

Community Engagement-Related Intervention to Address Antimicrobial Resistance (AMR) across Human, Animal and Environmental Health: A Systematic Review

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Abstract Antimicrobial resistance (AMR) is widely recognized as a major issue in global public health. WHO has implemented awareness campaigns as a strategy to combat the issue of AMR. Nevertheless, it has been discovered that solely raising awareness is insufficient. As a result, a new approach involving community engagement has gained traction and is now widely utilized in developing nations. The systematic review seeks to address intervention to prevent AMR within the framework of community engagement utilizing a one-health approach. PubMed, Scopus, and Web of Science databases were searched in accordance with PRISMA guidelines. Following strict inclusion and exclusion criteria, a structured search protocol was employed to retrieve and screen the article. Out of 7730 studies (after duplicates were removed), twenty-six studies were discovered up to 2024. The study design was varied, and most of them were Randomized Control Trials (RCT), and study population

were mostly conducted among the immediate community. In this synthesis, most studies emphasized community-oriented approaches based on WHO criteria in terms of community engagement. Current efforts to tackle antimicrobial resistance interventions mainly focus on human health and human needs. Community engagement can potentially address a wide range of AMR-related issues, providing a valuable opportunity for involvement. The success of community engagement heavily relies on the type of intervention offered to the community. Achieving behavioral changes is more difficult with complex interventions, but simpler interventions involving community leaders are more likely to lead to successful behavioral changes.

Keywords Community Engagement, AMR, Human, Animal, Environment

1. Introduction

Antimicrobial resistance (AMR) is currently acknowledged as a significant global public health concern [1]. It is estimated that AMR has the potential to cause approximately 700,000 fatalities worldwide annually. However, if substantial measures are not taken, this number could escalate to 10 million deaths annually by 2050. Moreover, the cumulative economic burden associated with AMR is projected to reach around US\$100 trillion by the same year [2].

The misuse and overuse of antimicrobials in human, animal, and environmental settings, as well as the transmission of resistant bacteria and resistance genes within and among these sectors worldwide, are the primary causes of antimicrobial resistance [3]. According to the 2015 Global Action Plan on Antimicrobial Resistance (AMR) by the World Health Organization (WHO), one of the five main aims is to enhance public awareness of antibiotics and AMR [4]. Nevertheless, recent assessments indicate that simply raising awareness and providing education are inadequate to foster significant and enduring shifts in behavior [5–7]. The community engagement (CE) approach has recently emerged as a popular method for addressing AMR, especially in developing countries [8]. Numerous interpretations exist for CE. However, it is frequently described as a collaborative process that fosters trust and alliances between a distinct community and broader stakeholders, including policymakers, service providers, and research teams [9].

In recent years, the utilization of CE has witnessed a significant rise within the framework of the One Health strategy. This comprehensive approach aims to tackle various challenges that affect the well-being of humans, animals, and the environment [10–12].

Research on addressing AMR through community engagement focused on a One Health perspective is growing extensively in LMIC countries [9, 13]. Consequently, it is necessary to reassess the primary intervention studies that have been published, including primary intervention studies of community engagement-related interventions in addressing AMR across human, animal, and environmental health.

To address AMR in the context of human, animal, and

environmental health, 8344 publications have been identified that report community-engagement-related interventions on AMR. The publications were divided into five separate research clusters, each distinguished by a different color and the magnitude of its nodes (Figure 1). The clusters were identified through an analysis of keywords that appear together in various studies. This analysis groups similar terms that often show up in research papers, forming clusters based on how strongly they are connected. The clustering is shaped by keyword co-occurrence, research focus areas, network analysis, and publication information. Cluster 1, which is represented by the red area, emphasizes the importance of consumer engagement in the field of antibacterial research. Cluster 2, illustrated by the green section, is linked to the involvement of healthcare professionals in the diagnostic phase, in addition to the element of patient education. Cluster 3, which is denoted by the blue area, signifies the commitment to addressing AMR within the animal industry, with a specific focus on the participation of veterinary medicine. Cluster 4 (yellow area) demonstrates that community engagement is associated with particular age and gender categories, including male, female, children, adolescents, parents, etc. Cluster 5, depicted by the purple section, is connected with engaging with individuals who have particular health conditions or diseases, like tuberculosis and HIV. According to the bibliometric analysis, most of the extensive network focused on human subjects in addressing AMR through CE interventions. However, the animal health intervention showed smaller nodes, indicating fewer publications in this field and an absence of particular nodes in the environmental study associated with this research topic. Community engagement projects related to AMR frequently involve collaboration across different disciplines and are designed to tackle various levels of research questions [9, 13].

To understand these issues, we systematically reviewed the literature on community engagement-related interventions in addressing AMR based on One Health component. The research questions are well-suited to the systematic review design. The systematic review aimed to address interventions to prevent AMR conducted through a community engagement approach across human, animal, and environmental health.

