prerequisite for the award of **PGDM (Hospital & Health Management)** for which it has been submitted. It is understood that by this approval the undersigned do not necessarily endorse or approve any statement made, opinion expressed or conclusion drawn therein but approve the dissertation only for the purpose it is submitted.

Dissertation Examination Committee for evaluation of the dissertation.

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Certificate from Dissertation Advisory Committee

This is to certify that **Ms. Ruchi Babra**, a graduate student of the PGDM (Hospital & Health Management) has worked under our guidance and supervision. He/ She is submitting this dissertation titled **"Use of digital interventions in promoting antimicrobial resistance awareness (AMRA) in the community: A scoping review" at "EY LLP"** in partial fulfilment of the requirements for the award of the PGDM (Hospital & Health Management).

This dissertation has the requisite standard and to the best of our knowledge no part of it has been reproduced from any other dissertation, monograph, report or book.

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INTERNATIONAL INSTITUTE OF HEALTH MANAGEMENT RESEARCH,

NEW DELHI

CERTIFICATE BY SCHOLAR

This is to certify that the dissertation titled **Use of digital interventions in promoting antimicrobial resistance awareness (AMRA) in the community: A scoping review** and submitted by **Ruchi Babra**, Enrolment No. **PG/21/088** under the supervision of **Dr. Anandhi Ramachandran** for award of PGDM (Hospital & Health Management) of the Institute carried out during the period from **01-02-2023 to 02-05-2023** embodies my original work and has not formed the basis for the award of any degree, diploma associate-ship, fellowship, titles in this or any other Institute or other similar institution of higher learning

Feedback Form

Name of the Student: Ruchi Babra

Name of the Organization in Which Dissertation Has Been Completed: NHA LTI, Project Under ERNST & YOUNG, NEW DELHI

Area of Dissertation: EY LLP Government & Public Sector

Attendance: 100%

Objectives achieved: Identified available data extraction workflows with respect to PHR app and ABHA ID

Detailed Analysis of Workflow including roles and data elements.

Gap analysis on the available services against required services.

Deliverables:

Detailed documentation including Inception Report and Business requirement Document (SRS & FRS) to LTI.

Strengths:

Good Communication skills, Action Oriented, Highly Patient

Suggestions for Improvement: Great job on the recent work.

Let's focus on minimizing rework and streamlining efforts to enhance efficiency further. Keep up the excellent work!

Suggestions for Institute (course curriculum, industry interaction, placement, alumni)

Date: 02 05-2023

Place: Delhi **Signature of Organization Mentor (Dissertation)**

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OBSERVATIONAL LEARNING

About EY

The four service lines that make up EY's marketing strategy are Consulting, Assurance, Tax, and Strategy & Transactions Services.

EY India

EY India takes pride in the fact that it serves clients globally across all industries and sectors. EY has been involved in initiatives frequently supported by international donors like the World Bank, DFID, and Asian Development Bank, working on institutional development, capacity building, and policy advising to economies in transition. EY has provided guidance on the reform of the governance framework and structures for operations and development in a number of nations across various sectors.

Several government clients at the national, state, and municipal levels of government in India are actively working with EY India's dedicated Government Advisory Services team on health scheme implementation projects. The team has expertise in a range of public policy, PPP advice,and e-Governance advisory fields. EY has expertise working with numerous Ministries/Departments at the Central level, State and local governments, municipalities, publicsector corporations, and not-for-profit organizations on large-scale health reform initiatives.

EY GPS Sector

The Global Government and Public Sector (GPS) Center serves as the focal point for a network of highly skilled professionals from our assurance, tax, strategy, and transactions departments who are dedicated to supporting you in the government and public sector enterprises and organizations. The group with the highest level of industry expertise and language proficiency was selected from two groups of experts who speak worldwide about emerging trends.

By the networking and knowledge exchange, we can:

Together with local expertise and understanding, we offer our clients global experience and insight. We also offer sustainable solutions that get things done rather than just diagnosing issues.

- Deliver in both established and developing areas with a can-do attitude.
- Develop solutions that are specialized for use by the general population. We are aware of what has been successful in the past and can adapt these strategies to your problems.
- We have a thorough awareness of your problems and can provide timely insights

on themost important topics facing the public sector.

- Provide you with a solid team of seasoned experts.
- Keep our promise to provide dependable, high-quality service

EY acknowledges that investing in the health sector helps the nation's economy flourish and averts economic loss brought on by disease. Our main goal is to offer development sector organizations professional services with value-added. premature and se death. The firm's Our primary objective is to provide development sector organizations with value-added professional services Our main goal was to offer development sector organizations professional services withvalue-added. Our main goal is always beings to offer development sector organization'sprofessional services with value-added.

Service Lines Visited and Worked - I am currently employed in the field of Technology Consulting within the Government and public sector, with a specific focus on healthcare. My role entails providing consulting services to assist government entities in leveraging technology effectively to enhance healthcare services and outcomes.

Problems and issues Faced - Working in the government and public sector presents a multitude of challenges daily. The dynamic nature of government initiatives and their scale requires individuals to approach their work with sincerity, delicacy, and a strong focus on leveraging technology in the healthcare sector. This integration of technology is crucial for effective program implementation and delivery of services.

Observation/Learning –

- ✓ EY has played a significant role in enhancing my professional development by improving my client management skills and technical abilities.
- ✓ The theoretical knowledge gained during my management course at IIHMR

has been instrumental in finding effective solutions to challenges encountered while working at EY.

- ✓ Working at EY has positively impacted my confidence, work approach, and technical competencies.
- ✓ EY has provided me with valuable opportunities to engage with a diverse range of clients, allowing me to develop my client handling skills.

I was involved in two projects –

1. National Health Authority project at EY, which focuses on the digitalization of healthcare. In this role, I am responsible for various documentations such as FRS and SRS documentation, BRD, GAR, and stakeholder consultations.
2. Vendor Evaluation and Onboarding – I am responsible for conducting Pre- Bid meeting, vendor follow ups, preparing vendor evaluation toolkits and conducting the complete vendor evaluation for the client.

Additionally, I have gained experience in creating Bid Proposals and preparing Pursuit summaries for the leadership team at EY.

