World Journal of Public Health
2026, Vol. 11, No. 2, pp. 105–117
https://doi.org/10.11648/j.wjph.20261102.12

SciencePG
Science Publishing Group

Research Article

Understanding of Antimicrobial Resistance and Antibiotic Stewardship Among Community Members in the Uganda Luwero District

Jakub Alexander Kreuter*, Michelle Lynn Cathorall, Lenis Pangwun Chen-Edinboro, William Opoku-Agyeman

College of Health and Human Services, University of North Carolina Wilmington, Wilmington, United States

Abstract

Antimicrobial resistance is a growing issue worldwide, directly contributing to more than one million deaths each year. Developing countries like Uganda rely on the continued effectiveness of antimicrobials to combat endemic diseases. This study investigated antimicrobial resistance awareness and antibiotic use behaviors among members of the Luwero district in Uganda. An electronic survey was administered to community members in Uganda's Luwero district, the survey tool included questions reflecting aspects of antibiotic stewardship such as how often antibiotics should be taken, dose completion, and rational use. It was found that very few respondents correctly defined antimicrobial resistance and many stopped taking antibiotics when they felt better. There was no significant relationship found between level of education and the variables of interest. Knowledge gaps regarding appropriate use and frequency of dosing of antibiotics were observed among respondents. Education was found to not be associated with accurate knowledge of antibiotic use, reflective of the lack of educational initiatives regarding AMR in Uganda. Further investigation is necessary to more fully illuminate antibiotic use and stewardship in this region.

Keywords

Antimicrobial Resistance, Rural, Antibiotics

1. Introduction

Antimicrobial resistance (AMR) directly causes more than one million deaths annually (WHO, 2023a). Healthcare systems worldwide rely on the ongoing efficacy of essential antibiotics to save lives. Easy access to antibiotics coupled with the public's limited understanding of antimicrobial stewardship (AMS) jeopardizes lives [1, 2]. Antibiotic resistance leads to increased hospitalization, mortality, and economic losses globally. In 2019, the presence of resistant bacteria was directly responsible for 1.27 million deaths and contributed to an another 4.95 million [3]. Although estimating the precise economic impact is challenging, the World Bank anticipates that AMR will add an extra $1 trillion to the global economic burden by year 2030 [4]. In Africa, communicable diseases remain the primary cause of death, leading to 4.12 million fatalities in 2019 [5]. Since the year 2000 deaths from communicable diseases across the continent decreased by 30.6%, partly due to the accessibility of effective antimicrobials.

*Correspondence: Jakub Alexander Kreuter (Jalexkreuter@gmail.com)

Received: 27 February 2026; **Accepted:** 11 March 2026; **Published:** 26 March 2026

Infectious diseases have remained the leading cause of mortality in Uganda for decades, positioning the country as a hotspot for both emerging and reemerging epidemics [6]. The consequences of diseases including Ebola, Marburg, and yellow fever extend beyond morbidity and mortality, straining Uganda's healthcare infrastructure and impacting its economy. In 2021 malaria alone imposed an economic burden of approximately $577 million USD [7]. The high prevalence of communicable diseases coupled with inadequate enforcement of antibiotic regulations in local medical centers has driven the rise of AMR in the country [8].

To date, efforts to investigate the Ugandan public's understanding of AMR and AMS have been limited to the Wakiso district [9, 10]. These studies found that while community members generally understood aspects of AMR and antimicrobial use, the complex nature of antibiotic use challenged more complete analyses. Muleme et al. (2023) reported that most respondents were aware of AMR but had a limited understanding of its development and the threat it poses. Similarly, Musoke et al. (2023) observed a generally correct understanding of AMR but noted that inappropriate use was common. There appears to be a basic understanding of antibiotics and AMR among peri-urban Ugandan communities, however, an incomplete understanding of AMR and stewardship practices like dose completion contribute to behaviors that promote AMR. A knowledge gap exists in the current literature on awareness of AMR among Ugandan populations in strictly rural settings. Expanding this research into rural districts provides an important source of data to enhance our understanding of these communities' pharmaceutical use, disease epidemiology, and behavioral health. Assessing the knowledge level in rural communities is critical due to the generally higher burden of infectious disease in these areas, which creates a significant reliance on antibiotics. By obtaining a clearer picture of antimicrobial use, culturally relevant interventions could help combat inappropriate antibiotic use. While clinical procedures and protocols have long been in place relative to AMS, public education on stewardship strategies primarily target key behaviors such as prescription sharing, non-adherence, and self-medication. As it stands, the field is largely unaware of how rural Ugandan populations perceive antibiotic use and their associated habits. Identifying knowledge gaps could guide future health education programs and mitigate the impact of anthropogenic AMR.