Table 1. Characteristics of the included studies

Authors	Study Design	Location	Country Category ^{a)}	Study Participant	Study Outcome
Rostami et al, 2019 [20]	One time intervention with cross-sectional survey evaluation	Iran	LMIC	Immediate (general population) and Non Immediate (doctor)	Knowledge on AMR and program quality
Shehadeh et al, 2016 [37]	One group pre-post interventional study	Jordan	LMIC	Immediate (general population)	<ul style="list-style-type: none"> • Knowledge regarding appropriate and safe antibiotic use and resistance among adults in Jordan. • Behaviour of safer antibiotic use and reduction of self-medication.
Bakarruddin et al, 2022 [29]	One-group pre-test-post-test experimental design	Malaysia	UMIC	Immediate (school children)	Level of knowledge
Quynh Hoa et al, 2017 [30]	Two-armed cluster randomised controlled trial	Vietnam	LMIC	Non immediate (HCP / health care provider)	HCP's knowledge and practice
Nyamu et al, 2021 [21]	One group pre-post interventional study	Kenya	LMIC	Non immediate (HCP and HC Volunteer)	Patients with URTI receiving AB
Awad et al, 2006 [31]	Stratified cluster randomised trial design	Sudan	LIC	Non Immediate (HCP)	From each patient encounter, data were abstracted on the prescriber's qualification, patient details, diagnosis, the antibiotic prescribed, its dose and duration of therapy. The total number of encounters with antibiotics prescribed was determined in each health center.
Appiah et al, 2021 [26]	Mixed methods	Ghana	LMIC	Immediate (school children)	Knowledge, attitude, beliefs
Holloway et al, 2009 [32]	Controlled before-and-after design	Nepal	LMIC	Immediate (student, mother, family) and Non Immediate (HCP, CHW, District Health Office (policy maker level), Community carer)	<ul style="list-style-type: none"> • Outcome indicators specified in the protocol were: • % Consulting at a health post (CHP) • % Prescribed and treated with an antibiotic of any class (PAb) • % Prescribed and treated with cotrimoxazole (PcT) • % Prescribed and treated with amoxicillin (PAx) • % Treated with an antibiotic obtained over-the counter (AOTC, i.e., obtained without a prescription from a drug retailer rather than a health post) • % Consulting a FCHV • % Treated with a safe home remedy (SAFE).
Salimi et al, 2021 [33]	Quasi-experimental study with experimental and control groups	Iran	LMIC	Immediate (mother)	Knowledge and beliefs, behaviors, sources of information, adherence, and awareness about antibiotics resistance
Tseklevs et al., 2023 [22]	Innovative mixed-method approach	Ghana	LMIC	Immediate (household)	Current practices and perceptions of cleanliness and hygiene in relation to household dust and household environments.

Table 1 continued

Ashiru-Oredope et al., 2022 [23]	Descriptive study	(Ghana, Kenya, Malawi, Nigeria, Sierra Leone, Tanzania, Uganda, United Kingdom, and Zambia)	LMIC	Non Immediate (HCP and health students)	Perceived knowledge, confidence and sharing lesson
Maung Swe et al, 2020 [18]	Pre-post one group experimental	Myanmar	LMIC	Immediate (general community)	Knowledge, enjoyment/fun, willingness to support engagement activities, preference of method
Iskandar et al, 2023 [38]	A prospective cross-sectional pre-/post study	Lebanon	LMIC	Immediate (elementary and middle school children)	Knowledge and awareness
Charoenboon et al, 2019 [27]	Mixed-method	Thailand & Lao PDR	LMIC	Immediate (household)	Attitude and behaviour
Appiah et al, 2022 [39]	Prospective, single group randomized design	Ghana	LMIC	Immediate (schoolchildren, parents)	Knowledge, beliefs and attitude
Shen et al, 2021 [34]	Quasi-experimental study	China	UMC	Immediate (household, pig farmer)	Changes in Knowledge, Attitudes and Reported Practices Pre- and Post-Trial
Haenssger et al, 2018 [6]	Quasi-experimental design	Lao PDR	LMIC	Immediate (household)	Outputs (individual): direct and indirect exposure to educational activity, lessons and feedback from educational activity; Outcomes (individual): awareness and understanding of drug resistance, "desirability" of antibiotic-related attitudes and knowledge; Impacts (illness): patterns of healthcare utilisation during acute illnesses, sources of antibiotics during acute illnesses
Thornber et al, 2019 [24]	a pilot study	Bangladesh	LMIC	Immediate (farmer)	Impact of animation on aquaculture farmers in Bangladesh
Ebels et al, 2016 [19]	Qualitative study in pictogram model development	India & Kenya	LMIC	Immediate (mothers of children) and Non Immediate (HCP & caregivers)	Adherence to childhood pneumonia treatment
Hafez et al, 2024 [40]	A quasi-experimental design	Egypt	LMIC	Immediate (mothers of children less than 6 years)	<ul style="list-style-type: none"> The level of knowledge among mothers about antibiotics The level of mothers' attitude regarding the self-prescribed antibiotics The level of mothers' appropriateness regarding the use of antibiotics

Table 1 continued

Arparsrithongsagul et al, 2015 [35]	quasi-experiment with a pretest–posttest nonequivalent comparison group design	Thailand	LMIC	Immediate (groceries owner)	Baseline on antibiotic groceries owner, the extent of antibiotic availability in village grocery stores, the presence of antibiotics in village grocery stores, and the knowledge of village grocery owners regarding antibiotics
Fernandes et al, 2019 [41]	A prospective quasi-experimental pre-post study	India	LMIC	Immediate (school student)	Knowledge
Saleh at al, 2021 [42]	Pre-post study	Jordan	LMIC	Non Immediate (community pharmacist)	Knowledge and Perception of community pharmacist
Radhakrish-nan et al, 2023 [36]	Concurrent parallel group single-blinded randomized control study	India	LMIC	Immediate (adult population)	Knowledge, attitude, and practice of antibiotic use.
Khoshgoftar et al, 2021 [25]	Quasi-experimental study	Iran	LMIC	Immediate (general population)	Knowledge, attitudes, and performance
Huque et al, 2016 [28]	Mix method	Bangladesh	LMIC	Non immediate (HCP)	The proportion of children aged five and younger 1) Individuals who were accurately diagnosed, 2) individuals who were appropriately treated, 3) individuals who were referred to the relevant services when needed, and 4) individuals for whom antibiotics were administered judiciously (given when advised in the job aid and withheld when not recommended).