Overall, my experience at EY has exposed me to a variety of tasks and responsibilities, contributing to my professional growth and expanding my skill set.

Project Report

Abstract

This scoping review explores the utilization of digital interventions for promoting awareness of antimicrobial resistance (AMR) in communities. The study aims to address two primary research questions related to the global awareness level of the community towards AMR, existing digital tools employed for promoting AMR awareness, and then provide the insights derived from the use of digital tools for AMR awareness for India.

Study Design:

A comprehensive analysis of existing literature and studies on digital interventions for AMR awareness was conducted. The review examined global and national levels of AMR awareness and identified various digital tools employed for this purpose. Insights from the use of digital tools were analyzed to determine their potential applicability in the country under study.

Results:

The review found that there are regional and demographic differences in how the community perceives AMR. The digital technologies identified included mobile apps, online platforms, educational websites, social media campaigns, interactive games, and digital educational tools. The tools employed a range of strategies and engaged certain target audiences, assisting in the dissemination of knowledge about AMR and encouraging behavior change. Key learnings from successful digital interventions highlighted the value of adapting interventions to cultural contexts, multidisciplinary collaboration, and tailored strategies.

Conclusion:

The findings highlight the significance of digital interventions in raising AMR

awareness and promoting responsible antimicrobial use. Strategic design and implementation of targeted digital interventions are crucial for effectively combatting the escalating threat of antimicrobial resistance. By integrating the insights learned from successful digital interventions, policymakers and healthcare professionals can develop evidence-based strategies to enhance AMR awareness and effectively address the challenges posed by antimicrobial resistance.

Introduction

Antimicrobials are substances with the ability to kill or prevent the development of micro-organisms. Antimicrobial resistance (AMR) can, however, develop because of improper use and over-the-counter consumption of these antibiotics. When bacteria develop antimicrobial resistance (AMR), infections become more challenging to treat and pose a higher risk of spreading. Food security and world health are just a couple of the many areas of modern development which are seriously threatened by this phenomenon [1].

The effects of AMR are concerning, with 700,000 deaths worldwide annually being related to resistance to antimicrobials [2]. According to the World Health Organization (WHO), which ranks it as one of the top ten global threats, if left unaddressed, it is projected to result in 10 million deaths yearly by 2050. To combat this issue, the WHO aims to curb the escalating rate of AMR, with a particular focus on countries where antibiotics are easily accessible for treatment without a prescription [3].

Among the countries facing significant challenges in combating AMR, India stands out with the highest rate of human antibiotic use globally and a substantial burden of antimicrobial-resistant organisms [4]. Addressing AMR has become a priority in various global initiatives, including the Global Action Plan on AMR and the G20, which advocate for responsible antibiotic use, improved surveillance systems, and investments in the development of new antibiotics and alternative treatments.

To effectively combat AMR, it is essential to involve the community through education and awareness campaigns. While traditional approaches have relied on text-based or paper-based materials [5], the advent of digital interventions offers numerous

advantages. Digital tools have a wider reach and provide improved access to health education resources. They can be easily delivered at any time, personalized to individual needs, and updated in real-time. Additionally, the expansion of internet networks, particularly in low- and middle-income countries (LMICs), has facilitated connectivity to previously remote and underserved regions [6].

As a result, it is critical to use appropriate digital tools to successfully target certain audiences and raise awareness while supporting desirable practices. These strategies can help to solve the AMR problem by providing education and raising awareness among individuals and communities. We can maximize the impact of educational activities and contribute to the collective efforts to battle AMR by utilizing the potential of digital interventions.

The aim of this study is to identify the digital technologies used to raise community awareness about antimicrobial resistance (AMR) and to emphasize their potential as a viable tool for AMR stewardship in India.

Rationale of the Study

Problem Statement - Antimicrobial resistance (AMR) is a growing global threat, leading to increased morbidity, mortality, and healthcare costs. Despite several initiatives to increase awareness, there is still a lack of community understanding of AMR, and traditional awareness-raising strategies are difficult at reaching a broad audience.

Scope of Work -Using easily accessible digital technologies to encourage optimal antibiotic usage and raise awareness of AMR is necessary to address this problem. The findings from this study will provide valuable insights into the potential use of digital tools that can help to create awareness to AMR.

Research Questions

1. What is the awareness level of community towards AMR?
2. What are the existing digital tools being used for promoting AMR awareness among the community?

Objectives

To identify the use of digital technologies for increasing awareness about antimicrobial resistance (AMR) in the community

Specific Objective –

1. To understand the awareness of the community towards AMR
2. To explore the digital tools used for promoting AMR awareness among the community

Methodology

A scoping review was conducted between 1st Feb 2023 to 2nd May 2023. We followed the following methodology - Searching databases for relevant articles using keywords in Table 1

Search strategy: We search articles with the relevant keywords like Antimicrobial Resistance, Knowledge Practice Attitude, digital intervention, awareness, community, general public etc.

A comprehensive search was conducted in two databases: PubMed and ProQuest. The search terms used were determined through a predefined set of keywords, as outlined in

Table 1

These keywords were chosen based on their relevance to the research topic and objectives.

Table 1- Keywords

Combinations of terms -
Antimicrobial Resistance OR AMR
AND
Awareness OR Knowledge OR Attitude OR Perception
AND
Community OR General Public
AND
Digital tools OR Digital interventions

The initial search yielded a total of 1,616 articles across the two databases. The titles and abstracts were reviewed to determine their potential significance in light of the research objectives. During this screening process, inclusion and exclusion criteria were applied.