This study was an initial investigation into antibiotic use and awareness of AMR in rural Uganda, specifically, whether participants practice key principles of AMS and rational antibiotic use. Findings reflect community response data regarding AMR knowledge outside an urban or peri-urban environment. Wakiso district. Additionally, this research aligns with Objective 2 of the WHO Global Action Plan on AMR: to enhance the knowledge and evidence base through surveillance and research.

2. Methods

2.1. Study Location and Participants

This study was conducted in five communities in the Luwero District of central Uganda. The economy of Luwero largely relies on small-scale agriculture, livestock farming, and commercial forestry. As a predominantly rural and low-income area, residents often rely on subsistence farming. Communities were located in the Nyimbwa Sub County and Ssambwe parish. The current population estimate for Nyimbwa subcounty is 32,500 in 2024 with a parish population of 10,493 recorded in 2014 [11, 12]. Residents primarily work in agriculture or animal care, selling their produce at local markets. The dominant religions in the area are Christianity, Islam and, to a lesser extent, indigenous religions. Uganda's official language is English, taught in schools, yet fluency among respondents varied and participants typically preferred Luganda, a local language.

2.2. Enrollment and Data Collection Procedures

The research team used convenience sampling, visiting residents' homes and inviting their participation in the study. They first explained its scope and then presented the consent form. Enrollees provided verbal consent, which was documented by a member of the research team. A cross-sectional study design was employed, with data collected in person using a structured questionnaire. The questionnaire was designed by the principal investigator, incorporating key principles of AMS including dose completion, dose frequency, and resistance awareness. It also assessed respondents' understanding of and attitudes toward rational antibiotic use. Questions were read aloud in English, while a Ugandan team member translated them for participants who were either not proficient in English or preferred their local language. Answers provided in Luganda were translated into English when needed. Eligible respondents were village residents aged 18 or older. Only one interview per household was conducted.

Research teams, co-led by a U.S. public health undergraduate research assistant and a Ugandan social work student, along with four to six additional Ugandan students, collected data from five communities. Before data collection was initiated team members received training on the survey tool. The initial entry into the communities included meetings with local leaders and community health workers (CHWs), which helped foster community involvement by building rapport. The teams made daily visits to the communities for four consecutive weeks in June and July 2024.

The Institutional Review Board (IRB) of the University of North Carolina Wilmington, U.S. exempted this research study (H24-0549). The research office of the Ugandan university reviewed and accepted the U.S. IRB approval of the study protocol. Conducted anonymously, the study did not collect

any personally identifiable information.

2.3. Data Collection Instrument

Survey questions were organized into three main categories: demographics, antibiotic usage, and antimicrobial stewardship, and were part of a larger survey (see Appendix). Questions were largely adapted from similar studies [13-15]. Demographics included birth year, educational background, and gender. The antibiotic usage questions focused on use within the last three months, sources for obtaining antibiotics, the frequency of prescriptions from health centers, and recommendations for antibiotic dosage. A three-month timeframe was selected to align with related studies [15]. The response options for how frequently respondents believed they should take antibiotics were "Often," "Sometimes," and "Not Often" where "Often" indicated misuse. AMS-related questions asked whether respondents completed their prescribed antibiotic courses, whether they would share antibiotics with others, and which illnesses they would self-treat with antibiotics. Response options included diagnoses such as the flu, tuberculosis, common cold, and malaria, along with symptoms like headaches, vomiting, and fever. These options highlight prevalent misconceptions that viral infections such as the flu, and minor ailments such as headaches, should be treated with antibiotics due to their perceived effectiveness [16]. Questions about antibiotic resistance assessed whether participants were aware of and could define AMR. The response categories for defining AMR included the Centers for Disease Control official definition, as well as incorrect answers reflecting common misconceptions such as the belief that AMR is a natural process within the human body.

2.4. Data Management and Analysis

Responses were collected electronically using Qualtrics Offline on tablets. After completing data collection, the data were uploaded to the University of North Carolina Wilmington's Qualtrics XM cloud storage. Only members of the U.S. research team who had university credentials, could access the data. The raw data were then exported for local storage on a password-protected laptop. SPSS was used for inferential data analysis, while descriptive statistics were calculated using Microsoft Excel. At the study conclusion, the principal investigator retained the electronic data as mandated by the IRB, and then the data were deleted. Descriptive statistics of demographic and key variables were reported as means for continuous variables and as counts and percentages for categorical variables. Chi-square tests for independence were performed to examine the relationship between education level and key variables.

3. Results

This study enrolled 234 respondents. Respondents ranged from 19-101 years of age (M = 42, SD =16.1). Variance in response totals result from non or incomplete response to the survey. Most participants had completed either primary or secondary education, representing 80% of the sample (n = 185). Demographics are shown in *Table 1*.