*) Based on World Bank List Category 2023

Table 2. Results of the included studies





Authors	Description of Community Engagement Related Intervention	Involvement of the Community Member in the Program/Intervention	Conclusion or Results of Community Engagement Related Intervention	Contribution to AMR from One Health Perspectives (Human, Animal or Environment)	Level of CE & CE Approach (based on WHO)	MMAT Scoring
Rostami et al, 2019 [20]	Campaign through conference, video, poster and face to face training for general population and medical staff (general practitioners, specialists and medical residents)	Isfahan University of Medical Sciences developed the campaign with the help of a diverse committee and received their endorsement. Medical staff shared AMR prevention information at conferences. Trained pharmaceutical and medical students conducted educational sessions in the city using brochures during the campaign.	The campaign program has been an opportunity to strengthen the antibiotic awareness among general population and medical staffs.	Human	Consulted & Involved (Community based)	
Shehadeh et al, 2016 [37]	Pharmacist-led educational intervention using card entitled ‘Get smart, know when antibiotics can be used’ in general population	During a 10-minute conversation, the pharmacist had the participant answer questions on a questionnaire about antibiotics, their appropriate use, and resistance.	The ‘Get smart, know when antibiotics can be used’, a pharmacist-led education has been significantly improving the knowledge of participants about safety and use of antibiotics.	Human	Consulted & Involved (Community based)	
Bakaruddin et al, 2022 [29]	Educational intervention through series of pictorial story books in school children aged 6-7 years old	Non immediate community member involves in the intervention development (book company, pharmaceutical company and academic/practitioners). Parents’ immediate community members guide their children during the intervention such as reading the question.	The utilization of pictorial storybook read-along video interventions from the Siri Kenali Ubat series has demonstrated efficacy in enhancing children’s understanding of the appropriate use of medication, specifically focusing on medication storage and antibiotic resistance.	Human	Inform (Community oriented)	
Quynh Hoa et al, 2017 [30]	A multifaceted educational program was designed to enhance the understanding and practices of healthcare workers regarding sexually transmitted infections (STIs) and acute respiratory infections (ARIs).	The ARI intervention arm was led by medical doctors and lecturers from Hanoi Medical University who were experts in paediatrics and antibiotic use, with a focus on ARIs. The STI arm interventions included three educational sessions that coincided with the timing of the ARI interventions. These educational sessions on STIs were facilitated by individuals who possessed similar levels of expertise in the field.	The multi-faceted intervention led to a substantial enhancement in both ARI knowledge and prescription practices within the intervention group.	Human	Inform (Community oriented)	

Table 2 continued





Nyamu et al, 2021 [21]	An interactive educational program involving health facility personnel and CHVs (Community Health Volunteers).	The researcher consulted with health care providers and CHVs to discuss their comprehension of staff views on AMR, the factors contributing to the high volume of clinical visits for URTIs, and the rationales behind the elevated antimicrobial (AM) usage.	An interactive educational program led to a decrease in antimicrobial prescriptions among the targeted age group, which has the potential to safeguard the community against the serious implications of antimicrobial resistance (AMR).	Human	Inform (Community oriented)	
Awad et al, 2006 [31]	Multifaceted intervention on prescribing practices of antibiotics among health care providers	In the development of intervention, FGD was conducted to enable engagement with the HCP regarding the barrier in AM prescribing practice. During the intervention, clinical pharmacologists were involved in 2 of the intervention groups to facilitate interactive discussion.	Using a combination of audit and feedback with academic detailing or seminars is more effective in changing antibiotic prescribing practices than using audit and feedback alone.	Human	Consulted & Involved (Community based)	
Appiah et al, 2021 [26]	Educational intervention through storytelling and picture drawing on school children at the junior high school	During preparation of the intervention, members of Ghana Education Service were involved in selecting schools. Teachers were involved in engagement and adaptation of material. During intervention delivery, teachers lead the story telling sessions.	Adapting storytelling and picture drawing techniques is essential to educate school-aged children about antibiotics and antimicrobial resistance.	Human	Consulted & Involved (Community based)	
Holloway et al, 2009 [32]	Training health post staff and school teachers to deliver education programs through street performances, posters, discussions, and workshops as part of a community intervention.	During the initial phase of the project, a local leader was consulted to choose the project location. In 2002, a study was carried out with BNMT, government representatives, and community members to collect suggestions and perspectives. All community members participated in the project, which employed a training of trainer (ToT) approach. The community project, utilizing the ToT approach, provided various educational activities such as street shows, posters, talks, and planning workshops.	Multi-faceted community-based intervention on ARI showed effective results to promote rational treatment especially improvement of antibiotic prescribing.	Human	Collaborate (Community managed)	

Table 2 continued






Salimi et al, 2021 [33]	Mobile-based education and booklet-based education on antibiotic use among mothers of children aged 1-6 years	During the intervention creation process, discussions took place with pediatricians, pediatric nurses, and faculty members specializing in pediatric nursing and parent education. Their input was considered, leading to adjustments in the educational material to align with adult learning principles (andragogy).	Using mobile-based education can enhance mothers' knowledge and attitudes towards antibiotics, as well as their behaviors and awareness of antibiotic resistance.	Human	Inform (Community oriented)	
Tseklevs et al., 2023 [22]	Home cleaning intervention “Dust Bunny Project “ through combined design and microbiology methods in household	The study preparation involved a partnership between researchers from Lancaster University (LU), UK and the Noguchi Memorial Medical Research Institute (NMIMR), Ghana. Community members played an active role in the study by participating in workshops and helping with the intervention.	New cleaning techniques were introduced, such as a more systematic approach to cleaning at home, more frequent cleaning, the use of cleaning products, and using specific cleaning materials for various surfaces and rooms.	Human, Environment	Consulted & Involved (Community based)	
Ashiru-Oredope et al., 2022 [23]	Development of online game to improve antimicrobial stewardship (AMS) among health care providers and health students.	In the process of creating the AMS games, stakeholders were involved. The game was a collaboration between partners in the UK and eight African countries in the CwPAMS. Twenty-seven stakeholders from various health professions in nine countries provided input on the game. Players can act as facilitators during the game.	The AMS game online was enjoyable and increased the knowledge and awareness among health students and health care professionals.	Human	Consulted & Involved (Community based)	
Maung Swe at al, 2020 [18]	Co-design community intervention to explore antibiotic utilization for febrile illnesses by utilizing forum theatre performances within the community setting.	Prior to the workshop, consultative meetings took place with health and administrative authorities. Housewives, manual workers, and civil society organization members participated in the workshop to identify issues related to AMR.	Forum theatre can be a fun and interactive method to engage the public in discussions about antibiotic use for febrile illness and to promote awareness of proper antibiotic usage in the community.	Human	Collaborate (Community managed)	
Iskandar et al, 2023 [38]	A program led by pharmacists to teach elementary and middle school students about microbes, infections, antibiotics, and antibiotic resistance.	The educational material for the intervention was reviewed by pharmacists, school teachers, and parents before being tested with junior and senior students to confirm the effectiveness of the wording, slide design, and relevance. The intervention was then conducted by pharmacists with teaching expertise or newly qualified pharmacists.	The educational tool led by the pharmacist effectively improved understanding of antibiotic use and AMR among elementary and middle school students.	Human	Consulted & Involved (Community based)	

