

Gaps in One Health Strategies for Rational Antimicrobial Use in Eastern, Central and Southern Africa: A Systematic Review

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SUMMARY

Antimicrobial resistance (AMR) is accelerated by inappropriate antimicrobial use across human and animal-health systems, yet the extent to which One Health approaches have informed antimicrobial stewardship in Eastern, Middle, and Southern Africa remains incompletely described. This systematic review synthesized evidence on antimicrobial-use practices, self-medication, prescribing and dispensing, stewardship, and cross-sectoral One Health integration in the region. Peer-reviewed English-language studies published from 2012 to 2024 were identified through bibliographic and supplementary searches and screened using predefined eligibility criteria. Ninety-three unique studies were included. Evidence was concentrated in human-health settings, particularly community and hospital studies, with fewer livestock and veterinary studies and very limited integrated cross-sectoral research. Commonly reported concerns included non-prescription access to antimicrobials, self-medication, empirical prescribing, limited diagnostic support, restricted access to professional veterinary services, and gaps in antimicrobial stewardship and regulatory oversight. Study designs, populations, definitions, and measurement instruments were heterogeneous; therefore, findings were synthesized primarily narratively. The evidence indicates substantial gaps in integrated One Health approaches to rational antimicrobial use and limited intervention evidence. Strengthening coordinated stewardship, surveillance, diagnostic capacity, regulation, and cross-sectoral research is needed to support rational antimicrobial use in the region.

Keywords: Antimicrobial resistance; One Health; Antibiotics; Surveillance; East Africa

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INTRODUCTION

Antimicrobial resistance (AMR) is a major threat to the effective prevention and treatment of infectious diseases in humans and animals. Antimicrobials remain essential for clinical care and livestock production, but inappropriate use, non-prescription access,

empirical treatment and weak stewardship accelerate selection for resistant organisms. Across many low- and middle-income settings, these problems are compounded by limited diagnostic capacity, uneven access to trained health professionals, weak enforcement of

medicine regulations and substantial reliance on private drug outlets (Katakweba et al., 2012; Mbonye et al., 2016; Caudell et al., 2017; Horumpende et al., 2018; Frumence et al., 2021).

The drivers of antimicrobial use differ across sectors, the human-health studies in the region have described self-medication, use of previous prescriptions, purchase of antibiotics from community pharmacies and drug shops, and empirical prescribing in health facilities (Kajeguka and Moses, 2017; Horumpende et al., 2018; Mukokinya et al., 2018; Sambakunsi et al., 2019; Mabilika et al., 2022). In livestock systems, antimicrobial use could be shaped by access to veterinary services, farmer experience, availability of veterinary medicines and production practices (Caudell et al., 2017; Kimera et al., 2020; Mangesho et al., 2021; Mankhomwa et al., 2022). These interconnected drivers support the rationale for a One Health approach to antimicrobial stewardship.

Regulatory architecture may influence the coordination of antimicrobial governance across human and animal-health sectors. In Tanzania, the Tanzania Medicines and Medical Devices Authority (TMDA 2023) regulates both human and veterinary medicines. Similarly, Uganda's National Drug Authority (NDA 2024), the Rwanda Food and Drugs Authority (Rwanda FDA, 2025), the Zambia Medicines Regulatory Authority (ZAMRA,

2025), and the South African Health Products Regulatory Authority (SAHPRA, 2024) have mandates encompassing both human and veterinary medicines. In contrast, Kenya operates separate regulatory institutions, with the Pharmacy and Poisons Board (PPB, 2022) responsible for human medicines and the Veterinary Medicines Directorate (VMD, 2022) regulating veterinary medicines. These different regulatory arrangements are relevant to One Health antimicrobial stewardship because effective antimicrobial governance requires coordination of medicine registration, prescribing and dispensing, pharmacovigilance, surveillance, and regulatory enforcement across human and animal-health sectors. Understanding such institutional differences is therefore important when assessing the implementation and coordination of One Health strategies for rational antimicrobial use across the region.

Against this background, this systematic review assessed evidence on rational antimicrobial use and the adoption of One Health strategies in Eastern, Middle, and Southern Africa. Specifically, it synthesized evidence on antimicrobial-use practices in human and animal-health settings; examined self-medication, prescribing, dispensing and stewardship practices; assessed the extent of cross-sectoral One Health integration; and evaluated available intervention evidence addressing inappropriate antimicrobial use.

MATERIALS AND METHODS

Eligibility criteria

The review used predefined eligibility criteria and is reported in accordance with PRISMA 2020 (Page et al., 2021). The protocol was not prospectively registered in PROSPERO or another public registry. Eligible reports were peer-reviewed original studies conducted in countries classified within Eastern, Middle, or Southern Africa and published in English from 2012 to 2024. Eligible populations included

community members, patients, healthcare professionals, students or trainees, livestock keepers, veterinary professionals, medicine dispensers and other participants relevant to human or animal health. Eligible concepts included antimicrobial use, self-medication or self-prescription, prescribing and dispensing, antimicrobial stewardship, and related knowledge, attitudes and practices. Observational, qualitative, mixed-methods and eligible intervention studies were considered.

Reviews, editorials, commentaries, opinion pieces, case reports, conference abstracts without sufficient data and unpublished reports were excluded from the study-level synthesis.

Information sources and search strategy

The search covered PubMed, Scopus, Web of Science, Embase, Excerpta Medica and Google Scholar, supplemented by targeted web searching and reference-list checking. Search concepts combined terms for antimicrobials and antimicrobial use or consumption; prescribing, dispensing, self-medication, rational use and antimicrobial stewardship; One Health and human, animal, environmental and agricultural sectors; and geographical terms. Database-specific syntax was adapted to each platform. The geographical scope followed the United Nations M49 classification for Eastern Africa, Middle Africa and Southern Africa. Eligible countries were Angola, Botswana, Burundi, Cameroon, Central African Republic, Chad, Comoros, Democratic Republic of the Congo, Congo Republic, Djibouti, Eritrea, Eswatini, Ethiopia, Kenya, Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, Rwanda, Seychelles, Somalia, South Africa, South Sudan, Tanzania, Uganda, Zambia and Zimbabwe. Sudan was excluded because it is classified in Northern Africa. The term 'developed countries', was removed because it was inconsistent with the review scope (Table 1).

Selection process

Records were managed in Mendeley and duplicate records were removed before screening. Two reviewers independently screened titles and abstracts against the eligibility criteria. Potentially eligible reports proceeded to full-text assessment by the same two reviewers. Disagreements were resolved through discussion and consensus; where consensus could not be reached, a third member of the review team was consulted. Inter-reviewer agreement was not formally

calculated. The final PRISMA 2020 flow diagram should report records identified, duplicates removed, records screened, reports sought and not retrieved, full-text exclusions with reasons, and unique studies included (Figure 1).

Data extraction

A standardized Microsoft Excel extraction form was piloted on a sample of included studies and refined before full extraction. Two reviewers independently extracted data and compared entries; disagreements were resolved by consensus or, when necessary, consultation with a third reviewer. Extracted variables included author, year, country, study design, setting, population, unit of analysis, sample size, sector, antimicrobial classes, patterns of antimicrobial use, prescribing and dispensing practices, self-medication or self-prescription, antimicrobial stewardship activities, One Health integration and factors associated with antimicrobial use.

Risk-of-bias assessment

Methodological quality was assessed with Joanna Briggs Institute (JBI) design-specific critical appraisal tools (Barker et al., 2023). Analytical cross-sectional, cohort, case-control, qualitative and intervention studies were appraised using the corresponding JBI checklist. Two reviewers independently judged applicable domains as Yes, No, Unclear or Not applicable. Disagreements were resolved by consensus, with a third reviewer consulted when required. No unvalidated numerical quality score or arbitrary cut-off was used. Appraisal findings informed interpretation of the evidence rather than study eligibility.