Table 1. *Demographics (N=234).*

	n	%
Gender		
Male	78	33
Female	156	67
Education		
None	21	9
Primary	90	39
Secondary	95	41
Higher	26	11
Age		
18–24	26	12
25–34	63	28
35–44	42	19
45–64	66	29
65+	26	12

Among those surveyed, 42% (n = 98) were aware of antibiotic resistance (Table 2). However, only 3% (n = 7) of respondents correctly defined the term. When questioned about the recommended frequency of antibiotic use, 28% (n = 64) answered that they should be taken often. Furthermore, 43% (n = 70) indicated they would be willing to share antibiotics with someone who is unwell. Regarding adherence to prescribed antibiotics, 32% (n = 30) stated they stopped treatment once they felt better. Of the 121 respondents who had taken antibiotics in the last three months, 15% (n = 18) admitted they did not finish the entire course. In answering whether antibiotics remain effective after repeated use, 57% (n = 130) believed they work better when used repeatedly. Additionally, 50% (n = 116) thought that antibiotics could cure the flu, while only 25% (n = 59) believed they could be effective against tuberculosis.

Table 2. *Descriptive Statistics.*

	n	%
How often should antibiotics be taken?		
Not often	71	30
Sometimes	98	42
Often	64	28
How do antibiotics work after repeated usage?		
Better	130	57
Same	37	16
Worse	62	27
Which of these can you use antibiotics for? (Select all which apply) *		
Malaria	185	79
Flu	116	50
Common Cold	63	27
Vomiting	49	21
Fever	80	34
Headache	124	53
Tuberculosis	59	25
Have you heard of antibiotic resistance?		
Yes	98	42
No	136	58
What is the definition of antimicrobial resistance?		
Antimicrobial resistance is when the human body stops responding to antibiotics and can no longer fight disease.	37	16
Antimicrobial resistance happens when germs like bacteria and fungi develop the ability to defeat the drugs designed to kill them. That means the germs are not killed and continue to grow.	7	3
Antimicrobial resistance is when a person has a negative reaction when taking antibiotics.	5	2
Does Not Know	185	79
Would you share antibiotics with someone who was sick?		
Yes	70	30
No	163	70
I normally stop taking antibiotics when I start to feel better.		
Agree	30	32
Disagree	64	68
Have you taken antibiotics in the last three months?		
Yes	121	52
No	113	48
Did you use all of the antibiotics?		
Yes	104	85

	n	%
No	18	15

*Respondents selected multiple answers, resulting in >100%

A chi-square test of independence was performed to examine the relationship between education (none, primary, secondary, and higher) and key categorical variables of interest from the questionnaire. The relationship between level of education and familiarity with antibiotic resistance was not statistically significant χ^2 (3, N= 232) = 0.026, p = 0.999). Similarly, there was no significant relationship between the frequency of antibiotic use and education level χ^2 (3, N=232) = 2.933, p = 0.402. Lastly, no significant association was found between participants' level of education and their willingness to share antibiotics χ^2 (3, N=232) = 2.461, p = 0.482.

4. Discussion

This study explored perceptions of antibiotic use and understanding of AMR in a rural population in the Uganda Luwero District. To the best of our knowledge, this is the first research on AMR conducted in the district. While participants generally comply with AMS principles including personal use and dose completion, very few are aware of AMR or how it develops. Additionally, findings showed a lack of knowledge about appropriate antibiotic use and often confused antibiotics with common over-the-counter drugs like analgesics or antihistamines. Many participants reported stopping antibiotic treatments prematurely, coupled with the belief that antibiotics should be used frequently, both are behaviors closely linked to the rise in AMR. These results underscore the challenges in assessing individuals' understanding of complex issues like AMR and highlight inconsistencies in self-reported adherence to medication use. This suggests a pressing need for health education initiatives advocating for AMS alongside better patient education regarding AMR and the rational use of antibiotics.

While this study does not replicate previous studies, some themes and conclusions overlap with expected variance. Muleme et al. (2023) observed there was at least a general understanding of AMR and the threat posed in peri-urban Uganda. While the study emphasized the agricultural use of antibiotics, it demonstrated the current state of general knowledge on these topics. The current study demonstrated a far inferior level of knowledge among the study population. This discrepancy is likely the result of more subsistence farmers versus commercial farmers, the latter being generally better-informed regarding agriproduct and medication use including antibiotics and the potential harm from their misuse. Additionally, this region was subject to a previous AMR education program in 2020 [17]. The results in the current study likely reflect knowledge levels more accurately amongst the rural population compared to the peri-urban locations of previous studies.