Table 2 continued

Charoenboon et al, 2019 [27]	Educational activity regarding antibiotic-related information consists of six sessions of various activities with different purposes and being interactive among the adult population in three villages in northern Thailand	The community members (adult household) were passively received education material that was informed.	The educational activity on antibiotics had a mild impact on people's health-related attitudes and behaviors. Language barriers posed challenges for some, and disparities in healthcare contributed to higher antibiotic sales, rumors, and resistance from the public.	Human	Inform (Community oriented)	
Appiah et al, 2022 [39]	AMR animation as educational tools to improve AMR awareness among schoolchildren aged 13-14 years and their parents	Schoolchildren and science teachers from each school which involved in this study participated in the developing animation of AMR. These Science teachers engaged with the students after the baseline survey has been done	Parents' knowledge and attitudes towards AMR could be influenced by AMR animation videos developed with input from schoolchildren.	Human	Consulted & Involved (Community based)	
Shen et al, 2021 [34]	An intervention package has been developed to improve understanding, attitudes, and behaviors regarding antibiotic use in rural communities and backyard pig farms. This package includes training sessions, speakerphone support, posters, and a handbook.	Community member only passively received information that was informed by the hospital doctor and information through poster, speaker phone and handbook	The visual and auditory intervention resulted in a notable rise in human understanding of antibiotic use, but did not have the same effect on pig antibiotic use knowledge.	Human, Animal (pig farmers)	Inform (Community oriented)	
Haenssger et al, 2018 [6]	The antibiotic education program for adult peri-urban villagers in Salavan is structured around six sessions. These sessions feature activities such as community mapping, a medicine matching game, a resistance game, role-playing, a healthy-wealthy game, and a feedback and reflection session.	Community members did not participate in developing the intervention, as the study team was responsible for creating and evaluating the activity.	The educational activity brought about changes in attitudes towards antibiotics and in the understanding of "drug resistance" among the participants directly involved, in line with the activity's content.	Human	Inform (Community oriented)	

Table 2 continued










<p>Thornber et al, 2019 [24]</p>	<p>Development of digital video animation to share AMR messages with aquaculture farmers in Bangladesh via social media like Facebook and Twitter.</p>	<p>The making of the animation included input from aquaculture industry experts and community engagement professionals at a workshop in Dhaka, Bangladesh. The final product was a 4-minute digital animation that incorporated culturally relevant elements like landscape, characters, clothing, and background music.</p>	<p>Preliminary data shows that the rapid and effective dissemination of digital animation has engaged rural aquaculture communities within a six-month period.</p>	<p>Animal (fish farmers)</p>	<p>Consulted & Involved (Community based)</p>	
<p>Ebels et al, 2016 [19]</p>	<p>Developing user-friendly pictorial instructions for using Amoxicillin Dispersible Tablets (DTs) in treating childhood pneumonia can enhance antibiotic adherence and reduce the likelihood of antibiotic resistance.</p>	<p>This study engaged or collaborated with stakeholder in developing the new pictogram design in Amox-DTs user friendly</p>	<p>Qualitative surveys during field testing in India and Kenya revealed that both healthcare providers and caregivers had positive reactions to the new pictogram design, resulting in improved adherence to antibiotic therapy for childhood pneumonia and preventing antibiotic resistance.</p>	<p>Human</p>	<p>Consulted & Involved (Community based)</p>	
<p>Hafez et al, 2024 [40]</p>	<p>Nursing-based educational intervention covers antibiotics, antimicrobial resistance, the dangers of self-prescribed antibiotics, and the safe use of antibiotics for mothers with children under 5 years.</p>	<p>Community member (mother) was not involved in the development of the intervention and passively informed about the educational material.</p>	<p>The educational program through nursing-based intervention significantly improved knowledge, attitudes, and habits among mothers of children less than 5 years.</p>	<p>Human</p>	<p>Inform (Community oriented)</p>	
<p>Arparsrithongsagul et al, 2015 [35]</p>	<p>Establishing MPI&CI (Multidisciplinary perspective intervention & Community Involvement) in Thailand to engage villagers and government officers, educate about antibiotics, inspect antibiotic availability in groceries, and notify grocery owners to decrease antibiotic sales.</p>	<p>The MPI&CI (Multidisciplinary Perspective Intervention & Community Involvement) is being developed by insights from focus groups with diverse stakeholders. Community leaders are actively educating villagers about antibiotics and investigating their availability. Government officers are also ensuring compliance with drug regulations for antibiotic sales.</p>	<p>The MPI&CI program boosted the groceries owner's knowledge and led to a decrease in antibiotic sales at village stores, which in turn reduced inappropriate antibiotic use and antimicrobial resistance.</p>	<p>Human</p>	<p>Collaborate (Community managed)</p>	

Table 2 continued

Fernandes et al, 2019 [41]	The e-bug program teaches schoolchildren aged 11-13 about antimicrobial resistance and how to prevent it. It covers topics like microbes, antimicrobial, infection control, immunity, hand hygiene, and probiotics.	The teachers are not involved. Pharmacists or newly graduated pharmacists are involved in the education delivery.	The educational program helped increase knowledge about antimicrobial use and microbes. Students were eager to learn and performed well on the post-test, showing a good understanding. This knowledge can be used as a new community strategy.	Human	Inform (Community oriented)	
Saleh et al, 2021 [42]	The online educational workshop aims to enhance the understanding and perspective of community pharmacists on AMS, as well as to improve their capacity in selecting the right antibiotic therapy.	Three clinical pharmacy PhD holders assisted in creating the questionnaire. The survey was tested on pharmacists to ensure clarity, and their responses were not included in the final analysis. Two clinical pharmacists with over ten years of experience in infectious diseases prepared and presented the intervention material.	The workshop successfully enhanced community pharmacists' understanding of AMS and their skills in choosing the right antimicrobial.	Human	Inform (Community oriented)	
Radhakrish-nan et al, 2023 [36]	The effectiveness of pamphlet and video based as clinical pharmacist educational interventional tool among adult population in rural area.	A pharmacist and a microbiologist collaborated to simplify WHO and Indian Council of Medical Research information for pamphlets and videos. The pharmacist is educated through videos and pamphlets. The team ensured the questionnaire is easy to understand and reliable.	The video-based educational tool had a greater impact on public awareness and perception of antibiotic use compared to the pamphlet-based tool.	Human	Inform (Community oriented)	
Khoshgoftar et al, 2021 [25]	The educational campaign in Iran addressing antibiotic use and microbial resistance has had a significant influence on the knowledge, attitudes, and behaviors of the general population.	A Public health students distributed surveys in targeted areas to the public. After gathering data, five experts were stationed at busy city locations to distribute educational materials.	The educational campaign raised awareness and improved attitudes, but there was no notable change in individual performance.	Human	Inform (Community oriented)	
Huque et al, 2016 [28]	Educational intervention and training will be provided to community health care providers (CHCPs) in rural community clinics (CCs) in Bangladesh, focusing on guidance regarding the proper use of antibiotics. This initiative aims to enhance the quality of care for children in these areas.	The participant received the education material and training.	The intervention not only enhanced the quality of care, but also boosted the utilization of appropriate antibiotics among the children in this study.	Human	Inform (Community oriented)	