Data synthesis

Studies were summarized descriptively by country, design, population, setting, sector, antimicrobial class and antimicrobial-use outcome. Quantitative pooling was considered only for sufficiently comparable populations,

definitions, instruments and outcomes. heterogeneous, the principal synthesis was narrative. Heterogeneity was therefore not used as an eligibility criterion.

Table 1. Search concepts and terms used in the review

Concept	Search terms
Antimicrobials and antimicrobial use	“antimicrobial” OR “antimicrobial use” OR “antimicrobial consumption” OR “antibiotic” OR “antibiotic use” OR “antibiotic consumption” OR “antibacterial” OR “antifungal” OR “antiprotozoal” OR “antimalarial” OR “antimicrobial resistance” OR “antibiotic resistance”
Use, prescribing and stewardship practices	“self-medication” OR “self-prescription” OR “prescribing” OR “prescription” OR “dispensing” OR “irrational use” OR “inappropriate use” OR “misuse” OR “overuse” OR “appropriate use” OR “rational use” OR “antimicrobial stewardship”
One Health and sectors	“One Health” OR “human health” OR “animal health” OR “veterinary” OR “livestock” OR “livestock production” OR “environment” OR “environmental health” OR “agriculture” OR “crop production”
Geographical terms	“Eastern Africa” OR “East Africa” OR “Middle Africa” OR “Central Africa” OR “Southern Africa” OR “Angola” OR “Botswana” OR “Burundi” OR “Cameroon” OR “Central African Republic” OR “Chad” OR “Comoros” OR “Democratic Republic of the Congo” OR “Republic of the Congo” OR “Djibouti” OR “Eritrea” OR “Eswatini” OR “Ethiopia” OR “Kenya” OR “Lesotho” OR “Madagascar” OR “Malawi” OR “Mauritius” OR “Mozambique” OR “Namibia” OR “Rwanda” OR “Seychelles” OR “Somalia” OR “South Africa” OR “South Sudan” OR “Tanzania” OR “Uganda” OR “Zambia” OR “Zimbabwe”

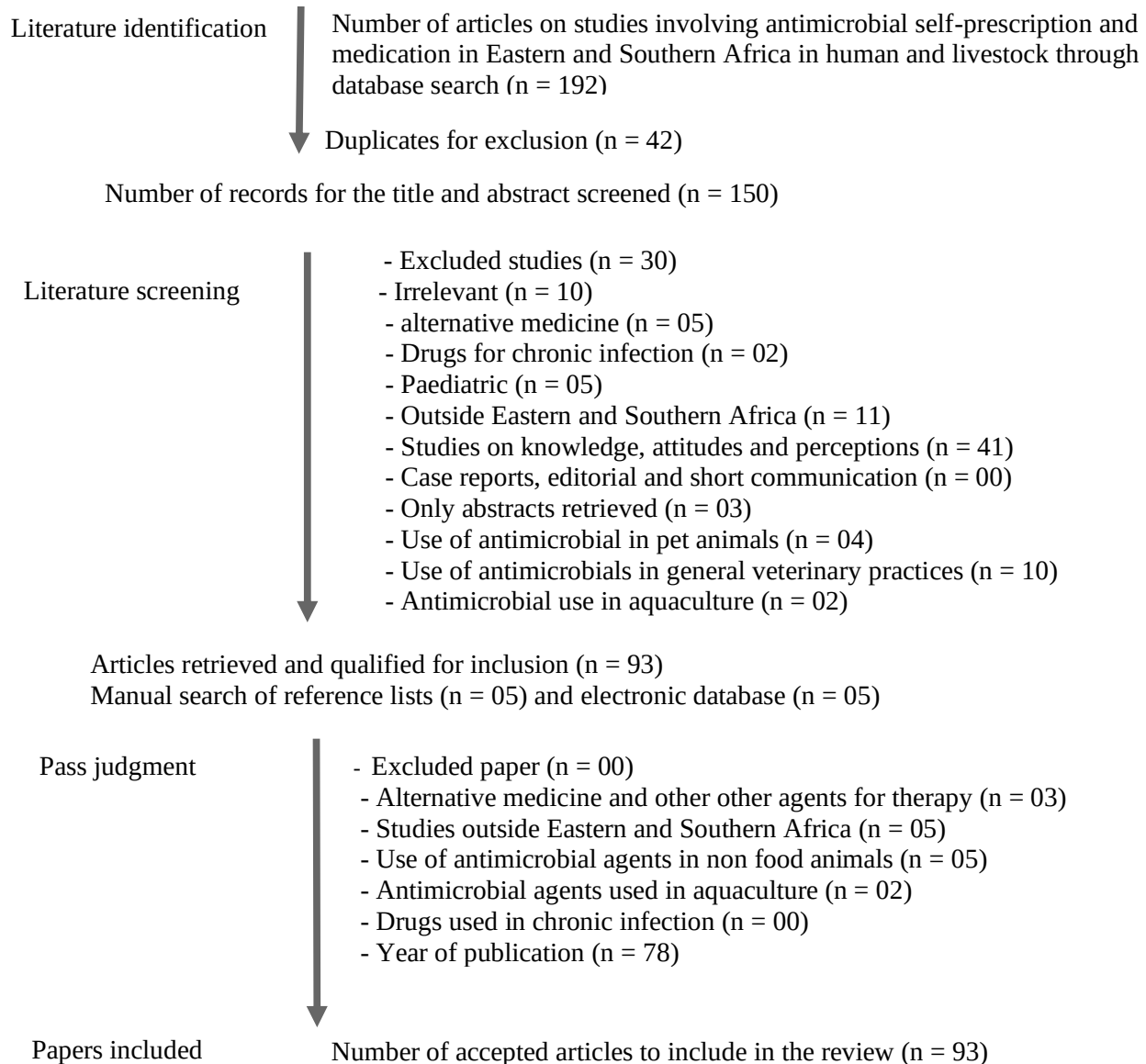
RESULTS

Study selection

The revised study library contained 93 unique studies that met the eligibility criteria. The final

included-study count used for the present synthesis is presented in Figure.

Figure 1: PRISMA diagram of the study identification and selection process



Study characteristics

The 93 unique studies represented multiple countries in Eastern, Middle and Southern Africa, with the largest contributions from Tanzania and Uganda (Table 2). Most studies were observational and cross-sectional, with additional qualitative and mixed-methods studies. Populations included community members, patients, healthcare professionals, students, livestock keepers, veterinary

personnel and medicine dispensers. The evidence addressed self-medication, prescribing and dispensing, antimicrobial stewardship, knowledge and practices, and patterns of antimicrobial use. Human-health evidence predominated, while livestock and veterinary studies were fewer. No environmental-sector study was identified in the current study-level synthesis; consequently, environmental and crop-sector evidence is not

presented as an empirical finding of this review.

Table 2: Geographical distribution and primary settings of included studies

Country	Unique studies (n)	Hospital (n)	Community (n)	Livestock/veterinary (n)
Botswana	2	0	2	0
Burundi	2	1	0	1
Democratic Republic of Congo	4	3	1	0
Kenya	6	3	2	1
Malawi	4	1	2	1
Mozambique	3	1	1	1
Namibia	7	4	2	1
Rwanda	4	3	0	1
South Africa	4	2	2	0
Tanzania	30	9	19	2
Uganda	18	7	9	2
Zambia	4	1	2	1
Zimbabwe	2	1	1	0
Multinational	3	1	2	0
Total unique studies	93	37	45	11

Sources of antimicrobials and treatment information

Sources of antimicrobials and treatment information (Table 3) varied across countries and sectors. In human-health studies, medicines were obtained from pharmacies, drug shops, public or private health facilities, retained medicines and informal sources. Information influencing antimicrobial use included previous treatment experience, old prescriptions, healthcare workers, dispensers and friends or relatives. In northern Uganda, drug shops accounted for 68.4% (1482/2161)

of reported antimicrobial acquisitions, while previous experience (28.9%; 189/668) and old prescriptions (22.9%; 153/667) were important information sources (Ocan et al., 2014). In animal-health settings, veterinary pharmacies or drug shops and animal-health personnel were prominent sources. In Uganda, veterinary pharmacies or drug shops supplied antimicrobials to 90.9% (30/33) of antibiotic users in one rural site and 77.8% (77/99) in a peri-urban farming site (Nayiga et al., 2020). Because denominators and reporting methods differed substantially, these findings were not pooled.