Inclusion criteria:

- Articles published in English language only
- Full text available
- All articles published in the years, i.e., 2015- 2023, were included in the study
- All study designs included
- Review articles

Exclusion criteria:

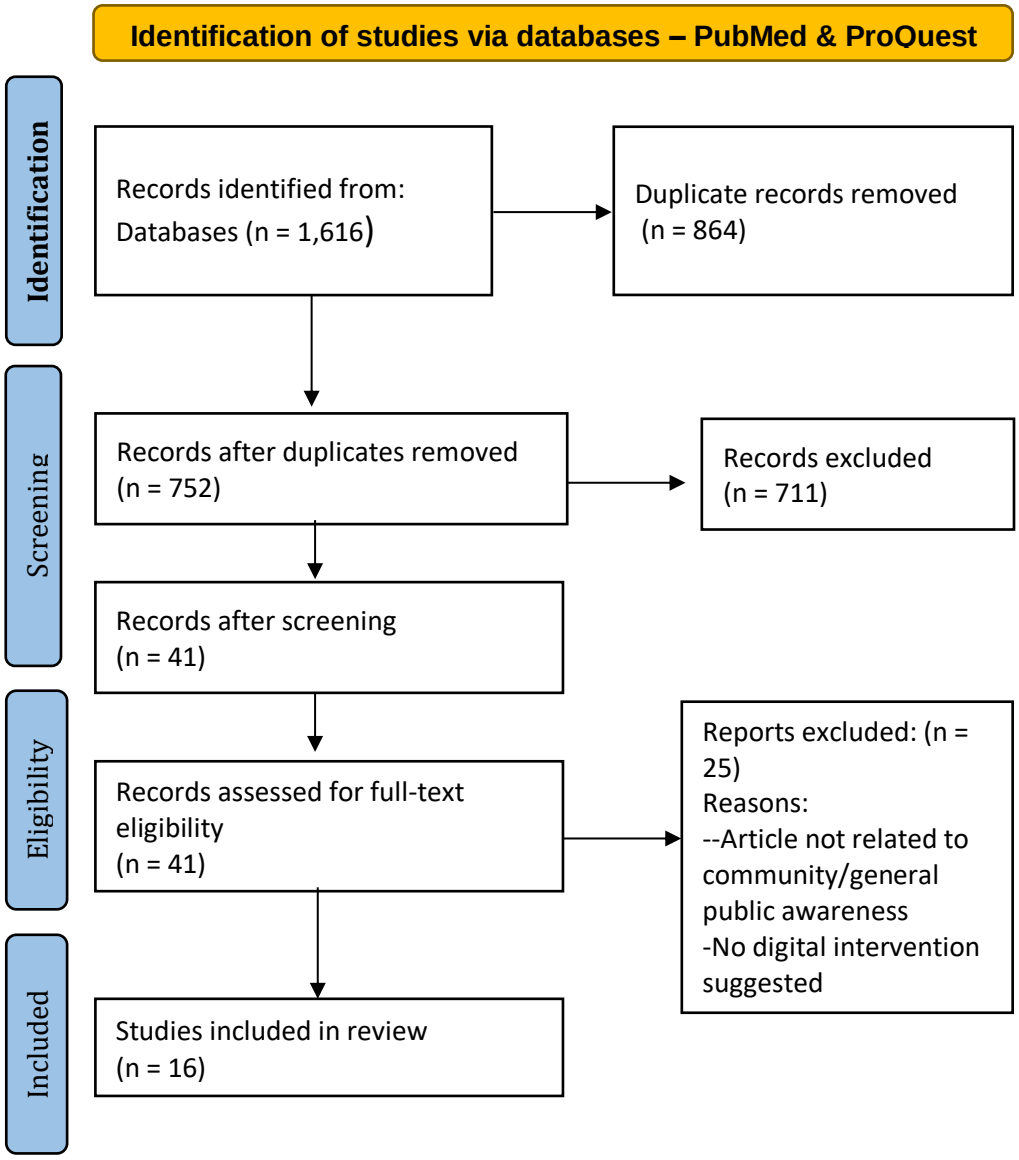
- News
- Blogs

- Studies related to awareness of providers
- Websites
- Articles not discussing about the impact of digital tools interventions in creating awareness of AMR

Data Selection & Search

- In our search, we identified a total of 1,616 publications. We applied exclusion criteria based on the titles and abstracts of the articles during the initial screening phase, which resulted in an overall selection of 41 papers that met the requirements for further review of their complete texts. Following that, during the detailed evaluation of these full texts, we discovered reasons to exclude 25 publications from the final selection. These exclusions were made for a variety of reasons and considerations. These reasons included papers not being related to digital interventions in antimicrobial resistance (AMR) awareness, papers focusing on doctors' awareness instead of the general public, and papers that did not suggest any intervention impact, Article not accessible
- After conducting a thorough full-text screening of the remaining 16 articles, we found that they were suitable for inclusion in our study.

PRISMA - ScR Flowchart



Data Extraction

We included 16 articles for analysis. we documented the 16 articles by extracting data under following heading:

Table 2-

- Author/Year of publication
- Objective
- Study Design
- Outcome

Table 3-

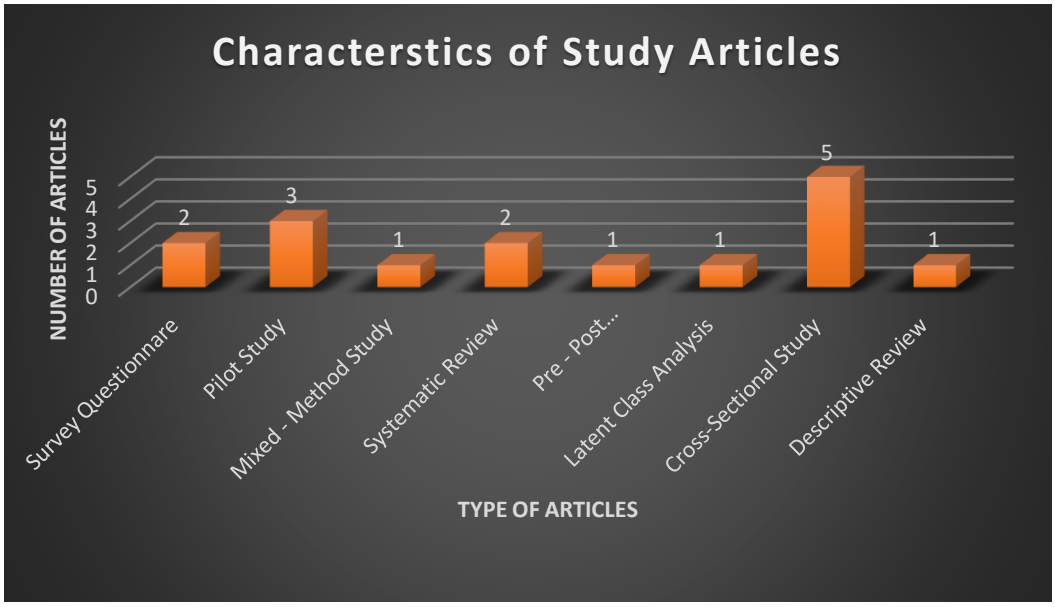
- Author/Year of publication
- Objective
- Study Design
- Outcome

Data Analysis

We used Thematic Analysis as a methodological approach to analyze and categorize the articles based on their underlying themes. Through a systematic process, we identified patterns, concepts, and topics within the articles, allowing us to organize and present our findings in a systematic manner. This approach provided a comprehensive overview of the various themes explored in the literature.