2.4. Hand Searching

Manual searching techniques were also employed, including hand-searching through electronic journals to find citations and references (also known as snowballing). The process entailed manually reviewing relevant peer-reviewed journals during the full-text screening.

2.5. Assessment of Methodological Quality

In this review, the MMAT (mixed method appraisal tool) will be employed to evaluate the methodological rigor of the papers included. This tool assesses five research categories, encompassing qualitative studies, randomized controlled trials, non-randomized studies, quantitative descriptive studies, and mixed methods studies [15–17].

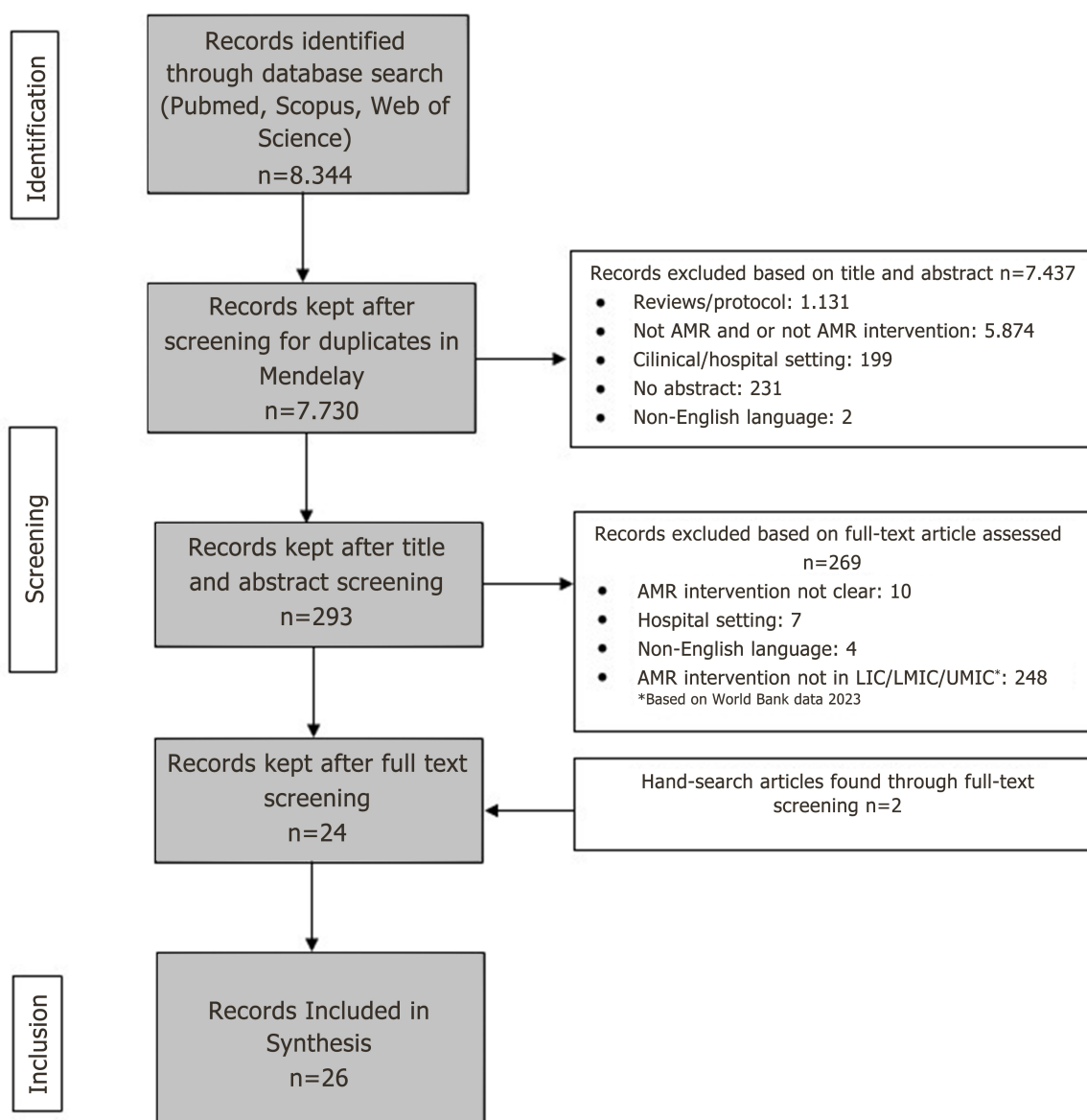


Figure 2. PRISMA flow-chart illustrating the identification, analysis, and selection of the articles

3. Results

3.1. Study Selection

A total of 8344 records were found from 3 databases. After removing 614 duplicates, 7730 titles and abstracts were screened. Of these, 7,437 studies were excluded for not meeting the eligibility criteria. The remaining 293 full-text studies were reviewed. After the review, 269 more studies were excluded for various reasons. Two additional studies were conducted by hand-searching the reference lists. In the end, 26 studies were included in the review. The details of the search and selection process can be seen in Figure 2.