Table 3: Reported sources of antimicrobials and information or treatment advice

Sector	Country	Population/unit	Source of antimicrobials	Information/advice	Quantitative evidence	Study
Human	Uganda	892 adults	Drug shops; health facilities; medicines retained at home	Previous experience; old prescriptions; friends/relatives; health workers; leaflets	Drug shops: 68.4% of antimicrobial acquisitions; previous experience: 28.9%; old prescriptions: 22.9%	Ocan et al. (2014)
Human	Rwanda	570 university students	Community pharmacies	Self-directed treatment based on perceived illness	Community pharmacy: 72.42% among students reporting antibiotic self-medication	Tuyishimire et al. (2019)
Human	Kenya	Pharmacy clients/prescriptions	Community pharmacies; antibiotics dispensed with or without prescriptions	Prescribers/pharmacy dispensing	94.1% of antibiotics were dispensed with a valid prescription; non-prescription dispensing was relatively uncommon	Mukokinya et al. (2018)
Human	DRC	Adult household heads, Kinshasa	Pharmacies/medicine outlets; non-prescription access	Previous experience, household/community influences and medicine providers	Qualitative evidence; no directly comparable frequency for sources	Shembo et al. (2022)
Human	Mozambique	Community/pharmacy participants, Maputo	Pharmacies and other routes of obtaining antibiotics without prescription	Previous experience, recommendations and other informal influences	Primarily qualitative evidence; study-specific findings	Torres et al. (2020); Rodrigues (2020)
Human	Malawi	105 questionnaire + 15 FGD participants	Pharmacies, drug stores/shops, market vendors, leftovers, friends/family	Previous experience and informal advice	Primarily descriptive/qualitative	Sambakunsi et al. (2019)
Human	Tanzania	Community participants	Pharmacies/drug outlets and other non-prescription sources	Previous treatment experience and informal sources	Study-specific estimates	Horumpende et al. (2018)
Human	Tanzania	Urban/rural community participants	Pharmacies/drug outlets	Previous experience and other influences	Study-specific estimates	Mabilika et al. (2022)
Human	Uganda	Rural and urban households	Public facilities and private medicine outlets	Healthcare/medicine providers	Setting-specific estimates reported	Nayiga et al. (2020)
Animal	Uganda	Rural households/peri-urban farms	Veterinary pharmacies/drug shops, veterinary officers, markets	Veterinary personnel and medicine sellers	Veterinary pharmacy/drug shop: 90.9% and 77.8% in the two settings	Nayiga et al. (2020)
Animal	Tanzania	Agro-pastoralist households	Veterinary and non-veterinary medicine sources	Veterinary care and livestock keepers' previous experience	Study-specific evidence	Caudell et al. (2017)
Animal	Tanzania	Poultry and pig farmers	Veterinary drug outlets/other supply channels	Farmers, veterinary personnel and medicine sellers	Study-specific evidence	Kimera et al. (2020)
Animal	Malawi	Small-scale livestock farmers	Veterinary/medicine supply channels	Farmer experience and animal-health advice	Qualitative evidence	Mankhomwa et al. (2022)
Animal	Kenya	Poultry-production system	Veterinary antimicrobial supply channels	Farmers, animal-health providers and antimicrobial suppliers	Not reported in the current extraction table	Kiambi et al. (2021)
Animal	Namibia	Livestock/veterinary medicine users	Veterinary medicine supply/storage channels	Farmers/animal-health personnel	Not reported in the current extraction table	Madzingira & Simasiku (2020)

Factors associated with inappropriate antimicrobial use

In human-health settings, reported factors included perceived mildness or familiarity of illness, cost and time associated with formal care, previous successful treatment, easy access to antimicrobials, use of leftover medicines and limited awareness of AMR (Bunduki et al., 2017; Horumpende et al., 2018; Mukokinya et al., 2018; Sambakunsi et al., 2019; Chuwa et al., 2021; Shembo et al., 2022). These findings (Table 4) arose predominantly from cross-sectional and qualitative studies and should be interpreted as

reported or associated factors rather than causal determinants.

In animal-health settings, reported influences included limited access to veterinary and livestock-extension services, ready availability of veterinary medicines, treatment without direct professional consultation, previous experience managing animal disease, and gaps in knowledge of dosing, administration, storage and prudent use (Katakweba et al., 2012; Caudell et al., 2017; Kimera et al., 2020; Mangesho et al., 2021; Mankhomwa et al., 2022). Some studies also described weaknesses in antimicrobial stewardship and regulatory oversight (Frumence et al., 2021).

Table 4. Reported factors associated with antimicrobial use in animal-health settings

Reported factor	Description	Representative studies
Limited access to veterinary and livestock-extension services	Limited availability, distance, or delayed access to animal-health professionals encouraged livestock keepers to make treatment decisions themselves	Caudell et al. (2017); Katakweba et al. (2012); Kiambi et al. (2021); Kimera et al. (2020); Madzingira & Simasiku (2020)
Easy access to veterinary medicines	Availability of antimicrobials through veterinary drug shops, medicine sellers, markets, and other supply channels facilitated farmer-led treatment	Caudell et al. (2020); Kiambi et al. (2021); Mangesho et al. (2021)
Access without veterinary prescription or consultation	Veterinary medicines could be obtained or administered without prior clinical assessment or direct professional consultation	Mankhomwa et al. (2022); Mkala (2022); Nayiga et al. (2020)
Previous treatment experience and local knowledge	Livestock keepers sometimes relied on previous experience, familiarity with animal diseases, and locally acquired knowledge when selecting treatment	Caudell et al. (2017); Mankhomwa et al. (2022); Mangesho et al. (2021)
Limited knowledge of appropriate antimicrobial use	Knowledge gaps relating to indications, dosing, administration, storage, treatment duration, or prudent antimicrobial use were reported	Hirwa et al. (2024); Katakweba et al. (2012); Madzingira & Simasiku (2020); Mupfunya et al. (2021)
Weak antimicrobial stewardship and regulatory oversight	Limited oversight of antimicrobial distribution and use and gaps in stewardship implementation were identified in some settings	Frumence et al. (2021); Kimera et al. (2020); Madzingira & Simasiku (2020); Sindato et al. (2020)

Antimicrobial classes reported

Human-health studies reported use of penicillins, fluoroquinolones, aminoglycosides, macrolides, lincosamides, tetracyclines, sulfonamide/trimethoprim

combinations, nitroimidazoles and antifungals. Animal-health studies reported penicillins, penicillin-streptomycin combinations, fluoroquinolones, aminoglycosides, macrolides including tylosin, tetracyclines,

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sulfonamides and antiprotozoals (Table 5). The current extraction table does not provide a verified common denominator for all antimicrobial-class frequencies; therefore, class-specific percentages are not calculated. Clindamycin is classified as a lincosamide and

tylosin as a macrolide. Adherence to antimicrobial withdrawal periods was not consistently assessed or reported, so the review cannot estimate compliance with recommended withdrawal periods.