Results

The graph shows the number and type of papers included in the study. Maximum number of the articles fetched after the search on the 2 databases were (16).



To answer our research question, we conducted a comprehensive scoping review, to explore the amount of data available on Knowledge Attitude Perception of community on AMR and Digital interventions involved in creating awareness of AMR. We included 16 articles in our review.

Out of these 16 studies, 06 studies discussed KAP of the community regarding Antimicrobial Resistance, 10 studies discussed digital interventions involved in creating awareness of AMR.

The tables below include the data extracted from the articles in a structured manner-

Table 2 - Awareness Level of AMR in the community

Author/ Year of Publishing	Objective	Study Design	Outcome
Vallin M, Polyzoi M, Marrone G, Rosales-Klintz S, Tegmark Wisell K, Stålsby Lundborg C./2016 [7]	(i) To provide an update on the knowledge and attitudes to antibiotic use and resistance of the Swedish population, and (ii) to identify which groups within the population are in particular need of improved knowledge or attitudes.	Latent Class Analysis	94% aware of antibiotic resistance; majority answered correctly; men, younger, higher education had greater knowledge; males less restrictive attitudes; high knowledge linked to appropriate attitudes; overall knowledge is high, improved since 2006; lower-educated, elderly need improved knowledge.
Ha TV, Nguyen AMT, Nguyen	This study explores the awareness of antibiotic use	Cross-sectional Study	64.2% aware of prescription drugs, 67.4% aware of antibiotic use, 55.8% aware of antibiotic

HST/2019 [8]	and resistance among general people in highland provinces in Vietnam and detects associated factors.		resistance; Low awareness in highland provinces of Vietnam. Positive Association - higher age, education, and family income and awareness of prescription medicine, antibiotics, and antibiotic resistance (AR). Awareness in males was significantly higher than that in females
Awad AI, Aboud EA./2019 [9]	This study was designed to determine knowledge, attitude, and practice towards antibiotic use among the public in Kuwait	Cross-Sectional Study (Primary Study)	72.8% of respondents were prescribed antibiotics, with 45.7% using them 2-5 times in the past year. Of those, 64.9% completed their last antibiotic course as prescribed, while 36.0% did not finish it. Participants had moderate knowledge (7/13 score), correctly understanding safety, skin reactions, and different antibiotics. Confusion on coughs, colds, viruses, bacteria. >50% unaware of imbalance and resistance. Healthcare field had higher knowledge.

			Respondents with higher education and healthcare-related occupations exhibited more positive attitudes compared to those with lower education levels.
Chukwu EE, Oladele DA, Awoderu OB, Afocha EE, Lawal RG, Abdus-Salam I, Ogunsola FT, Audu RA/2020 [10]	This survey provides at a glance, the current public awareness and common behaviours related to antibiotics use within the Nigerian population.	Cross-Sectional Study (Primary Study)	Low overall knowledge of AMR (8.3% good, 0.4% perfect, 8.5% no knowledge). Gender difference insignificant, but males scored higher. State variations in knowledge. Higher education linked to better knowledge. Urban respondents generally more knowledgeable, except in Borno State. Perception: 86% agree on proper antibiotic use, 76.4% on not keeping antibiotics, 91.0% endorse hand washing to prevent AMR.

Simegn, Wudneh, and Getachew Moges/2022 [2]	The study aimed to assess the level of awareness and knowledge of antimicrobial resistance and factors associated with knowledge among adults in Dessie City, Ethiopia.	Cross-Sectional Study (Primary Study)	Knowledge of AMR: Good knowledge: 58.5% No awareness of risk factors: 14.7% Unaware of consequences: 15.5% Knowledge Factors: Gender: Males had 1.99x better knowledge. Education: Grade 11-12 and college-educated had 3.73x and 3.50x better knowledge, respectively. Advice from health professionals: 1.84x better knowledge. Source of information: Relying on health professionals led to 2.51x better knowledge. Antibiotic use without prescription: 1.86x better knowledge. Low awareness and knowledge of antimicrobial resistance among adults

Gunasekera YD, Kinnison T, Kottawatta SA, Silva-Fletcher A, Kalupahana RS/2022 [3]	The current study aimed to explore the KAP of antibiotics and AMR, alongside perceptions of personal antibiotic usage, of the general public from two distinctly different communities in Sri Lanka; an urban community and a socio-culturally distinct rural community	Cross-Sectional Study (Primary Study)	In the urban area, 51.4% believed they had good knowledge of AMR, while 48.6% considered their knowledge poor. In the rural area, participants reported no knowledge of AMR Source of knowledge on AMR (urban area): Urban respondents primarily acquired their AMR knowledge from doctors (75.4%), while 28.7% relied on mass media. Gender difference insignificant Both urban and rural community members in Sri Lanka exhibit limited ability to identify antibiotics from a list of commonly used medicines. Additionally, their knowledge regarding the appropriate use of antibiotics and understanding of antimicrobial resistance (AMR) is inadequate