The current study found that education appeared to have no impact on knowledge of AMR or AMS, a finding that is consistent with the current lack of education on the topic in public schools [18]. Additionally, poor awareness of AMR observed in the current study highlights the absence of bottom-up initiatives to raise awareness about AMR and AMS among the public. The current AMR policy in Uganda acknowledges the need for such strategies [19]. Proposed strategies outlined under section 3.1.1 of the Uganda AMR National Action Plan (AMR-NAP) discuss the creation and dissemination of AMR material, awareness training within the formal education system, and public dissemination of relevant research findings. While the Ugandan government acknowledges the importance of education programs targeting AMR, examples remain scarce among professional groups and are absent amongst the general public. The Joint External Evaluation of the International Health Regulations, which assessed the AMR-NAP, called for "enhanced capacity to tackle antimicrobial resistance" but does not evaluate potential AMR educational initiatives (WHO, 2023c).

Many respondents were unaware of antibiotic resistance and its causes, increasing the risk of misuse. Respondents reported not completing prescribed antibiotic courses once their symptoms improved and a willingness to share antibiotics with others. Both actions lead to incomplete dosing, a significant factor in AMR. It is important to note that sociocultural studies show that Ugandans share characteristics with other African cultures, especially a collectivist identity, which may be relevant to this study [20]. In collectivist cultures group needs are prioritized over individual ones, which may explain the respondents' propensity to share antibiotics and indicate a potentially higher risk for misuse. On the other hand, harnessing communal collectivism has been shown to improve health behavior adoption and could be leveraged to enhance, rather than inhibit, AMR health education efforts [21, 22].

The irrational use of antibiotics further exacerbates the rise in AMR. Access to these medications over the counter is prevalent in Uganda, similar to other low- and middle-income countries [23, 24]. Inadequate regulation of antibiotic distribution heightens the likelihood of misuse [17, 25, 26]. This study revealed that 79%, 53%, and 50% of participants indicated they would use antibiotics for malaria, headaches, and flu, respectively. Additionally, 27% said they would use antibiotics for the common cold, whereas only 25% would consider their use for treating tuberculosis, an instance of rational

antibiotic use. Alarmingly, regulations to prevent such misuse seem poorly enforced, with few systems to monitor antimicrobial access [27]. USAID evaluations of current government regulations on antibiotics and similar medicines in Uganda show that while antibiotics cannot simply be purchased over the counter, lack of AMS policies, poor enforcement of prescribing, and low-quality drugs continue to contribute to AMR. Efforts to address antibiotics misuse in Uganda have primarily focused on the healthcare sector, mainly through educational initiatives for healthcare providers [28, 29]. Assessments of these Antimicrobial Stewardship Programs (ASPs) indicate their effectiveness in reducing antibiotic prescriptions and enhancing surveillance, but they lack training aimed at patient education. Broadening ASPs to incorporate goals that promote and facilitate patient education on antibiotics and AMR could enhance program effectiveness.

5. Limitations

The current study serves as an investigation of AMR awareness in a rural population of Luwero but does not have enough power to generalize to other rural regions of Uganda. The current study used a novel study tool, which has not been tested in other environments and could be expanded for future larger studies. The current study did not run an in-depth inferential analysis, which may be possible with a revised study tool.

6. Conclusion

While the results of this study indicate participants' familiarity with responsible medication practices such as not sharing medications and taking prescribed doses, only a small number recognized AMR and were aware of appropriate antibiotic usage. Further investigations of rural populations' perceptions will provide a clearer understanding of knowledge gaps. Considering the significant effect of AMR on the health of individuals in LMICs, promoting ASP by engaging the public and promoting patient education could leverage a previously overlooked approach and enhance existing AMR initiatives.

7. Recommendations

7.1. Community Education Programs

Public health professionals have long utilized community education and engagement to convey complex health issues. Unfortunately, AMR most impacts the public, which has largely been excluded from these initiatives in Uganda. While enhancing policy, surveillance, and capacity is vital for addressing AMR and the misuse of antibiotics, these measures may fall short if the public remains uninformed. Because Ugandan culture emphasizes communal values over individualism, a public health education campaign could achieve greater success by leveraging community networks and collective responsibility.

To guide these efforts a preliminary community assessment will identify which aspects of AMR and antimicrobial use are least understood by community members. This information should be collaboratively reviewed with key community leaders, health workers, and others who can offer valuable insights. Context-specific data should then be integrated into initiatives using relevant tools to ensure that the program content aligns with the key pillars of AMR. The WHO *People-centered approach to addressing antimicrobial resistance in human health* and the Wellcome Organization *Reframing Resistance*, among others, can support program developers in this effort [30-34]. With a well-informed curriculum, the educational program's output may take various forms such as traditional community education initiatives, virtual workshops, mass media campaigns, and place-based efforts. Alternative formats, including theater presentations, role-playing, and in-school programs, can also be utilized [35, 36]. Notably, a scoping review by Fletcher-Miles et al. (2020) and a community engagement evaluation by Mitchell et al. (2020) suggest that campaigns developed without cultural tailoring often experience limited efficacy.