Table 5. Antimicrobial classes and agents reported in human- and animal-health studies

Antimicrobial class	Examples reported	Sector	Representative studies
Penicillins	Penicillin, amoxicillin, amoxicillin-clavulanate, ampicillin/cloxacillin	Human	Bunduki et al. (2017); Chuwa et al. (2021); Elmahi et al. (2022); Mokwele et al. (2022); Nyeko et al. (2022)
Penicillins	Penicillin and related veterinary preparations	Animal	Hirwa et al. (2024); Madzingira & Simasiku, (2020); Mupfunya et al. (2020); Mubito et al. (2024)
Penicillin-aminoglycoside combinations	Penicillin-streptomycin	Animal	Katakweba et al. (2012); Madzingira & Simasiku, (2020)
Fluoroquinolones	Ciprofloxacin	Human	Bunduki et al. (2017); Mabilika et al. (2022); Rodrigues, (2024); Torres et al. (2020)
Fluoroquinolones	Enrofloxacin and related veterinary fluoroquinolones	Animal	Kiambi et al. (2021); Mkala, (2020)
Aminoglycosides	Gentamicin	Human	Gabriel et al. (2021); Thriemer et al. (2013)
Aminoglycosides	Gentamicin and aminoglycoside-containing veterinary preparations	Animal	Azabo et al. (2022)
Macrolides	Azithromycin, erythromycin	Human	Caudell et al. (2020); Kiambi et al. (2021); Mangesho et al. (2021)
Macrolides	Tylosin	Animal	Caudell et al. (2017); Kiambi et al. (2021); Mangesho et al. (2021); Mdegela et al. (2021)
Lincosamides	Clindamycin	Human	Sambakunsi et al. (2019); Tuyishimire et al. (2019)
Tetracyclines	Doxycycline	Human	Mdegela et al. (2021)
Tetracyclines	Oxytetracycline, tetracycline preparations	Animal	Nayiga et al. (2020)
Sulfonamides/trimethoprim	Co-trimoxazole (trimethoprim-sulfamethoxazole)	Human	Bunduki et al. (2017); Mabilika et al. (2022); Sambakunsi et al. (2019); Tuyishimire et al. (2019)
Sulfonamides	Sulfonamide-containing veterinary products	Animal	Kiambi et al. (2021); Torres et al. (2020)
Nitroimidazoles	Metronidazole	Human	Horumpende et al. (2021); Petro et al. (2021); Torres et al. (2020)
Antifungals	Fluconazole, nystatin, griseofulvin	Human	Horumpende et al. (2018); Sambakunsi et al. (2019)

Antiprotozoals	Various antiprotozoal veterinary medicines	Animal	Mankhomwa et al. (2022); Nayiga et al. (2020)
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Knowledge and subgroup synthesis

Knowledge of antimicrobial use and AMR varied among healthcare workers, health-professional students, community members and livestock keepers. Direct pooling was not retained because studies used heterogeneous questionnaires, scoring systems, definitions of adequate knowledge and cut-off values. Study populations and settings also differed substantially. Knowledge findings were therefore synthesized narratively, with study-specific definitions and estimates retained in the extraction dataset.

Intervention and One Health evidence

Intervention evidence was sparse. At least one included Tanzanian study evaluated an intervention intended to limit the emergence and spread of antimicrobial-resistant bacteria among Maasai communities over a two-month follow-up period (Roulette et al., 2017). The small number and heterogeneity of intervention studies precluded a pooled estimate of effectiveness. Similarly, although several studies included both human and animal-health considerations, the review identified little evidence of fully integrated One Health

surveillance or stewardship designs spanning multiple sectors. These findings support cautious interpretation of intervention effectiveness and highlight a gap in cross-sectoral implementation research.

Risk of bias

The risk of bias was assessed independently for each included study using the appropriate design-specific Joanna Briggs Institute (JBI) critical appraisal tool. Randomized-controlled trials and observational studies were therefore evaluated using criteria appropriate to their respective study designs. Individual domains were rated as Yes, No, Unclear or not applicable. No arbitrary numerical cut-off or summary score was used to classify studies as having low, moderate, or high methodological quality. Instead, risk of bias findings were interpreted at the domain level, with particular attention to randomization and allocation procedures, comparability of study groups, measurement of exposures and outcomes, identification and management of confounding, completeness of follow-up and appropriateness of statistical analysis. Table 3 presented the domain-level JBI appraisal for each included study.

DISCUSSION

This review shows that the regional evidence base on antimicrobial use is dominated by human-health studies and cross-sectional assessments of knowledge, self-medication, prescribing and dispensing. Livestock and veterinary evidence is smaller, environmental and antifungal evidence smaller still, and fully integrated cross-sectoral One Health research remains limited. This imbalance matters because antimicrobial selection pressures and medicine-use practices occur across interconnected human, animal and environmental systems, while governance, regulation and surveillance often remain

sector-specific (Collignon and McEwen, 2019; Gebreyes et al., 2014; Frumence et al., 2021).

Across human-health studies, non-prescription access, previous treatment experience, perceived familiarity of illness, cost and convenience were recurrent influences on antimicrobial use. These patterns recur consistently across community and student populations in Tanzania, Uganda, Malawi, Rwanda, Mozambique, Burundi, Eritrea and the Democratic Republic of the Congo (Horumpende et al., 2018; Sambakunsi et al., 2019; Tuyishimire et al., 2019; Torres et al.,

2019, 2020; Nahimana et al., 2022; Shembo et al., 2022; Gebregziabher et al., 2024). Prevalence estimates for self-medication with antibiotics vary considerably by setting and population, ranging from single-digit figures among some health-professional samples to over half of surveyed university students in some contexts, a range broadly consistent with the pooled regional estimate reported by Yeika et al. (2021).

Non-prescription dispensing appears to compound this pattern: simulated-client studies in Tanzania, Zambia and South Africa have repeatedly documented pharmacies and drug outlets supplying antibiotics without a prescription, often influenced by patient pressure, competition between outlets and weak enforcement of dispensing regulations (Horumpende et al., 2018; Kalungia et al., 2016; Mokwele et al., 2022). Facility-based studies extend this picture to prescribing practice itself, showing that WHO prescribing indicators are frequently exceeded in outpatient and hospital settings in Ethiopia, Zambia and Botswana, with polypharmacy and antibiotic over-prescription particularly common (Mashalla et al., 2017; Chizimu et al., 2024; Abejew et al., 2024). These findings should not be interpreted as causal, since much of the evidence is cross-sectional or qualitative, but they identify practical targets for stewardship, including dispensing practice, public communication, prescriber behaviour and access to timely diagnosis and clinical care.

Animal-health studies similarly described antimicrobial use as shaped by access to veterinary services, medicine supply channels, farmer and pastoralist experience, and production constraints. Evidence from Tanzania, Kenya, Uganda, Rwanda, Malawi, Namibia, Zambia and South Africa indicates that antimicrobial stewardship in livestock cannot be separated from the accessibility of veterinary advice, regulation of veterinary medicine distribution, and feasible alternatives for disease prevention (Caudell et al., 2017, 2020; Kimera et al., 2020; Nayiga et al., 2020;

Mupfunya et al., 2021; Mangesho et al., 2021; Mankhomwa et al., 2022; Hirwa et al., 2024).

Several studies point to informal or unqualified sources of veterinary medicines and advice as a recurring feature of livestock antimicrobial use, particularly among pastoralist and smallholder systems, where formal veterinary services are limited or costly (Mangesho et al., 2021; Kainga et al., 2023; Madzingira and Simasiku, 2020). Poultry production emerges as a particular area of concern, with studies from Tanzania and Zambia documenting non-prescription antibiotic use for disease prophylaxis rather than treatment of diagnosed illness (Mubito et al., 2024.; Mudenda et al., 2024). These are reported associations and recurring themes rather than proof that any single factor causes inappropriate use, but taken together they suggest that veterinary-sector interventions will need to address both medicine access and the broader production and advisory context in which use decisions are made.

Environmental and antifungal dimensions of antimicrobial use remain markedly underrepresented relative to human and animal health. Where environmental studies exist, they largely originate from South Africa and document the presence of antimicrobial-resistant bacteria in surface water, wastewater and recreational settings, pointing to environmental transmission pathways that are rarely captured in human- or animal-focused surveillance (Mupfunya et al., 2021; Mshana et al., 2013). Antifungal use and resistance are addressed in only a small number of country-specific studies, despite growing global recognition of fungal antimicrobial resistance as a One Health concern (Fisher et al., 2022). Tanzanian evidence on over-the-counter antifungal use (Mushi et al., 2017) and Ugandan data on the burden of serious fungal disease (Bongomin et al., 2024) suggest that antifungal practices and resistance warrant far greater attention within regional AMR research than they currently receive.