3.2. Study Characteristic

The studies in Table 1 show different characteristics like study design, location, participants, and outcomes. There were 26 studies analyzed, with 2 qualitative [18, 19], 6 quantitative descriptive [20–25], 3 mixed methods [26–28], 8 RCTs [29–36], and 7 non-randomized control trials [6, 37–42]. Iran and Ghana had 3 studies [20, 22, 25, 26, 33, 39], while Bangladesh [24, 28], Jordan [37, 42], and India [36, 41] each had 2 studies. Other countries with 1 study each include Myanmar [18], Nepal [32], Vietnam [30], Thailand [35], Sudan [31], Egypt [40], Malaysia [29], China [34], Lebanon [38], Lao PDR [6], and Kenya [21]. Additionally, 3 studies involved multiple countries [19, 23, 27]. Based on the 2023 World Bank Category, 22 studies were in LMICs [6, 18–26, 28, 30, 32, 33, 35, 36, 38–42], 1 in a LIC [31], and 3 in UMICs [27, 29, 34].

Based on the study participants, 4 studies involved the general population [18, 25, 36, 37], 4 involved school children (from elementary to junior high school) [26, 29, 38, 41], and 3 involved households [6, 22, 27]. There were two studies conducted among health care providers (HCP) [30, 31] and 2 among mothers [33, 40]. Additionally, 1 study included grocery owners [35], community pharmacists [42], farmers [24], and children under 5 years old [28]. The remaining 7 studies involved various participants in 1 study (HCP, policymakers, households, farmers, parents, mothers, caregivers, and school children) [19–21, 23, 32, 34, 39]. Out of these 26 studies, 18 were conducted within immediate communities [6, 18, 22, 24–29, 33–41], 6 within non-immediate communities [20, 21, 23, 30, 31, 42], and 2 within both types of communities [19, 32].

Study outcomes were measured in various indicator categories, including knowledge (and/or awareness) related to AMR and/or AMR program prevention, consumer behavior, HCP practice, perceived knowledge, confidence, and perception and practice related to environmental hygiene. Most studies (9 studies) measure knowledge (and/or awareness) related to AMR and/or AMR program prevention. Three studies measure consumer behavior, and 3 studies measure HCP practice. The rest of the studies (14

studies) have multiple outcome measures. Specific measures of these studies are described in Table 1.

We utilize the WHO classification for community engagement to group the approach of community engagement-related intervention among the studies included. According to WHO, there are four types of CE, but in this review, the studies only fit into three categories: community-oriented (13 studies) [6, 21, 25, 27–30, 33, 34, 36, 40–42], community-based (10 studies) [19, 20, 22–24, 26, 31, 37–39], and community-managed (3 studies) [18, 32, 35]. No study fit to be categorized as community-owned [43].

3.3. Community Oriented

We found 13 studies that used a community-oriented approach in their programs. The interventions took different forms. Most of the interventions (4 studies) involved various or multifaceted interactive activities [6, 27, 30, 34]. These studies divided the interventions into multiple sessions, each with different activities. The activities varied from one-time message delivery with several activities, from community mapping, games, and role-play to feedback and reflection, to multiple modes of delivery, such as training with an audiovisual approach, using a speakerphone to deliver the message in a public area, attaching posters at strategic places, and handbook distribution or case studies. Other formats used in the studies included single/one-time interactive face-to-face educational sessions [21, 28, 40]. Two studies used a combination of paper and digital methods to deliver educational messages, ranging from a combination of pamphlets and video-based tools to a combination of mobile and booklet-based tools [33, 36]. One study delivers intervention using single online training [42], and one study in the form of a single field campaign [25].

Regarding the community engagement approach, neither studies consulted with nor involved community members (immediate community or non-immediate community) in delivering the intervention (from development, implementation to evaluation). We categorized it as a community-oriented approach if the study only informs educational material to the community member and does not meet the criteria of consult and involved community member (need to fulfill both aspects). Most of the interventions were prepared or developed by academics' health care providers that either hold or have not held PhD, for example, clinical pharmacists and microbiologists or Health Care Providers and Community Health Volunteers. During the implementation of the intervention, academic members (academic clinical pharmacist and academic microbiologist, specialist pediatric, public health students, newly graduated pharmacist), hospital team (doctor), or study team provided the educational sessions. There was 1 study where parents (immediate community members) helped their children to read questions during the intervention.

Of the 13 studies, 4 focused on healthcare providers, and all indicated that community-oriented educational training could enhance their knowledge and practice of antibiotic use [21, 28, 30, 42]. Two digital studies showed improved knowledge and awareness among schoolchildren. Two studies using a combination of paper and digital methods and 1 face-to-face training also suggested improved knowledge, awareness, behavior, and practice regarding antibiotic use. However, these studies had a small number of respondents. Three other studies that used more complex approaches like multifaceted/various interactive activities with a wider number of subjects suggested that a community-oriented approach to educational intervention is able to improve knowledge and attitude of antibiotic use but limited only to exposed subjects or only in humans (not antibiotic use in pigs) or only mild (as many other factors may contribute such as antibiotic sales, rumors, and public resistance). One study using the field campaign method suggests educational intervention may improve knowledge, but improvement in attitude could not be proven.

3.4. Community Based

We reviewed 10 studies [19, 20, 22–24, 26, 31, 37–39] that fit the community-based engagement approach. Three (3) out of 10 of the studies used digital intervention to deliver the educational intervention. Three studies implemented a single approach to delivering the educational message: either card-based tools for the general population, pictograms to improve antibiotic treatment adherence or face-to-face training. Other formats were creative approaches such as children-led activities (storytelling and picture drawing) and home-cleaning interventions using co-design workshops. Two other studies use multiple activities across several sessions and multifaceted interventions involving audit and feedback combined with either academic detailing or seminars.

This review found that these 10 studies engaged in several intervention phases. During the development stage of the intervention, 4 studies engaged with community members (household, doctor, pharmacist, mother, and caregiver) for problem identification or exploration of barriers and threats in various formats (workshop, focus group discussion (FGD), or interactive dialogue session). Six (6) studies showed engagement with community members while developing material content and type through various activities (story-telling, drawing competition, participatory workshop). Six studies involved community members in providing feedback (through workshops, online questionnaires, and pilot testing). Nine studies involved the community during the implementation of the intervention. All of these researchers were able to reach their aim, even though 1 study did result in an improvement of knowledge report long-term evaluation and more controlled design needs to be considered in future research.