7.2. Patient Education

As was observed in the current study there remains a gap in knowledge regarding AMR. Given that most non-professionals receive their information about medications from health workers, exploiting this relationship could augment AMR awareness campaigns. These AMS programs have shown effectiveness in both high-income countries (HIC) and low- and middle-income countries (LMIC), leading to reductions in antibiotic prescriptions and inappropriate usage [37-40]. In LMICs, the focus of ASPs is mainly on educating healthcare professionals within hospitals, clinics, and pharmacies [41, 40]. Conversely, HICs that combine professional development with patient education has yielded better outcomes [41-43]. Given the literature highlighting improved outcomes when patients are engaged in their care, along with the low cost and minimal barriers associated with patient education, future ASPs incorporating this approach may also be effective in Uganda [44].

Abbreviations

AMR	Antimicrobial Resistance
LMIC	Low- and Middle-income Countries
HIC	High Income Countries
AMS	Antimicrobial Stewardship
IRB	Institutional Review Board
CHW	Community Health Worker
AMR-NAP	Uganda AMR National Action Plan
ASP	Antimicrobial Stewardship Programs
USAID	United States Agency for International Development

Author Contributions

Jakub Alexander Kreuter: Conceptualization, Formal Analysis, Investigation, Methodology, Writing – original draft, Software

Michelle Lynn Cathorall: Writing – review & editing, Project Administration

Lenis Pangwun Chen-Edinboro: Writing – review & editing, Supervision, Software

William Opoku-Agyeman: Writing – review & editing, Supervision, Software

Appendix

1) Participant Consented to Interview
Yes
No
2) Time/Date of Interview
3) Name of Research Assistant
Zoe Bruno
Jenna Bustamante
Kate Castro
Madison Duracinsky
Katie Gilliland
Freja Murphy
Jakub Kreuter
4) Name of Community
Kitwalayni
Ndejje-Kabuye
Gunda
Kisoba A
Kisoba B
Kitumwa
5) I normally stop taking antibiotics when I start to feel better.
Agree
Disagree
Unsure
6) Have you used antibiotics in the last 3 months?
Yes
No
7) What did you use the antibiotics for?
Malaria
Yellow Fever
Tuberculosis
Other
8) What was the name of the medicine?
Coartem
Riamet
Fansidar
Ceftrisol/Rocephin
Augmentin/Clavulin/Amoclan
Ampicillin
Other
9) Did you use all of the antibiotics?

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declare no conflicts of interest.

Yes
No
10) Where did you get the antibiotics?
Government health center
Private health center
Community Pharmacies
Other
11) When you go to the health center how often are antibiotics prescribed?
Never
Not Often
Sometimes
Often
Always
Depends
12) Have you heard of antibiotic resistance?
Yes
No
Unsure
13) What is the definition of antimicrobial resistance?
Antimicrobial resistance is when the human body stops responding to antibiotics and can no longer fight disease.
Antimicrobial resistance happens when germs like bacteria and fungi develop the ability to defeat the drugs designed to kill them. That means the germs are not killed and continue to grow.
Antimicrobial resistance is when a person has a negative reaction when taking antibiotics.
Unsure
Does Not Know
14) Which of these can you use antibiotics for? (Select all that apply)
Malaria
Tuberculosis
Fever
Headache
Vomiting
Flu
Common Cold
15) How often should antibiotics be taken...
Not Often
Sometimes
Often
16) How do antibiotics work after repeated usage?
Worse
Same
Better
17) Would you share antibiotics with someone who was sick?
Yes
No
18) How far is the closest healthcare facility?
19) Is this the healthcare facility you normally go to?
Yes
No
20) If not, how far is the healthcare facility you normally go to?
21) How do you usually get to the healthcare facility you normally go to?
Walk
Car
Boda Boda
Other
22) How long does it take you to get to this health center?

23) Is your healthcare facility private or public?
Private
Public
Unsure
24) What type of health insurance do you have?
Public
Private
None
25) When was the last time you went to the health center for treatment?
In the last week
In the last month
In the last 3 months
Unsure
26) What did you seek treatment for?
27) Have you been diagnosed with Malaria by a blood test in the last 3 months?
Yes
No
Unsure
28) Where did you go to get tested for Malaria?
Private Clinic or hospital
Government Clinic or hospital
Other
29) Was the health facility the closest one to you?
Yes
No
Unsure
30) Did you receive treatment for Malaria when you were diagnosed last?
Yes
No
31) Has anyone else in your house been diagnosed with Malaria by a blood test in the last 3 months?
Yes
No
32) What Year Were You Born?
33) Sex?
Male
Female
34) Highest Education Level Obtained?
None
Primary
Secondary
Higher
35) How many people live in the house with you?
36) How many nets do you have?
37) How many nets did you get during the last government distribution?
38) Did anyone sleep under the net last night?
Yes
No
Tables