The review also highlights a methodological limitation in the literature: studies used different definitions, questionnaires and thresholds for knowledge and appropriate antimicrobial use, and sample frames ranged from university students to healthcare professionals, livestock keepers and veterinary paraprofessionals, limiting direct comparability (Atalay and Gelaw, 2024; Frumence et al., 2021). This heterogeneity undermines the validity of a single pooled knowledge estimate and supports the narrative synthesis adopted here, consistent with established guidance for reporting systematic reviews where substantial clinical and methodological heterogeneity precludes meta-analysis (Page et al., 2021). Future studies would benefit from harmonized core indicators for antimicrobial use, prescribing, dispensing and stewardship, together with transparent reporting of denominators and sector-specific outcomes, building on existing national efforts such as point-prevalence surveys and stewardship situation analyses already piloted in Botswana and Zambia (Paramadhas et al., 2019; Chizimu et al., 2024).

One Health is most useful in this context as a framework for coordinated action rather than as

a label applied to studies that merely mention more than one sector (Gebreyes et al., 2014; Collignon and McEwen, 2019). Regional research should therefore distinguish multisectoral description from genuine integration of surveillance, governance, data interpretation or intervention across sectors. National policy instruments such as Tanzania's medicines promotion regulations, Kenya's Pharmacy and Poisons Board guidelines, and Kenya's Veterinary Medicines Directorate regulations (Tanzania Medicines and Medical Devices Authority, 2020; Pharmacy and Poisons Board, 2022; Veterinary Medicines Directorate, 2022) illustrate that human- and animal-health medicine governance in the region often continue to operate through parallel rather than jointly coordinated regulatory structures. The limited intervention evidence in the present review, using few examples beyond small-scale follow-up studies such as that of Roulette et al. (2017) among Maasai pastoralist communities, this could mean that recommendations for education, regulation, diagnostics or stewardship should be treated as priorities for implementation and evaluation, rather than as interventions whose effectiveness has already been established by this review.

CONCLUSION

Evidence from Eastern, Middle and Southern Africa indicates persistent challenges in rational antimicrobial use across human and animal-health settings, including self-medication, non-prescription access, empirical treatment and gaps in veterinary and antimicrobial-stewardship services. The evidence base is uneven across countries and sectors and provides limited evaluation of integrated One Health interventions. Stronger cross-sectoral surveillance, diagnostic capacity, stewardship, regulation and implementation research are needed. Future studies should use transparent, harmonized measures and evaluate whether coordinated One Health interventions improve

antimicrobial-use practices and reduce avoidable selection pressure for AMR.

Study limitations

This review has several limitations. Restriction to English-language and predominantly peer-reviewed publications may have excluded relevant non-English and grey literature, contributing to incomplete geographic coverage and potential publication bias. Differences in database coverage and search terminology may also have affected retrieval. Considerable heterogeneity existed in definitions of antimicrobial use, measurement instruments, populations and outcomes, limiting comparability. Most evidence was

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cross-sectional and frequently relied on self-reported practices, increasing the potential for recall and social-desirability bias and precluding causal inference. Potential overlap among reports cannot be completely excluded. Evidence was concentrated in human-health

settings, with fewer animal-health studies and no environmental-sector study identified in the current study-level synthesis. Finally, sparse intervention evidence prevents firm conclusions about effectiveness.

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Conflict of interest

The authors do not have any conflict of interest.

Authors' contributions

All authors contributed substantially to the conception or design of the review, data interpretation, drafting or critical revision of the manuscript, approved the final version and agree to be accountable for the work.

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Data availability

The study-level extraction and critical-appraisal data supporting this review are available from the corresponding author on reasonable request.

REFERENCES

- Alhomoud F, Aljamea Z, et al. Self-medication and self-prescription with antibiotics in the Middle East-do they really happen? A systematic review of the prevalence, possible reasons, and outcomes. Vol. 57, International Journal of Infectious Diseases. Elsevier B.V.; 2017. p. 3-12.
- Anand Paramadhas BD, Tiroyakgosi C, et al. Point prevalence study of antimicrobial use among hospitals across Botswana; findings and implications. *Expert Rev Anti Infect Ther* 17(7): 535-46, 2019.
- Atalay YA, Abebe Gelaw K. Prevalence of knowledge, attitudes, and practices regarding antimicrobial resistance in Africa: a systematic review and meta-analysis. Vol. 15, Frontiers in Microbiology. Frontiers Media SA; 2024. p. 1-14.
- Azabo R, Mshana S, Matee M, Kimera SI. Antimicrobial usage in cattle and poultry production in Dar es Salaam, Tanzania: pattern and quantity. *BMC Vet Res* 18(1): 1-12, 2022.
- Banda O, Vlahakis PA, Daka V, Matafwali SK. Self-medication among medical students at the Copperbelt University, Zambia: A cross-sectional study. *Saudi Pharm J* 29(11): 1233-7, 2021.
- Barker, TH., Stone, JC., Sears, K. KM et al. Revising the JBI quantitative critical appraisal tools to improve their applicability : an overview of methods and the development process. *Methodology* 21(3): 478-93, 2023.
- Bbosa GS, Mwebaza N, Odda J, Kyegombe DB, Ntale M. Antibiotics/antibacterial drug use, their marketing and promotion during the post-antibiotic golden age and their role in emergence of bacterial resistance. *Health*:06(05): 410-25, 2014.
- Bongomin F, Kwizera R, Namusobya M, van Rhijn N, et al. Re-estimation of the burden of serious fungal diseases in Uganda. *Ther Adv Infect Dis* 11, 2024.
- Brata C, Fisher C, Marjadi B, Schneider CR, Clifford RM. Factors influencing the current practice of self-medication

- consultations in Eastern Indonesian community pharmacies: A qualitative study. *BMC Health Serv Res* 16(179): 1-10, 2016.
- Bulabula ANH, Dramowski A, Mehtar S. Antibiotic use in pregnancy: Knowledge, attitudes and practices among pregnant women in Cape Town, South Africa. *J Antimicrob Chemother* 75(2): 473-81, 2020.
- Bunduki G, Mumbere M, Mbahweka F. Assessment of Antibiotic Self-medication Pattern among University Students in Eastern Democratic Republic of the Congo. *J Pharm Res Int* 18(1): 1-7, 2017.
- Bwire GM, Kibwana UO, Nkinda L, et al. JAC-Antimicrobial Resistance Implementation research for promoting access and rational use of antibiotics for children: lessons learnt from Tanzania. *JAC-Antimicrobial Resist* 5(2): 1-4, 2023.
- Caudell MA, Quinlan MB, Subbiah M, Call DR, et al. Antimicrobial use and veterinary care among agro-pastoralists in Northern Tanzania. *PLoS One* 12(1), 2017.
- Caudell MA, Dorado-Garcia A, Eckford S, Creese C, et al. Towards a bottom-up understanding of antimicrobial use and resistance on the farm: A knowledge, attitudes, and practices survey across livestock systems in five African countries. *PLoS One* 15(1): 1-26, 2020.
- Chizimu JY, Mudenda S, Yamba K, Lukwesa C, et al. Antimicrobial stewardship situation analysis in selected hospitals in Zambia: findings and implications from a national survey. *Front public Heal* 12: 1367703, 2024.
- Chuwa BB, Njau LA, Msigwa KI, Shao ER. Prevalence and factors associated with self medication with antibiotics among university students in moshi kilimanjaro Tanzania. *Afr Health Sci* 21(2): 633-9, 2021.
- Collignon PJ, & McEwen SA. One health-its importance in helping to better control antimicrobial resistance. Vol. 4, *Tropical Medicine and Infectious Disease*. MDPI AG; 2019.
- Dixon J, Macpherson EE, Nayiga S, Manyau S, et al. Antibiotic stories: a mixed-methods, multi-country analysis of household antibiotic use in Malawi, Uganda and Zimbabwe. *BMJ Glob Heal* 6(11): 1-15, 2021.
- Dixon J, Manyau S, Kandiye F, Kranzer K, Clare I, Chandler R. Social Science & Medicine Antibiotics , rational drug use and the architecture of global health in Zimbabwe. *Soc Sci Med* 272: 113594;, 2021.
- Durrance-Bagale A, Jung AS, Frumence G, Mboera L, et al. Framing the drivers of antimicrobial resistance in Tanzania. *Antibiotics* 10(8): 1-16, 2021.
- Eliakimu E. Antimicrobial stewardship in Tanzania: A consideration of strengths, weaknesses, opportunities and challenges for maintenance and further development of efforts. *Int J Heal Gov* 21(3): 150-64, 2016.
- Elmahi OKO, Musa RAE, Shareef AAH, Omer MEA, et al. Perception and practice of self-medication with antibiotics among medical students in Sudanese universities: A cross-sectional study. *PLoS One* 17: 1-15, 2022.
- Elmahi OKO, Musa RAE, Shareef AAH, et al. Perception and practice of self-medication with antibiotics among medical students in Sudanese universities: A cross-sectional study. *PLoS One* 17: 5-8;, 2022.
- Fisher MC, Alastruey-Izquierdo A, Berman J, et al. Tackling the emerging threat of antifungal resistance to human health. Vol. 20, *Nature Reviews Microbiology*. *Nature Research*; 2022. p. 557-71.