Table 3 - Digital interventions

Title/Year of Publishing	Study Design	Intervention	Outcome
An evidence-based antimicrobial stewardship smartphone app for hospital outpatients: Survey-based needs assessment among patients/2016 [11]	Survey questionnaire	Smartphone Application	The high level of support for electronic platforms among doctors during consultations and the large ownership of electronic devices among patients indicate a potential audience for an app providing antimicrobial and infection-specific information. However, the concern of 13% of patients regarding privacy highlights the importance of healthcare providers addressing and safeguarding patient data in the clinical use of mobile devices.
Applying digital information delivery to convert habits of Antibiotic	Mixed-Method Study	Tablets, e-learning	Implementation of digital devices in healthcare, such as tablet applications and e-learning platforms, faced

Use in primary care in Germany: Mixed-methods study/2020 [12]			challenges and hesitation among medical professionals. Barriers included perceived incompatibility with existing routines, low technology affinity, and concerns about complexity. Personalized approaches, involving peer support and opinion leaders, are suggested strategies to promote the value and effectiveness of digital tools. Tailoring implementation strategies is important to address barriers, facilitators, and perceptions for higher intervention fidelity.
Public Health Interventions to Improve Antimicrobial Resistance	Systematic review	Social Media Gamification Theatre/Plays	• Interactive interventions (theatre plays, videos) raise awareness and improve attitudes towards AMR, but limited scale.

Awareness and Behavioural Change Associated with Antimicrobial Use: A Systematic Review Exploring the Use of Social Media/ 2022 [13]			• Interactive formats (plays) promote deeper engagement and ownership. • Gamification shows success in immediate and long-term retention. • Social media potential for engaging wide audience, caution against false information. • Clinicians as reliable sources on social media, tailored platforms for target audience. • Lack of common outcome tool hinders effective interventions. • Long-term impact and sustained knowledge evaluation needed.
Health Professions Digital Education on Antibiotic Management: Systematic Review	Systematic review and Meta Analysis	Mixed - interventions	Personal digital assistants, brief text messages, online digital education (emails, webpages), and online integrated education were

and Meta-Analysis by the Digital Health Education Collaboration/2019 [14]			the interventions that were examined. In 4 out of 6 studies, digital education resulted in greater reduction in antibiotic prescription or dispensing rates compared to traditional education. Compared to traditional education, mobile education significantly improved post-intervention knowledge scores, with a substantial effect size. Results regarding the attitudes of healthcare workers and patient-related outcomes were contradictory or inconclusive. According to three studies, digital education is more economical than conventional education.

			No studies reported on skills, satisfaction, or potential adverse effects associated with the interventions.
The impact of antimicrobial resistance awareness interventions involving schoolchildren, development of an animation and parent's engagements: a pilot study/2022 [15]	Pilot study	Animation	The revised animation, incorporating feedback from parents and students, effectively aligned with AMR messaging and improved appeal. Changes were made to ensure proper antibiotic disposal was depicted, addressing concerns of contributing to AMR. The impact evaluation targeting parents showed positive effects, with reported discussions between parents and children about AMR, indicating the intervention's effectiveness in raising awareness and

			promoting dialogue on the topic.
Changing Patient and Public Beliefs About Antimicrobials and Antimicrobial Resistance (AMR) Using a Brief Digital Intervention/2021 [16]	Pre- and post-intervention study	Infographics/ messages	• There were changes in beliefs across all three domains: necessity for antibiotics, concerns, and general perceptions. • Overall, scores for general perception increased and the perceived need for antibiotics decreased. Effect on Perceptions of Need • Following the intervention, there was a significant decrease in overall necessity beliefs and a rise in overall concerns scores.
eHealthResp, a Digital Intervention to Improve Antibiotic Prescribing in	Pilot Study	Smartphone Application	• Feedback from 12 participating physicians indicated a highly positive evaluation of the

Respiratory Infections: A Pilot Study [17]			eHealthResp online course and mobile application. • The digital health tools could improve the quality of antibiotic prescription for respiratory tract infections and decrease diagnostic uncertainty, doctors agreed • The interactive nature, relevance, and user-friendliness of the course and app were highlighted. • The study demonstrates the potential value of digital health tools • Additional training for healthcare professionals can further increase the impact of these interventions in combating antibiotic resistance.

Raising awareness of antimicrobial resistance in rural aquaculture practice in Bangladesh through digital communications: a pilot study/2019 [18]	Pilot Study	Social Media Education programme	The educational animation on antibiotic resistance had a significant impact on farmers, with 97% expressing a willingness to change their future antibiotic use. The social media campaign reached a wide audience, with 11,200 tweets and 17,614 Facebook views, primarily from male viewers under 35 years old in the Dhaka division of Bangladesh. Targeting farm shops can be effective in addressing antibiotic sales and usage in future antimicrobial resistance action plans.
Raising awareness of antimicrobial resistance among the general public in the UK: the role of public	Descriptive review	Social Media Education programme Digital Games	The Conversation and Twitter effectively disseminate AMR-related information and facilitate public conversations. The e-Bug program provides educational

engagement activities [19]		Films, Theatre and TV programmes	resources on microbiology, hygiene, and prudent antibiotic use in schools and community groups. Digital games (e.g., Bacteria Combat) and citizen science initiatives (e.g., Antibiotics Unearthed, Swab and Send) engage students and the public in AMR-related activities. Theatre productions explore AMR themes and dispel misconceptions. Films and TV programs (e.g., "Antibiotic Apocalypse," "Resistance") engage young adults and showcase the challenges of controlling AMR.
Development of and User Feedback on a Board and Online Game to	Survey questionnaire	Online Games	• The AMS game incorporated key elements of good practice, such as competition, clear rules,

Educate on Antimicrobial Resistance and Stewardship [20]			choice, challenges, coaching, and performance assessment. • Usability testing and feedback surveys showed that healthcare teams enjoyed playing the AMS game and gained more knowledge about AMS. • The game encouraged discussion, learning, and awareness of One Health in AMS.