Table A1. *Descriptive Statistics.*

	n	%
How often should antibiotics be taken?		
Not often	71	30
Sometimes	98	42
Often	64	28
How do antibiotics work after repeated usage?		
Better	130	57
Same	37	16
Worse	62	27
Which of these can you use antibiotics for? (Select all which apply) *		
Malaria	185	79
Flu	116	50
Common Cold	63	27
Vomiting	49	21
Fever	80	34
Headache	124	53
Tuberculosis	59	25
Have you heard of antibiotic resistance?		
Yes	98	42
No	136	58
What is the definition of antimicrobial resistance?		
Antimicrobial resistance is when the human body stops responding to antibiotics and can no longer fight disease.	37	16
Antimicrobial resistance happens when germs like bacteria and fungi develop the ability to defeat the drugs designed to kill them. That means the germs are not killed and continue to grow.	7	3
Antimicrobial resistance is when a person has a negative reaction when taking antibiotics.	5	2
Does Not Know	185	79
Would you share antibiotics with someone who was sick?		
Yes	70	43
No	163	57
I normally stop taking antibiotics when I start to feel better.		
Agree	30	32
Disagree	64	68
Have you taken antibiotics in the last three months?		
Yes	121	52
No	113	48
Did you use all of the antibiotics?		
Yes	104	85
No	18	15

Table A2. *Demographics (N=234).*

	n	%
Gender		
Male	78	33
Female	156	67
Education		
None	21	9
Primary	90	39
Secondary	95	41
Higher	26	11
Age		
18–24	26	12
25–34	63	28
35–44	42	19
45–64	66	29
65+	26	12

References

[1] Brink AJ. Antimicrobial stewardship (AMS) in the community. Clin Pulm Med 2016, 23(1): 1-10. https://doi.org/10.1097/CPM.0000000000000107

[2] Jani K, Srivastava V, Sharma P, Vir A, Sharma A. Easy access to antibiotics, spread of antimicrobial resistance and implementation of One Health approach in India. J Epidemiol Glob Health 2021, 11: 444-452. https://doi.org/10.1007/s44197-021-00008-2

[3] World Health Organization. Antimicrobial resistance. 2023. https://www.who.int/news-room/fact-sheets/detail/antimicrobial-resistance

[4] World Bank. Drug-resistant infections: a threat to our economic future. 2017 Mar 1.

[5] World Health Organization. Mortality regional factsheet. 2023b. https://files.aho.afro.who.int/afahobckpcontainer/production/files/iAHO_Mortality_Regional-Factsheet.pdf

[6] Buregyeya, E., Atusingwize, E., Nsamba, P., Musoke, D., Naigaga, I., Kabasa, J. D., et al. (2020). Operationalizing the one health approach in Uganda: Challenges and opportunities. Journal of Epidemiology and Global Health, 10(4), 250.

[7] Snyman, K., Pitt, C., Aturia, A., Aber, J., Gonahasa, S., Namuganga, J. F., Nankabirwa, J., et al. (2025). Who pays to treat malaria and how much? Analysis of the cost of illness, equity and economic burden of malaria in Uganda. Health Policy and Planning, 40(1), 52-65.

[8] Mbonye, A. K., Buregyeya, E., Rutebemberwa, E., Clarke, S. E., Lal, S., Hansen, K. S., et al. (2016). Prescription for antibiotics at drug shops and strategies to improve quality of care and patient safety: A cross-sectional survey in the private sector in Uganda. BMJ Open, 6(3), e010632.

[9] Musoke, D., Lubega, G. B., Gbadesire, M. S., Boateng, S., Twesigye, B., Gheer, J, et al. (2023). Antimicrobial stewardship in private pharmacies in Wakiso district, Uganda: A qualitative study. Journal of Pharmaceutical Policy and Practice, 16(1), 147.