3.5. Community-managed

We reviewed 3 studies that fit the community-managed engagement approach [18, 32, 35]. All three of these 3 studies have a different kind of interventions, 1 study uses various educational activities (workshop, poster, street performance, discussion) with the training of trainer (ToT) method given to health post staff (similar to community cadre) and teachers [32]; 1 study conducts a combination of educational and field investigations targeting the general population and groceries owner [35]; 1 study performs forum theatre as a creative art approach [18]. In terms of the community engagement approach, all of these studies show similarities in that these 3 studies have more varied and stronger engagement with the immediate community and non-immediate community, particularly with government officers who hold the authority.

In a study by [32], community leaders, government officials, and community members (mothers, students, and caregivers) were consulted to choose the intervention site. The Training of Trainers method was used to train teachers and health staff for 3 days. Workshops were organized for students, retailers, and community leaders to create action plans. Trained teachers conducted educational activities for children. Children performed street theater for mothers' groups, followed by interactive discussions led by female community health volunteers (FCHVs). Teachers played a crucial role in guiding and supporting data collection. All these activities show that all community members are actively involved in preparing and managing the intervention. The intervention successfully promoted rational treatment and improved antibiotic prescribing [32].

In 2020, Maung Swe, et al. [18] conducted research that involved initial steps before intervention, such as consultative meetings with health and administrative officials. The study emphasized the involvement of housewives, manual laborers, and civil society members in story-gathering workshops to address antimicrobial resistance issues. Community leaders played a key role in organizing these workshops, showing the importance of authorities in managing participants. The forum theatre encouraged active participation from community members, who were urged to offer suggestions and even take on acting roles. Community leaders were instrumental in mobilizing members to attend the theater performance. Local qualitative researchers were also involved in the evaluation phase. The study's results suggest that forum theatre can effectively engage the public and promote awareness about antibiotic use in the community.

A study using a community-managed approach, implementing a Multidisciplinary Perspective Intervention & Community Involvement (MPI&CI) was conducted in 2015 [35]. Before starting the intervention, a Focus Group Discussion (FGD) was conducted with various stakeholders to gather information. The intervention included educating on antibiotics, checking antibiotic availability in stores, and informing store owners if

antibiotics were found. Community members like villagers, leaders, health volunteers, and government officers were involved in the implementation. The study demonstrated the involvement of change agents, reaching authorities with significant roles in public policy. Results showed that the MPI&CI intervention increased knowledge among store owners and reduced antibiotic sales, decreasing inappropriate antibiotic use and antimicrobial resistance.

3.6. Quality Assessment of the Studies

The quality assessment of the studies included in the analysis is listed in supplementary Table 2. The majority of the studies (17 out of 26, 66.6%) achieved a combined score of four or higher, while five studies received a score of three, four studies received a score of two, and none received a score of one. None of the articles were excluded from the analysis based on quality. The primary methodological limitations (identified in 8 studies) were determined to have a potential risk of confounding bias [6, 27, 28, 34, 37–39, 41, 42]. Seven studies were noted to have a bias risk for blinding of randomization due to insufficient clarity in describing the allocation process of the clusters [29–35]. Furthermore, six studies lacked adequate details on sampling methods for recruitment from the target population [20–25], and four studies lacked justification for the selected statistical methods [21–24]. Nevertheless, all the studies included in the analysis clearly stated their objectives and were deemed appropriate.

4. Discussion

This review aimed to investigate existing literature on AMR prevention programs across human, animal, and environmental health sectors to gain insights into how these programs implemented community engagement techniques and strategies tailored to their specific circumstances. The global action plan on antimicrobial resistance outlines five key areas of focus, with two primary objectives that can be met through community involvement: enhancing awareness and knowledge of antimicrobial resistance through effective communication, education, and training and promoting positive consumer behavior to optimize the use of antimicrobial drugs in human and animal health. Identifying the most appropriate community engagement methods and procedures for different settings is essential. By utilizing the level of community participation recommended by the World Health Organization, we closely examined how this approach has been applied in various research studies and countries. The results indicate that interventions incorporating a range of approaches and strategies varied from community-oriented to community-managed.

Antimicrobial resistance (AMR) poses a complicated global challenge shaped by various factors that intersect different disciplines. It has consequences for both human

and animal health, agriculture, and the environment [44]. Currently, the emphasis on community engagement focusing on one health is a widely accepted method for managing the incidence of AMR [11, 12]. Community engagement is defined as the active participation of communities in decision-making processes and in the planning, design, governance, and implementation of services. This approach has been identified as a potentially effective strategy for enhancing health promotion and healthcare delivery [45, 46]. Community engagement begins when a specific group of individuals (i.e., a community) is identified as having a need. The process starts by defining both the community and its health concerns. The concept of community can be defined in various ways. In addition to geographical boundaries, boundaries can also be defined by social or economic characteristics, interests, values, or traditions. Communities often self-identify or may be identified by external individuals, often referred to as a population [10]. Understanding the full extent of a community's influence is essential when addressing the issue of AMR. As a One Health issue, AMR requires the participation of stakeholders from all sectors, including human, animal, and environmental health [47].

In this review, most of the community engagement studies on interventions to address AMR issues are from LMIC (22/26 studies) in which this due to the fact that this strategy takes into account the specific context and helps communities create solutions that are relevant to their local needs [8]. In LMIC countries, a significant issue arises from procuring antimicrobials in the human and animal industries without a prescription, as informal stakeholders often depend on them instead [48]. LMICs face additional challenges related to financial constraints and limited resources, which may contribute to self-medication practices such as exchanging antibiotics among relatives or adapting human antimicrobials for veterinary purposes [49, 50].

Methodologically, research on AMR utilizing CE typically leans towards a mixed-methods study [51, 52]. This preference arises from the necessity for research teams to first gather foundational data on a specific aspect or driver of AMR before delving into the examination and potential alteration of certain undesirable behaviors associated with this driver. Utilizing mixed-method approaches enables the flow of knowledge between the research team and the community. This facilitates the project's adaptation to specific circumstances and fosters a truly captivating process in which all parties involved may both acquire new knowledge and exchange their expertise [12]. Only three of the studies included in this synthesis utilized a mixed-method approach. These three studies all emphasized the importance of engaging communities in educational efforts related to antibiotics. The limited use of this approach in recent studies focusing on CE approaches to antimicrobial resistance (AMR) prevention interventions might result from the complexity and resource-intensive

nature associated with mixed methods studies. Additionally, a lack of confidence and experience among researchers may have hindered conducting such studies. High costs and the need for support were also identified as significant factors influencing the decision to conduct mixed-method studies [53–56].