Thematic analysis: Thematic analysis of the studies included in the research paper revealed a range of key themes, including:

Awareness of community - AMR	Existing Digital Tools
Education	Online Games
Gender	Education Platforms
Antibiotic Course incompletion	Animation
Knowledge Gaps and Misconception	Smartphone Applications
Self – Medication	Social Media
	Algorithmic Intervention

Awareness Level of community- AMR

There are various factors contributing to the awareness of AMR in the community

Education Level and Training

All the reviewed articles (as of 06/06) consistently highlight the positive relationship between education and the awareness level of Antimicrobial Resistance (AMR) in the community. Higher education equips individuals with comprehensive knowledge in areas such as microbiology, infectious diseases, and the underlying mechanisms of AMR. This higher level of education leads to increased awareness and promotes responsible practices regarding the use of antibiotics.

In a specific study conducted by Vallin et al, a sample of 2,500 individuals aged 18-74 from Sweden was selected after applying exclusion criteria. Participants were categorised based on their responses using latent class analyses, and the relationship between sociodemographic characteristics and participation in various latent classes was

examined. The findings indicated that individuals with higher education demonstrated a higher level of knowledge regarding AMR. Higher education respondents were less likely to fall into the category of having less knowledge and more likely to fall into the category of having accurate knowledge when compared to those with the lowest educational level. [7]

Overall, the collective evidence from the reviewed articles consistently supports the notion that higher education is positively associated with increased AMR knowledge and a more appropriate attitude towards antibiotic usage.

Gender and Demographics

Out of the five articles analyzed on the association of gender with the awareness level of Antimicrobial Resistance (AMR) as of 05/06, the results indicate varying perspectives on the influence of gender on AMR awareness.

One study conducted by **Van et al,** found that compared to men, women were less likely to be aware of prescription drugs, suggesting a gender disparity in awareness levels. [8]

On the other hand, two studies concluded that gender difference was insignificant in relation to the awareness levels of antibiotics. These studies found no significant difference in awareness between men and women.

However, three studies, including the aforementioned study, support the notion that men have a higher likelihood of being aware of antibiotic usage and antimicrobial resistance compared to women. These studies suggest that there might be a gender-based difference in awareness levels, with men being more informed about AMR.

Importance of Completing Antibiotic Course

03 out of 6 studies are discussing regarding this theme – Importance of completing Antibiotics

In a study conducted by **Awad et al**, it was found that approximately two-thirds of the participants (64.9%) reported completing their antibiotic course as prescribed. However, a significant proportion of respondents (36.0%) did not finish the full course. The reasons cited for not completing the course included feeling better (67.8%), forgetting to take the antibiotic (24.1%), and experiencing side effects (8.1%) that made them feel unwell. [9]

To stop the emergence of antibiotic resistance, it is essential to emphasize the value of completing the entire course of antibiotics. When antibiotics are not taken for the entire prescribed duration, there is a higher risk of not fully eradicating the infection. This incomplete treatment can allow the surviving bacteria to develop resistance to the antibiotics used, leading to treatment failures in future infections and facilitating the spread of resistant bacteria.

Another study conducted by **Chukwu et** al also revealed a concerning lack of awareness among individuals regarding the significance of completing a full course of antibiotics and the role they play in preventing the spread of antimicrobial resistance (AMR). [10]

In the study conducted by **Simegn et al**, it was found that 61.4% of respondents recognized the improper usage risk factor of failure to complete the course of therapy, and 54.3% acknowledged the risk of taking antibiotics without a prescription. [2]

By emphasizing the importance of completing antibiotic courses as prescribed, we can raise awareness about the potential consequences of premature discontinuation and contribute to the prevention of antibiotic resistance.

Misconceptions about Antibiotics Effectiveness

One of the articles, **Gunasekera et al** suggested that there were Misconception revolving around antibiotic usage which includes Antibiotics are effective against viruses, body becomes resistant to antibiotics, rather than bacteria, causing resistance, belief that antibiotic-resistant bacteria can spread directly from person-to-person, confusion between antibiotics and non-antibiotics like paracetamol, leading to inappropriate use. [3]

The study conducted by **Awad et al** found several noteworthy findings. Over half of the respondents held the incorrect belief that antibiotics can expedite recovery from most coughs and colds, and that they are effective against viral infections. Additionally, participants did not recognize the effectiveness of antibiotics against bacterial infections. Another misconception observed was the lack of understanding about the disruption of the body's bacterial balance, with two-fifths of respondents failing to acknowledge this effect. Furthermore, a significant majority did not perceive the link between antibiotic use in animals and its impact on antibiotic effectiveness in humans, indicating a lack of understanding about the connection between animal agriculture and antibiotic resistance. These findings highlight the need for targeted educational interventions to address these misconceptions and promote responsible antibiotic use among the general population. [9]

Self – Medication

All the articles are talking about the damages by Self-medication of Antibiotics. (5/6) are associated with the fact that self- administration is highly see in the population whereas the 01 articles states that the population’s cultural values has helped to manage this phenomenon.

The increase in antibiotic resistance was linked mainly to the incorrect dosing of antibiotics and abuse of medicines including self-medication.

One of the articles included conducted by **Awad et al**, the study revealed that a notable portion of the study population practiced self-medication. Among those who self-medicated, a significant percentage shared antibiotics with others without consulting a healthcare professional. Furthermore, some individuals used antibiotics that were originally prescribed for a previous infection, even if it recurred later or for a different type of infection. Obtaining antibiotics directly from private pharmacies, both domestically and abroad, without a prescription was reported. Self-medication with antibiotics was primarily employed to address common ailments such as the common cold, sore throat, cough, genitourinary infections, and superficial wounds. [9]

Due to a lack of regulations and laws to control self-medication, Vietnam has been one of the world's hotspots for AR. [8]

Only one out of 6 studies we witnessed a positive attitude of the population towards self-medication, **Vallin et al** states in his study that a unique cultural profile that promotes a cautious attitude towards antibiotic use. Swedish society values deliberation, consensus, and a low power distance, which means decisions are often made collectively. They are also adaptable and open to handling unknown situations, with a low uncertainty avoidance. In terms of masculinity, Sweden scores lower, indicating a lesser emphasis on traditional gender roles. It's interesting to note that Swedish individuals relationship with self-medication may be due to their high level of individualism. [7]

Digital Tools

Online Games

Games have been widely utilized to address both infectious and non-infectious diseases and to promote health and well-being. They are effective in health education as they engage and motivate players, making the learning experience enjoyable [23]. In the context of antimicrobial resistance (AMR), AMS games have emerged as an innovative approach to raising awareness.