[10] Muleme J, Ssempebwa JC, Musoke D, Kankya C, Wafula ST, Okello J, et al. Antimicrobial resistance among farming communities in Wakiso District, Central Uganda: a knowledge, awareness and practice study. PLoS One 2023, 18(6): e0284822. https://doi.org/10.1371/journal.pone.0284822

[11] Uganda Bureau of Statistics (UBOS). Population by Parish: Census 2014 – Central Region. Kampala, Uganda: UBOS, 2018. https://www.ubos.org/wp-content/uploads/publications/03_2018Population_by_Parish_Census_2014_Central_Region.pdf

[12] Uganda Bureau of Statistics (UBOS). Revised Sub-county Population Projections, 2015–2030: 146 Districts. Kampala, Uganda: UBOS, 2015. https://www.ubos.org/wp-content/uploads/statistics/Revised_Subcounty_population_2015_2030_146_Districts.xls

[13] Awad AI, Aboud EA. Knowledge, attitude and practice towards antibiotic use among the public in Kuwait. PLoS One 2015, 10(2): e0117910. https://doi.org/10.1371/journal.pone.0117910

[14] Chapot L, Sarker MS, Begum R, Hossain D, Akter R, Hasan MM, et al. Knowledge, attitudes and practices regarding antibiotic use and resistance among veterinary students in Bangladesh. Antibiotics 2021, 10(3): 332. https://doi.org/10.3390/antibiotics10030332

[15] Gillani AH, Ji W, Hussain W, Imran A, Chang J, Yang C, Fang Y. Public knowledge, attitude, and practice regarding antibiotic use in Punjab, Pakistan: a cross-sectional study. Expert Rev Anti Infect Ther 2021, 19(3): 399–408. https://doi.org/10.1080/14787210.2021.1862621

[16] Karuniawati H, Hassali MAA, Suryawati S, Ismail WI, Taufik T, Wiladatika A. Public practices towards antibiotics: a qualitative study. Clin Epidemiol Glob Health 2020, 8(4): 1277-1281.

[17] Musoke D, Kitutu FE, Mugisha L, Amir S, Brandish C, Ikhile D, et al. A One Health approach to strengthening antimicrobial stewardship in Wakiso District, Uganda. Antibiotics 2020, 9(11): 764. https://doi.org/10.3390/antibiotics9110764

[18] Waswa JP, Kiggundu R, Joshi MP, Mpagi J, Kasujja H, Murungi M, et al. Addressing gaps in AMR awareness in the public: an evidence-based policy brief to guide school curriculum review in Uganda. Front Public Health 2023, 11: 1154321. https://doi.org/10.3389/fpubh.2023.1154321

[19] Government of Uganda (GoU). Uganda Antimicrobial Resistance National Action Plan II 2024/25–2028/29. Kampala: Central Public Health Laboratories, 2024. World Health Organization. The second joint external evaluation exercise applauds Uganda for having one of the best emergency preparedness and response systems in Africa. 2023. https://www.afro.who.int/countries/uganda/news/second-joint-external-evaluation-exercise-applauds-uganda-having-one-best-emergency-preparedness-and

[20] Rarick C, Winter G, Nickerson I, Falk G, Barczyk C, Asea P. An investigation of Ugandan cultural values and implications for managerial behavior. Glob J Manag Bus Res 2013, XIII.

[21] Betsch C, Böhm R, Airhihenbuwa CO, Butler R, Chapman GB, Haase N, et al. Improving medical decision making and health promotion through culture-sensitive health communication: an agenda for science and practice. Med Decis Making 2016, 36(7): 811-833.

[22] Parker AG, Grinter RE. Collectivistic health promotion tools: accounting for the relationship between culture, food, and nutrition. Int J Hum-Comput Stud 2014, 72(2): 185-206.

[23] Auta A, Hadi MA, Oga E, Adewuyi EO, Abdu-Aguye SN, Adeloye D, Strickland-Hodge B, Morgan DJ. Global access to antibiotics without prescription in community pharmacies: a systematic review and meta-analysis. J Infect 2019, 78(1): 8-18. https://doi.org/10.1016/j.jinf.2018.08.005

[24] Mukonzo JK, Namuwenge PM, Okure G, Mwesige B, Namusisi OK, Mukanga D. Over the counter suboptimal dispensing of antibiotics in Uganda. J Multidiscip Healthc 2013, 6: 303-310. https://doi.org/10.2147/JMDH.S49031

[25] Kibuule D, Kagoya HR, Godman B. Antibiotic use in acute respiratory infections in under-fives in Uganda: findings and implications. Expert Rev Anti Infect Ther 2016, 14(9): 863-872. https://doi.org/10.1586/14787210.2016.1196465

[26] Olamijuwon E, Konje E, Kansiime C, Kesby M, Keenan K, Neema S, et al. Antibiotic dispensing practices during COVID-19 and implications for antimicrobial resistance (AMR): parallel mystery client studies in Uganda and Tanzania. Antimicrob Resist Infect Control 2023, 12(1): 10. https://doi.org/10.1186/s13756-023-01188-8

[27] USAID Medicines, Technologies, and Pharmaceutical Services (MTaPS) Program. Uganda's Current Policies and Regulations on Antimicrobial Stewardship for Human Health, Animal Health, and Agriculture. 2022.