- Frumence G, Mboera LEG, Katale BZ, Sindato C, et al. Policy actors and human and animal health practitioners' perceptions of antimicrobial use and resistance in Tanzania: A qualitative study. *J Glob Antimicrob Resist* 25: 40-7, 2021.
- Frumence G, Mboera LEG, Sindato C, Durrance-Bagale A, et al. Practices and challenges of veterinary paraprofessionals in regards to antimicrobial use and resistance in animals in Dar es salaam, Tanzania. *Antibiotics* 10(6): 1-11, 2021.
- Gabriel S, Manumbu L, Mkusa O, Kilonzi M, Marealle AI. JAC- Antimicrobial Resistance Knowledge of use of antibiotics among consumers in Tanzania. *JAC-Antimicrobial Resist* 1-8, 2021.
- Gebregziabher NK, Netsereab TB, Franchesko BT, et al. Prevalence of self-medication practices with antibiotics and associated factors among students in five colleges in Eritrea: a cross-sectional study. *Antimicrob Resist Infect Control* 13(1): 106, 2024.
- Gebreyes WA, Dupouy-camet J, Newport MJ, et al. The Global One Health Paradigm : Challenges and Opportunities for Tackling Infectious Diseases at the Human , Animal , and Environment Interface in Low-Resource Settings. *PLoS Neglected Trop Dis* 8(11): e3257, 2014.
- Godman B, Egwuenu A, Haque M, et al. Strategies to improve antimicrobial utilization with a special focus on developing countries. *Life* 11(6), 2021.
- Haakuria VM, Pyatt AZ, Mansbridge SC. Exploration of veterinary service supply to rural farmers in Namibia: a one health perspective. *Pan African Med J One Heal* 2(17), 2020.
- Haenssge MJ, Charoenboon N, Zanello G, et al. Antibiotic knowledge, attitudes and practices: New insights from cross-sectional rural health behaviour surveys in low-income and middle-income South-East Asia. *BMJ Open* 9(8), 2019.
- Havyarimana, C., Makuraza, F., Nyandwi, J., et al. Evaluation of the Regulation of Antibiotics Consumption in Bujumbura, Burundi. *J Pharm Pharmacol* 5(10), 2017.
- Hertz JT, Madut DB, Tesha RA, William G, et al. Self-medication with non-prescribed pharmaceutical agents in an area of low malaria transmission in northern Tanzania: a community-based survey. *Trans R Soc Trop Med Hyg.* 2019;113(4):183-188. doi: 10.1093/trstmh/try138.
- Hirwa EM, Mujawamariya G, Shimelash N, Shyaka A. Evaluation of cattle farmers' knowledge, attitudes, and practices regarding antimicrobial use and antimicrobial resistance in Rwanda. *PLoS One* 19(4), 2024.
- Hoque R, Ahmed SM, Naher N, Islam MA, et al. Tackling antimicrobial resistance in Bangladesh: A scoping review of policy and practice in human, animal and environment sectors. *PLoS One* 15(1): 1-22, 2020.
- Horumpende PG, Said SH, Mazuguni FS, Antony ML, et al. Prevalence, determinants and knowledge of antibacterial self-medication: A cross sectional study in North-eastern Tanzania. *PLoS One* 13(10): 1-13, 2018.
- Horumpende PG, Sonda TB, van Zwetselaar M, et al. Prescription and non-prescription antibiotic dispensing practices in part I and part II pharmacies in Moshi Municipality, Kilimanjaro Region in Tanzania: A simulated clients approach. *PLoS One* 13(11): 1-14, 2018.
- Hosain MZ, Lutful Kabir SM, Kamal MM. Antimicrobial uses for livestock production in developing countries. *Vet World* 14(1): 210-21, 2021.
- Iramiot JS, Kajumbula H, Bazira J, Kansiime C, Asiimwe BB. Antimicrobial resistance at the human - animal interface in the Pastoralist Communities of Kasese District , South Western Uganda Contagious

- Bovine pleuropneumonia. *Sci Rep* 1-15, 2020.
- Jp M, Nikwigize S, Karangwa C, Manishimwe R, et al. Knowledge , Attitudes and Practices on Antibiotics Use among Cattle Keepers in Nyagatare District , Rwanda. *J Public Health and Epid*. 8(4), 2021.
- Kainga H, Phonera MC, Chikowe I, Chatanga E, et al. Determinants of Knowledge, Attitude, and Practices of Veterinary Drug Dispensers toward Antimicrobial Use and Resistance in Main Cities of Malawi: A Concern on Antibiotic Stewardship. *Antibiotics* 12(1): 1-17, 2023.
- Kajeguka DC, Moses EA. Self-medication practices and predictors for self-medication with antibiotics and antimalarials among community in Mbeya city, Tanzania. *Tanzan J Health Res* 19(4), 2017.
- Kalungia AC, Burger J, Godman B, Costa J de O, Simuwelu C. Non-prescription sale and dispensing of antibiotics in community pharmacies in Zambia. *Expert Rev Anti Infect Ther* 14(12): 1215-23, 2016.
- Kamba PF, Charani E, Nambatya W, Rajab K, Aguma HB. Gaps and opportunities in sustainable medicines use in resource limited settings : A situational analysis of Uganda. *Br Pharmacol Soc*. 2022:1-7.
- Kassa T, Gedif T, Andualem T, Aferu T. Antibiotics self-medication practices among health care professionals in selected public hospitals of Addis Ababa, Ethiopia. *Heliyon* 8(1): e08825, 2022.
- Katakweba AAS, Mtambo MMA, Olsen JE, Muhairwa AP. Awareness of human health risks associated with the use of antibiotics among livestock keepers and factors that contribute to selection of antibiotic resistance bacteria within livestock in Tanzania. *Livest Res Rural Dev* 24(10), 2012.
- Kaupitwa GJ, Seth Nowaseb, Brian Godman DK. Analysis of policies for use of medically important antibiotics in animals in Namibia: implications for antimicrobial stewardship. *Expert Rev Anti Infect Ther* 20(10): 1365-79, 2022.
- Khairy WA, Nasser HA, Sarhan MD, et al. Prevalence and predictors of self-medication with antifungal drugs and herbal products among university students: A cross-sectional study from egypt. *Risk Manag Healthc Policy* 14: 2191-200, 2021.
- Kiambi S, Mwanza R, Sirma A, Czerniak C, et al. Understanding antimicrobial use contexts in the poultry sector: Challenges for small-scale layer farms in Kenya. *Antibiotics* 10(2): 1-16, 2021.
- Kimera ZI, Frumence G, Mboera LEG, Rweyemamu M, et al. Assessment of drivers of antimicrobial use and resistance in poultry and domestic pig farming in the Msimbazi river basin in Tanzania. *Antibiotics* 9(12): 1-20, 2020.
- Kimera ZI, Frumence G, Mboera LEG, Rweyemamu M, et al. Assessment of drivers of antimicrobial use and resistance in poultry and domestic pig farming in the Msimbazi river basin in Tanzania. *Antibiotics* 9(12): 1-20, 2020.
- Kivumbi MT, Standley CJ. Efforts to identify and combat antimicrobial resistance in uganda: A systematic review. Vol. 6, *Tropical Medicine and Infectious Disease*. MDPI AG; 2021.
- Loosli K, Nasuwa F, Melubo M, Mnzava K, et al. Exploring drivers of self-treatment with antibiotics in three agricultural communities of northern Tanzania. *Antimicrob Resist Infect Control* 13(1), 2024.
- Mabilika RJ, Mpolya E, Shirima G. Prevalence and predictors of self-medication with antibiotics in selected urban and rural districts of the Dodoma region, Central <https://doi.org/10.4314/tvj.v41i2.8>