In a recent study titled "Development of and User Feedback on a Board and Online Game to Educate on Antimicrobial Resistance and Stewardship," conducted by **Ashiru-Oredope et al** stated that the AMS game received highly positive feedback, with 91.9% of participants expressing enjoyment. The game's simple design made it easy to understand and play, while its interactive nature facilitated discussions and enhanced learning. The game effectively conveyed knowledge about AMR and promoted awareness of antimicrobial stewardship (AMS). Players also gained insight into the role of One Health in AMS and acquired familiarity with key AMS terminologies. Furthermore, more than 90% of participants expressed their willingness to share the game's lessons with colleagues and patients. [19]

Based on these findings, integrating games into AMR education programs is a promising strategy. Games provide an engaging and interactive platform to effectively educate individuals about the importance of responsible antimicrobial use. By leveraging the power of gamification, we can enhance the dissemination of knowledge and promote behavior change in tackling AMR.

Redfern et al stated that the educational games, such as those created by The Game Doctor, play a crucial role in the healthcare sector by providing digital solutions for

education and training. A good example is the video game Bacteria Combat, which highlights antimicrobial resistance (AMR). [18]

A review of the Bacteria Combat game showed that the majority of students in grades 9–12 (95%) thought it was captivating. This highlights the effectiveness of educational games in capturing the attention and engaging young learners. [18]

In summary, educational games developed by The Game Doctor present a promising approach to educate and train individuals in various healthcare-related topics, including AMR. These games have demonstrated their ability to effectively engage learners and provide valuable educational experiences.

Education Platform

In their study," **Doering et al** suggested that participants perceived the digital educational solutions provided as valuable for enhancing health literacy and facilitating changes in antibiotic usage patterns. However, including new solutions into traditional primary care routines and aligning them with professional principles posed hurdles for healthcare workers. A key impediment to the utilization of digital information in primary care has been found to be a lack of technological affinity. The majority of patients supported the use of digital health information, although some expressed worry about maintaining device cleanliness and whether older patients would benefit from digital technologies. [12]

Another study reveals about e-Bug which is an educational program that targets children and young people, providing them with knowledge about microbiology, hygiene, and the spread and treatment of diseases. One of its key objectives is to decrease the occurrence of antibiotic resistance by promoting awareness of the advantages of responsible antibiotic use and the consequences of inappropriate usage.

Animations

We have found 2 articles that have experimented on animations as a method to spread awareness about AMR.

In one of the study, **Thornber et al** uses animated images in the form of a small video or comics targeting the people of Bangladesh. They use both Bangle (local language) and English to create their animation. They use multiple media to improve their reach. They saw a reach of more that 18000 views. They were not able to check if their animation brought about any behavioral changes. [6]

Another study conducted by **Appiah et al**, we tried to reach out to parents through story-telling in an animated form. They made a 3 min and tested subjects before and after seeing the video. Significant change could be noted in parents' attitude.

By going through these articles, it is safe to conclude that animations is an effective way to raise awareness about AMR.

Algorithmic Intervention

One of the studies included in the research paper discussed the Algorithmic interventions have shown promising potential in increasing awareness about antimicrobial resistance (AMR) and reducing its occurrence. By targeting patient beliefs and expectations, these interventions can effectively address the underlying drivers of AMR. Through personalized messaging and tailored approaches, algorithmic interventions have been successful in modifying perceptions regarding antibiotic demand. Notably, the study by **Chan et al** demonstrated the positive impact of such interventions, including reducing perceived antibiotic necessity, increasing concerns about antibiotics and AMR, and strengthening perceptions in general. These findings underscore the effectiveness of algorithmic interventions in influencing patient behavior and promoting appropriate antibiotic use. Integrating these interventions into healthcare

practices can empower individuals with knowledge and contribute to global efforts in combating AMR. [16]

Social Media

There are 3 studies that are talking about the impact of social media in as an important tool for spreading awareness as well as changing the attitude of people towards the use of antibiotics.

The study conducted by **Redfern et al** suggests that the reach that social media can provide is magnanimous. Some social media platforms like Twitter, could be used to share information and engage the public in conversations about antimicrobial resistance (AMR). But even though the reach is high, but only the spread of information remains constricted by the interest of people, the type of social media handles or hashtags they follow, etc. This could result in awareness initiatives to only reach an audience that is already engaged and scientifically literate. [18]

Thornber et al suggests that social media is effective in reaching the people as they were able to achieve 9100 views in Facebook for their animated video in first 2 weeks alone. Also, these platforms are low cost and have the potential to reach large audiences quickly. Consequently, after reviewing these articles, we may draw the conclusion that social media can be a useful tool for spreading awareness, but it's crucial to select the appropriate platforms. [6]

Smartphone Application

Two studies out of the all included in the study discussed the role of smartphone application in creating awareness of AMR

The use of smartphones holds significant promise in effectively spreading awareness about antimicrobial resistance (AMR), as supported by the pilot study conducted by

Silva et al. The evaluation of an eHealthResp online course and mobile application revealed highly positive feedback from participants. These digital tools were commended for their user-friendliness, relevance, and trustworthiness. Physicians unanimously agreed that the interventions fostered critical thinking and aided clinical decision-making, addressing the challenges of inappropriate antibiotic prescribing and diagnostic uncertainties. However, additional training for healthcare professionals was identified as crucial to maximize the impact of these digital platforms in the fight against AMR. The study highlights the potential of smartphones as effective instruments for disseminating AMR-related information and improving antibiotic prescription practices [17]

Discussion

The findings from the reviewed articles collectively provide valuable insights into the awareness level of the community regarding antimicrobial resistance (AMR) and responsible antibiotic use. Education level emerged as a significant determinant, with higher education positively associated with increased AMR knowledge and responsible practices. However, the influence of gender on AMR awareness remains varied, with some studies suggesting a gender disparity while others finding no substantial differences. The importance of completing antibiotic courses as prescribed was highlighted as a crucial factor in preventing antibiotic resistance. Misconceptions about antibiotic effectiveness were prevalent, indicating the need for targeted educational interventions. Additionally, self-medication with antibiotics was identified as a common practice, emphasizing the need for increased awareness and responsible use. By addressing these findings and tailoring educational interventions to specific demographic groups, we can enhance community awareness of AMR and promote responsible antibiotic use, thereby combatting the escalating threat of antibiotic resistance and ensuring the efficacy of these vital medications for future generations. When it comes to raising awareness about antimicrobial resistance (AMR), various digital tools have been explored, including smartphone applications, online games, animations, and social media platforms. These tools have both positive and negative aspects.