[28] Kiggundu R, Waswa J, Nakambale HN, Kakooza F, Kassuja H, Murungi M, et al. Development and evaluation of a continuous quality improvement programme for antimicrobial stewardship in six hospitals in Uganda. BMJ Open Qual 2023, 12(2): e002293. https://doi.org/10.1136/bmjoq-2022-002293

[29] Kimbowa IM, Ocan M, Eriksen J, Nakafeero M, Obua C, Lundborg CS, et al. Characteristics of antimicrobial stewardship programmes in hospitals of Uganda. PLoS One 2022, 17(5): e0268032. https://doi.org/10.1371/journal.pone.0268032

[30] World Health Organization. People-centered approach to addressing antimicrobial resistance in human health: WHO core package of interventions to support national action plans. 2023.

[31] Wellcome. Reframing resistance. 2019. https://wellcome.org/sites/default/files/reframing-resistance-report.pdf

[32] Mitchell J, Cooke P, Baral S, Bull N, Stones C, Tsekleves E, et al. The values and principles underpinning community engagement approaches to tackling antimicrobial resistance (AMR). Glob Health Action 2020, 12 (sup 1): 1837484. https://doi.org/10.1080/16549716.2020.1837484

[33] Mitchell J, Hawkings H, Latham S, Fieroze F, Arjyal A, Barrington DJ, Baral S, et al. Addressing antimicrobial resistance through community engagement: a framework for developing contextually relevant and impactful behaviour change interventions. JAC Antimicrob Resist 2023, 5(6): dlad124. https://doi.org/10.1093/jacamr/dlad124

[34] Bawate C, Callender-Carter ST, Guyah B, Ouma C. Community education training to optimize the use of artemisinin-based combination therapy in Kamuli District, Uganda. BMC Public Health 2024, 24: 2062. https://doi.org/10.1186/s12889-024-19619-y

[35] Marvasi M, Casillas L, Vassallo A, Purchase D. Educational activities for students and citizens supporting the one-health approach on antimicrobial resistance. Antibiotics 2021, 10(12): 1519. https://doi.org/10.3390/antibiotics10121519

[36] Fletcher-Miles H, Gammon J, Williams S, Hunt J. A scoping review to assess the impact of public education campaigns to affect behavior change pertaining to antimicrobial resistance. Am J Infect Control 2020, 48(4): 433-442. https://doi.org/10.1016/j.ajic.2019.10.010

[37] Gonzales R, Anderer T, McCulloch CE, Maselli JH, Bloom FJ Jr, Graf TR, et al. A cluster randomized trial of decision support strategies for reducing antibiotic use in acute bronchitis. JAMA Intern Med 2013, 173(4): 267-273. https://doi.org/10.1001/2013.jamainternmed.747

[38] Metlay JP, Camargo CA, MacKenzie T, McCulloch C, Maselli J, Levin SK, et al. Cluster-randomized trial to improve antibiotic use for adults with acute respiratory infections treated in emergency departments. Ann Emerg Med 2007, 50(3): 221-230. https://doi.org/10.1016/j.annemergmed.2007.01.013

[39] Waswa J, Kiggundu R, Nakambale HN, Kakooza F, Kassuja H, Murungi M, Akello H, Morries S, Joshi MP, Stergachis A, Konduri N. Addressing gaps in AMR awareness in the public: an evidence-based policy brief to guide school curriculum review in Uganda. Front Public Health 2023, 11: 1123456. https://doi.org/10.3389/fpubh.2023.1287523

[40] Kimbowa IM, Eriksen J, Nakafeero M, Obua C, Stålsby Lundborg C, Kalyango J, et al. Antimicrobial stewardship: attitudes and practices of healthcare providers in selected health facilities in Uganda. *PLoS One* 2022, 17(2): e0262993. https://doi.org/10.1371/journal.pone.0262993

[41] Cuevas C, Batura N, Wulandari LPL, Khan M, Wiseman V. Improving antibiotic use through behaviour change: a systematic review of interventions evaluated in low- and middle-income countries. Health Policy Plan 2021, 36(5): 754-773. https://doi.org/10.1093/heapol/czab035

[42] Belongia EA, Knobloch MJ, Burney AKieke J, Davis JP, Janette C, Besser RE. Impact of statewide program to promote appropriate antimicrobial drug use. Emerg Infect Dis 2005, 11(6): 912-920. https://doi.org/10.3201/eid1106.041072

[43] Cross ELA, Tolfree R, Kipping R. Systematic review of public-targeted communication interventions to improve antibiotic use. J Antimicrob Chemother 2017, 72(4): 975-987. https://doi.org/10.1093/jac/dkw520

[44] Adams R. Improving health outcomes with better patient understanding and education. Risk Manag Healthc Policy 2010, 6: 1-8. https://doi.org/10.2147/RMHP.S7500