- Tanzania: a cross-sectional study. *Antimicrob Resist Infect Control* 11(86): 1-9, 2022.
- Madoshi BP, Kudirkiene E, Mtambo MMA, Muhairwa AP, et al. Characterisation of commensal *Escherichia coli* isolated from apparently healthy cattle and their attendants in Tanzania. *PLoS One* 11(12), 2016.
- Madzingira O, Simasiku S. A survey of the usage and storage practices of veterinary medicines among communal cattle farmers in the Kabbe South Constituency, Zambezi region. *Wijas* 2: 61-9, 2020.
- Mangesho PE, Caudell MA, Mwakapeje ER, et al. "We are doctors": Drivers of animal health practices among Maasai pastoralists and implications for antimicrobial use and antimicrobial resistance. *Prev Vet Med* 188(2021), 2021.
- Mankhomwa J, Tolhurst R, M'biya E, Chikowe I, et al. A Qualitative Study of Antibiotic Use Practices in Intensive Small-Scale Farming in Urban and Peri-Urban Blantyre, Malawi: Implications for Antimicrobial Resistance. *Front Vet Sci* 9: 1-16, 2022.
- Manyau S, Dixon J, Mutukwa N, Kandiye F, et al. Antibiotics and the Biopolitics of Sex Work in Zimbabwe. *Med Anthropol Cross Cult Stud Heal Illn* 41(3): 257-71, 2022.
- Martin K, Fatima D, Steward M, Webrod M, et al. Medication administration omission errors: Frequency and their causes during medication administration process at Ndola Teaching Hospital in Zambia. *African J Pharm Pharmacol* 15(9): 174-82, 2021.
- Mashalla Y, Setlhare V, Massele A, Sepako E, Tiroyakgosi C, et al. Assessment of prescribing practices at the primary healthcare facilities in Botswana with an emphasis on antibiotics: Findings and implications. *Int J Clin Pract* 71(12): 1-10, 2017.
- Mbonye AK, Buregyeya E, Rutebemberwa E, et al. 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 1-6, 2016.
- Mdegela RH, Mwakapeje ER, Rubegwa B, et al. Antimicrobial use, residues, resistance and governance in the food and agriculture sectors, Tanzania. *Antibiotics* 10(4), 2021.
- Metta E, Haisma H, Kessy F, Hutter I, Bailey A. "we have become doctors for ourselves": Motives for malaria self-care among adults in southeastern Tanzania. *Malar Journal* 13(1): 1-13, 2014.
- Mikecz O, Pica-Ciamarra U, Felis A, Nizeyimana G, et al. Data on antimicrobial use in livestock: Lessons from Uganda. *One Heal* 10(June): 100165, 2020.
- MKALA RS. Antibiotic prescription practice at veterinary pharmaceutical shops and its potential impact on the development of antimicrobial resistance in Moshi, Northern Tanzania. *J Drug Deliv Ther* 12(1-S): 100-4, 2022.
- Mokwele RN, Schellack N, Bronkhorst E, Brink AJ, et al. Using mystery shoppers to determine practices pertaining to antibiotic dispensing without a prescription among community pharmacies in South Africa - a pilot survey. *JAC-Antimicrobial Resist* 4(1), 2022.
- Mshana SE, Matee M, Rweyemam M. Antimicrobial resistance in human and animal pathogens in Zambia. *Ann Clin Microbiol Antimicrob* 12(28): 1-10, 2013.
- Mubito EP, Shahada F, Kimanya ME, Buza JJ. Antimicrobial use in the poultry industry in Dar-es-Salaam, Tanzania and public health implications. 2(4):51-63.
- Mudenda S, Daka V, Matafwali SK, Kanaan MHG, et al. Prevalence of Self-Medication and Associated Factors among Healthcare

- Students during the COVID-19 Pandemic: A Cross-Sectional Study at the University of Zambia. *Open J Soc Sci* 11(10): 340-63, 2023.
- Mudenda S, Mulenga KM, Nyirongo R, et al. Non-prescription sale and dispensing of antibiotics for prophylaxis in broiler chickens in Lusaka District, Zambia: findings and implications on one health. *JAC-Antimicrobial Resist* 6(3): 1-5, 2024.
- Mukokinya MA, Opanga S, Oluka M, Godman B. Dispensing of antimicrobials in Kenya: A cross-sectional pilot study and its implications. *J Res Pharm Pract* 7(2): 77, 2018.
- Mupfunya CR, Qekwana DN, Naidoo V. Antimicrobial use practices and resistance in indicator bacteria in communal cattle in the Mnisi community, Mpumalanga, South Africa. *Vet Med Sci* 7(1): 112-21, 2021.
- Mushi MF, Masewa B, Jande M, Mirambo MM, Mshana SE. Prevalence and factor associated with over-the-counter use of antifungal agents', in Mwanza city, Tanzania. *Tanzan J Health Res* 19(1): 1-8, 2017.
- Musoke D, Namata C, Lubega GB, Kitutu FE, et al. Access, use and disposal of antimicrobials among humans and animals in Wakiso district, Uganda: a qualitative study. *J Pharm Policy Pract* 14(1): 1-12:, 2021.
- Musoke D, Lubega GB, Gbadesire MS, Boateng S, et al. Antimicrobial stewardship in private pharmacies in Wakiso district, Uganda: a qualitative study. *J Pharm Policy Pract* 16(1), 2023.
- Musuuza JS, Guru PK, O'Horo JC, Bongiorno CM, et al. The impact of chlorhexidine bathing on hospital-acquired bloodstream infections: A systematic review and meta-analysis. *BMC Infect Dis* 19(1): 1-10, 2019.
- Mutua F, Kiarie G, Mbatha M, Onono J, et al. Antimicrobial Use by Peri-Urban Poultry Smallholders of Kajiado and Machakos Counties in Kenya. *Antibiotics* 12(5), 2023.
- Muwanguzi TE, Yadesa TM, Agaba AG. Antibacterial prescription and the associated factors among outpatients diagnosed with respiratory tract infections in Mbarara Municipality , Uganda. *BMC Pulm Med* 1-11, 2021.
- Mwita S, Meja O, Katabalo D, Richard C. Magnitude and factors associated with anti-malarial self-medication practice among residents of Kasulu Town Council, Kigoma-Tanzania. *Afr Health Sci* 19(3): 2457-61, 2019.
- Nahimana T, Harimenshi D, Ntawukuriryayo G, Girukwishaka D. Self-medication and associated factors among nursing student in Burundi Self-Medication and Associated Factors among Nursing Student Trainees at Ngozi Hospital-Burundi. Vol. 23, *Health Sci. Dis.* 2022.
- Nayiga S, Kayendeke M, Nabirye C, Willis LD, et al. Use of antibiotics to treat humans and animals in Uganda: A cross-sectional survey of households and farmers in rural, urban and peri-urban settings. *JAC-Antimicrobial Resist* 2(4): 1-11, 2020.
- Nayiga S, Willis LD, Staedke SG, et al. Taking Opportunities , Taking Medicines : Antibiotic Use in Rural Eastern Uganda Taking Opportunities. *J. Med Anthropol* 41(4): 418-30, 2022.
- Nyaki FS, Taksdal M, Mbuya AW, Sariko M, et al. Predictors of Nutritional Status in Patients Treated for Multidrug-Resistant Tuberculosis at a Referral Hospital in Tanzania Journal of Clinical Infectious Diseases Predictors of Nutritional Status in Patients Treated for Multidrug-Resistant Tuberculosis. *J Clin Infect Dis Pract* 1(2): 1-5, 2016.