The majority of individuals targeted for intervention in this analysis are human. Presently, CE strategies primarily address the consumption aspect of antimicrobial resistance. Efforts are concentrated on comprehending the methods by which individuals acquire antimicrobials and the reasons behind their inappropriate usage [27, 57, 58]. Despite the ongoing development of various studies, such as using antimicrobials in agricultural settings, the foundation of rationality lies in addressing human necessities [24]. Our analysis indicates that the majority of community involvement efforts are directed toward the human element, highlighting the urgency for low- and middle-income country (LMIC) communities to prioritize immediate consequences [8]. While the environmental repercussions of antimicrobial resistance (AMR) will eventually affect communities, it is more straightforward to illustrate the direct threats of AMR on food security and economic stability. This could contribute to the limited adoption of community engagement strategies when independently addressing environmental or animal health concerns [59, 60].

Community engagement plays a crucial role in facilitating transformations in behavior, environments, policies, programs, and practices within various communities. The varying levels, extents, and scopes of community engagement dictate the nature and extent of participation of community members. The five distinct stages of CE - inform, consult, involve, collaborate, and empower - are commonly known as participation levels. The WHO introduces four approaches to community engagement, ranging from the lowest to the highest level of involvement, problems to be addressed, and health promotion action: community-oriented, community-based, community-managed, and community-owned [43].

Our review finds that most of the studies (13 studies) use a community-oriented approach compared to a community-based approach (10 studies) and a community-managed approach (3 studies). Based on the WHO community level of participation, CE uses a community-oriented approach, which is the level where the community is informed and mobilized to participate in addressing immediate short-term concerns with strong external support. When highlighting issues about short-term goals, limited time is available to build trust and strong relationships with the community members, particularly considering cultural and socioeconomic variations, demographic characteristics, and limitations in terms of funding, time, and skilled personnel.

Of all studies that used a community-oriented approach, 9 used a simple intervention format (single face-to-face intervention, simple combination of paper and digital

intervention, single online meeting), reflecting short-term outcomes and small-scale resources. These studies show the intervention is able to reach its goals, which include improving knowledge and behavior (either immediate or non-immediate communities). However, when the intervention format is more complex, including multifaceted intervention but conducted in a community-oriented approach, the study results show weak results in improving behavior. This is justifiable as complex interventions cannot be done only in the short-term using a community-oriented approach. Community members must be engaged at all intervention phases, from designing to evaluating, enabling trust and relationships built well during the intervention.

A better result with more engagement appears in studies that use community-based and community-managed approaches regardless of the intervention format. Four (4) were conducted on health care providers (HCP), and all suggested interventions to prevent AMR using a community-based approach could improve HCP knowledge of AMR and/or practice in the antibiotic selection and/or prescription pattern. There were 5 studies using a community-based approach and measuring knowledge/awareness among immediate community members and 3 measuring consumer behaviors; all these studies except 1 indicate the intervention positively impacts the outcome measures. This result also appeared the same as studies that use a community-managed approach, which showed effective results in reaching their study aim.

Studies that engage more with the community show engagement in various intervention phases. For example, in the development phase, the problem, barrier, and threat were explored through workshops, focus group discussions (FGD), or interactive dialogue sessions. In some studies, the community member was also involved in developing content material and typed through creative activities such as storytelling competitions, workshops, or feedback sessions (through questionnaires). During the implementation phase, all studies involve community members, especially for studies using a community-based approach; the activity format is also engaging (such as using the training of trainer method, theatre performance, or the form of multidisciplinary community involvement). With a community-based approach, a stakeholder with the authority is also engaged in supporting the intervention, and the community is also actively involved in helping to conduct the intervention, not only receiving information but also showing that the intervention is also managed by the communities. Furthermore, many changing agents are involved, indicating that the study has reached the authorities level, which is important to public policy management.

The limitation of this review reflected the limitations of each study included. Even though most of the studies included have overall good quality evidence (4 out of 5), in detail, sampling bias contributes to the study's weakness,

followed by confounding bias. This review also could not reveal which intervention is more effective as studies related to community engagement were conducted using various methods with different types of evaluation. However, qualitatively, we can see the pattern those interventions that use more community engagement can show better results. A further limitation is that the studies focus on non-high-income countries, which may limit the review findings' transferability to other international contexts. Lastly, despite the significance of this aspect, our review is limited in the number of articles focusing on animals and environmental health, as antimicrobial resistance impacts not only human health but also the health of animals and the environment. For future research, we recommend expanding the focus to include more studies on animal and environmental health particularly in LMIC/UMIC, as these areas are critical in understanding the full scope of antimicrobial resistance. Investigating how antimicrobial use in veterinary practices and environmental contamination contributes to resistance patterns could provide valuable insights. Additionally, interdisciplinary approaches that integrate human, animal, and environmental health (One Health approach) would help address the interconnectedness of these sectors in tackling antimicrobial resistance more effectively.

5. Conclusions

In the context of researching AMR control at the community level, it is crucial to thoroughly assess the interventions aimed at preventing AMR through a community engagement strategy. The complexity of the engagement activities seems to have a substantial influence on the outcomes, especially with regard to modifying behavior.

The success of community engagement is greatly affected by the type of intervention given to the community. It becomes more difficult to achieve behavioral changes when complex interventions are implemented. Conversely, simpler interventions involving community leaders in their development are more likely to bring about successful behavioral changes. Engaging the community from the initial stages of research design is essential for a more profound level of community participation tailored to their specific requirements. This approach will likely result in a more substantial behavioral change than community engagement research that does not consider the community's needs.

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Supplementary Materials

Supplementary Table 1: https://www.academia.edu/125019566/Supplementary_Table_1?source=swp_share

Supplementary Table 2: https://www.academia.edu/125019893/Supplementary_table_2?source=swp_share

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