Smartphone applications have shown promise in raising AMR awareness among the public and healthcare professionals. They provide a means of communication, offer adherence reminders, and disseminate relevant information. However, it is important for app developers to ensure that these tools align with the specific needs and preferences of users. Addressing the challenges associated with antimicrobial stewardship and tailoring

app functionalities accordingly is crucial. Additionally, healthcare professionals may need additional training to effectively integrate these applications into their clinical practices.

Online games have demonstrated several positive impacts in the context of AMR. They are inherently engaging and motivating, capturing players' attention and interest. Games make learning enjoyable and fun, increasing information retention and understanding. They also facilitate discussions among players, encouraging dialogue and collaboration. However, it is important to ensure that game content accurately represents the complexity and severity of AMR to prevent potential misunderstanding. Moreover, games may not reach all individuals, particularly those who do not have access to gaming platforms or who are not interested in gaming.

Animations are an effective tool for raising awareness about AMR in a storytelling fashion. They can be tailored to specific target audiences, creating comics or videos that raise curiosity and engage people in discussions related to AMR. As digital creations, animations are easily shareable and can be disseminated through various media channels. However, there is a possibility that animations may not be treated seriously by some people, limiting their potential to bring about the expected change in behavior.

Social media platforms have a significant reach and can play a vital role in raising AMR awareness. They provide a low-cost means of information dissemination, which can be beneficial for reaching a large audience. However, the algorithms used by social media platforms may limit the reach of initiatives, as they tend to cater to the existing aware audience. Additionally, tracking the impact of social media initiatives on people's attitudes towards AMR can be challenging.

Digital education platforms have the potential to enhance health literacy by providing accessible and interactive information about AMR and appropriate antibiotic usage. They can influence and change healthcare professionals' and patients' antibiotic usage patterns through evidence-based information and promoting responsible antibiotic use. However, integrating new digital solutions into traditional primary care routines can be challenging. Healthcare workers may face difficulties in adopting and effectively using digital tools, while patients may have concerns about device hygiene and the usefulness of digital platforms, especially older patients.

Algorithmic interventions can be highly effective by targeting individuals' beliefs and practices. They can ensure attitude and behavior change and make use of health data to tailor interventions accordingly. However, developing effective algorithms can be complex and costly, and there are ethical considerations regarding the use of private health data to manipulate individual behavior.

Key Strategic points for potential Digital tools that can benefit India:

- ✓ Build smartphone apps and online games that are suited to India's different cultural and linguistic backgrounds. Consider developing regional language versions to enhance accessibility and reach a wider audience.

- ✓ Use social media channels with a huge user base in India, such as Facebook and WhatsApp, to communicate AMR-related information. Create interesting and shareable content in many languages to successfully target diverse age groups and areas.

- ✓ Collaborate with renowned Indian gaming platforms to develop online games that integrate AMR educational aspects. Consider collaborating with educational institutions to incorporate these games into the school curriculum or extracurricular activities.

- ✓ Create animations or short videos to address specific AMR myths or difficulties prevalent in the Indian setting. Use sympathetic characters and themes to captivate viewers and encourage AMR dialogues.

- ✓ Promote digital education platforms that are accessible via low-bandwidth internet connections, as internet speeds vary across India. Consider offline capabilities or mobile applications that can be accessible without constant internet access.

- ✓ Collaborate with healthcare professional associations and institutions to offer training and workshops on how to use digital platforms successfully for AMR education and communication. This can aid in addressing technology affinity issues and improving the integration of digital tools into therapeutic practices.

- ✓ Ensure that algorithmic interventions prioritize privacy and data protection, in accordance with India's relevant legal and ethical frameworks.

By tailoring digital tools to India's internet user base, language preferences, and cultural diversity, these recommendations aim to maximize the effectiveness of AMR awareness campaigns and promote responsible antibiotic use in the country.

Limitations of the Study:

1. By focusing on two databases, the findings of the scoping review may lack generalizability to a broader context. Ongoing activity to explore more databases
2. The inclusion criteria for this study focused solely on articles indicating a significant impact. However, further exploration is necessary to incorporate a broader range of literature and gather a more comprehensive understanding of the topic at hand.

Way Forward

In future, text mining techniques can be employed to facilitate the article screening process and reassess the study. By harnessing the power of text mining, the evaluation of relevant articles can be enhanced, potentially leading to a more robust and comprehensive analysis of the subject matter.

Conclusion

The awareness level of the community towards antimicrobial resistance (AMR) globally has been shown to be varied, with factors such as education level, gender, misconceptions, and self-medication practices influencing awareness. Digital tools, including smartphone apps, online games, animations, and social media platforms, have been utilized globally to promote AMR awareness. These tools have shown promise in engaging and educating diverse audiences, but their effectiveness depends on tailoring them to specific cultural contexts and addressing challenges such as accuracy of content and integration into healthcare practices.

In the Indian context, the use of digital tools for AMR awareness is still emerging. Recommendations include developing culturally and linguistically appropriate smartphone apps and online games, utilizing popular social media channels, collaborating with gaming platforms and educational institutions, creating engaging animations, promoting accessible digital education platforms, providing training for healthcare professionals, and ensuring ethical use of algorithms. By implementing these recommendations, we can enhance AMR awareness and promote responsible antibiotic use in India.

In conclusion, this study addressed all the above-mentioned objectives and highlights the importance of raising AMR awareness in the community and utilizing digital tools to achieve this goal. By tailoring these tools to specific cultural contexts and addressing challenges, we can effectively engage and educate the public about AMR, combat misconceptions, and promote responsible antibiotic use.

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