- Nyambega JO. Antibiotic Use and Misuse Among Adults in Magwagwa Ward, Nyamira County in Kenya. *IOSR J Pharm Biol Sci* 12(01): 87-92, 2017.
- Nyeko R, Otim F, Obiye EM, Abala C. Pre-hospital exposures to antibiotics among children presenting with fever in northern Uganda: a facility-based cross-sectional study. *BMC Pediatr* 22(1): 1-12, 2022.
- Ocan M, Bwanga F, Bbosa GS, Bagenda D, et al. Patterns and predictors of self-medication in northern Uganda. *PLoS One* 9(3): 1-7, 2014.
- Ocan M, Manabe YC, Baluku H, Atukwase E, et al. Prevalence and predictors of prior antibacterial use among patients presenting to hospitals in Northern Uganda. *BMC Pharmacol Toxicol* 16(26): 1-8, 2015.
- Odey TOJ, Tanimowo WO, Afolabi KO, et al. Antimicrobial use and resistance in food animal production: food safety and associated concerns in Sub-Saharan Africa. *Int Microbiol* 27(1): 1-23, 2024.
- Okello DM, Aliro T, Odongo W, Ndyomugenyi EK, Owiny DO. Alone or a combination: Ascertaining factors associated with choice of pig health management strategies amongst smallholder farmers in northern Uganda. *Prev Vet Med* 199: 105562, 2022.
- Olaru ID, Ferrand RA, Yeung S, Chingono R, et al. Knowledge, attitudes and practices relating to antibiotic use and resistance among prescribers from public primary healthcare facilities in Harare, Zimbabwe. *Wellcome Open Res* 6: 1-7, 2021.
- Otaigbe II, Elikwu CJ. Drivers of inappropriate antibiotic use in low- and middle-income countries. *JAC-Antimicrobial Resist* 5(3): 1-9, 2023.
- Page MJ, McKenzie JE, Bossuyt PM, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ* 372: n71, 2021.
- Pereko DD, Lubbe MS, Essack SY. Surveillance of antibiotic use in the private sector in Namibia using sales and claims data. *J Infect Dev Countries* 10(11): 1243-9, 2016.
- Petro BJ, Mkumbaye SI, Bakar RR, Yussuf NIH, et al. Antibiotic use in Moshi Urban: A cross-sectional Study of Knowledge and Practices among Caretakers of Children in Kilimanjaro Tanzania. *Rwanda J Med Heal Sci* 4(3): 347-56, 2021.
- Pharmacy and Poisons Board (PPB). Customer Service Guidelines. Nairobi: Pharmacy and Poisons Board; 2022.
- Rodrigues CF. Self-medication with antibiotics in Maputo, Mozambique: practices, rationales and relationships. *Palgrave Commun* 6(1): 1-12, 2020.
- Roulette CJ, Caudell MA, Roulette JW, Quinlan RJ, et al. A two-month follow-up evaluation testing interventions to limit the emergence and spread of antimicrobial resistant bacteria among Maasai of northern Tanzania. *BMC Infect Dis* 17(1): 1-10, 2017.
- Sambakunsi CS, Småbrekke L, Varga CA, Solomon V, Mponda JS. Knowledge, attitudes and practices related to self-medication with antimicrobials in Lilongwe, Malawi. *Malawi Med J* 31(4): 225-32, 2019.
- Sangeda RZ, Baha A, Erick A, Mkumbwa S, et al. Consumption Trends of Antibiotic for Veterinary Use in Tanzania: A Longitudinal Retrospective Survey From 2010-2017. *Front Trop Dis* 2: 1-10, 2021.
- Shembo AKP, Musumari PM, Srithanaviboonchai K, et al. A qualitative study on community use of antibiotics in Kinshasa, Democratic Republic of Congo. *PLoS One* 17(4 April): 1-14, 2022.
- Shitindi L, Issa O, Poyongo BP, Horumpende PG, et al. Comparison of knowledge, attitude, practice and predictors of self-

- medication with antibiotics among medical and non-medical students in Tanzania. *Front Pharmacol* 14(January): 1-17, 2023.
- Simon B, Kazaura M. Prevalence and factors associated with parents self-medicating under-fives with antibiotics in bagamoyo district council, tanzania: A cross-sectional study. *Patient Prefer Adherence* 14: 1445-53, 2020.
- Sindato C, Mboera LEG, Katale BZ, Frumence G, et al. Knowledge, attitudes and practices regarding antimicrobial use and resistance among communities of Ilala, Kilosa and Kibaha districts of Tanzania. *Antimicrob Resist Infect Control*. 9(1): 1-17, 2020.
- Tanzania Medicines and Medical Devices Authority (TMDA). Tanzania Medicines and Medical Devices (Control of Human and Veterinary Medicines Promotion) Regulations, 2025. Dodoma: TMDA; 2023.
- Tembo N, Mudenda S, Banda M, Chileshe M, Matafwali S. Knowledge, attitudes and practices on antimicrobial resistance among pharmacy personnel and nurses at a tertiary hospital in Ndola, Zambia: Implications for antimicrobial stewardship programmes. *JAC-Antimicrobial Resist*. 4(5): 1-8, 2022.
- Thriemer K, Katuala Y, Batoko B, Alworonga JP, et al. Antibiotic Prescribing in DR Congo: A Knowledge, Attitude and Practice Survey among Medical Doctors and Students. *PLoS One* 8(2): 1-8, 2013.
- Torres NF, Solomon VP, Middleton LE. Patterns of self-medication with antibiotics in Maputo City: A qualitative study. *Antimicrob Resist Infect Control* 8(1): 1-12, 2019.
- Torres NF, Solomon VP, Middleton LE. "Two-colour capsules": Self-management of health and the commonly used non-prescribed antibiotics amongst pharmacy customers 1-22, 2020.
- Tuyishimire J, Okoya F, Adebayo AY, et al. Assessment of self-medication practices with antibiotics among undergraduate university students in Rwanda. *Pan Afr Med J* 33: 1-7, 2019.
- Valimba R, Liana J, Joshi MP, Rutta E, et al. Engaging the private sector to improve antimicrobial use in the community: Experience from accredited drug dispensing outlets in Tanzania. *J Pharm Policy Pract*. 7(1): 1-7, 2014.
- Valimba R, Liana J, Joshi MP, Rutta E, et al. Engaging the private sector to improve antimicrobial use in the community: experience from accredited drug dispensing outlets in Tanzania 1-7, 2014.
- Veterinary Medicines Directorate (VMD). Veterinary Medicines Directorate Regulations. Nairobi: Veterinary Medicines Directorate; 2022.
- WHO. Antimicrobial resistance: accelerating national and global responses. World Health Organization. 2023.
- WOAH - World Organization for Animal Health. The OIE Strategy on Antimicrobial Resistance and the Prudent Use of Antimicrobials. *World Organ Anim Heal* : 1-61, 2016.
- Xu R, Mu T, Wang G, Shi J, et al. Self-Medication with Antibiotics among University Students in LMIC: A systematic review and meta-analysis. *J Infect Dev Countries* 13(8): 678-89, 2019.
- Yeika EV, Ingelbeen B, Kemah BL, et al. Comparative assessment of the prevalence, practices and factors associated with self-medication with antibiotics in Africa. Vol. 26, *Tropical Medicine and International Health*. John Wiley and Sons Inc; 2021. p. 862-81.