Perspective Paper

Current rates of purchasing of antibiotics without a prescription across sub-Saharan Africa; rationale and potential programmes to reduce inappropriate dispensing and resistance

Tiyani Milta Sono[1,2], Eugene Yeika[3], Aislinn Cook[4,5], Aubrey Kalungia[6], Sylvia A. Opanga[7], Joseph Elikem Efui Acolatse[8], Israel Abebrese Sefah[9], Ana Golić Jelić[10] , Stephen Campbell[1,11], Giulia Lorenzetti[4], Zia Ul Mustafa[12,13], Vanda Marković-Peković[10], Amanj Kurdi[1,14,15,16], Bene D Anand Paramadhas[17], Godfrey Mutashambara Rwegerera[18,19], Adefolarin A Amu[20], Mobolaji Eniola Alabi[21], Evelyn Wesangula[22], Margaret Oluka[7], Felix Khuluza[23], Ibrahim Chikowe[23], Joseph O. Fadare[24,25], Olayinka O. Ogunleye[26,27], Dan Kibuule[28], Ester Hango[29], Natalie Schellack[30], Nishana Ramdas[1], Amos Massele[31], Steward Mudenda[6,32], Iris Hoxha[33], Catrin E. Moore[4], Brian Godman[1,14*], Johanna C. Meyer[1,34]

[1]Department of Public Health Pharmacy and Management, School of Pharmacy, Sefako Makgatho Health Sciences University, Molotlegi Street, Garankuwa, Pretoria 0208, South Africa. Email: brian.godman@smu.ac.za (BG); hannelie.meyer@smu.ac.za (J.C.M); nishanaramdas@gmail.com (NR); stephen.campbell@smu.ac.za (SC)
[2]Saselamani Pharmacy, Saselamani 0928, South Africa. Email: tiyanim@gmail.com
[3]Programs coordinator/Technical supervisor for HIV/Malaria, Delegation of Public Health, North West Region, Cameroon. Email: eugenembinglo@gmail.com
[4]Centre for Neonatal and Paediatric Infection, St. George's University of London, London SW17 0RE, UK. Email: aicook@sgul.ac.uk (A.C.); glorenze@sgul.ac.uk (GL); camoore@sgul.ac.uk (C.E.M.)
[5]Health Economics Research Centre, Nuffield Department of Population Health, University of Oxford, Oxford OX1 2JD, UK
[6]Department of Pharmacy, School of Health Sciences, University of Zambia, Lusaka P.O. Box 50110, Zambia. Email: ckalungia@unza.zm (ACK); freshsteward@gmail.com (SM)
[7]Department of Pharmacology, Clinical Pharmacy and Pharmacy Practice, School of Pharmacy, University of Nairobi, Nairobi P.O. Box 19676-00202, Kenya. Email: sopanga@uonbi.ac.ke (SO); olukamarga@yahoo.com (MO)
[8]Cape Coast Teaching Hospital (CCTH), P.O. Box CC1363, Cape Coast, Ghana. Email: j.acolatse@ccth.gov.gh
[9]Pharmacy Practice Department, School of Pharmacy, University of Health and Allied Sciences, Volta Region, Ho PMB 31, Ghana. Email: isefah@uhas.edu.gh
[10]Department of Pharmacy, Faculty of Medicine, University of Banja Luka, Banja Luka, Republic of Srpska, Bosnia & Herzegovina. Email: ana.golic@med.unibl.org (AGJ); vanda.markovic-pekovic@med.unibl.org (VM-P)
[11]Centre for Epidemiology and Public Health, School of Health Sciences, University of Manchester, Manchester M13 9PL, UK. Email: stephen.campbell@manchester.ac.uk (SC)
[12]Discipline of Clinical Pharmacy, School of Pharmaceutical Sciences, Universiti Sains Malaysia, Gelugor 11800, Penang, Malaysia. Email: zia.ucp@gmail.com. ORCID Number 0000-0002-8109-4859
[13]Department of Pharmacy Services, District Headquarter (DHQ) Hospital, Pakpattan 57400, Pakistan.
[14]Department of Pharmacoepidemiology, Strathclyde Institute of Pharmacy and Biomedical Sciences, University of Strathclyde, Glasgow G4 0RE, UK. Email: amanj.baker@strath.ac.uk (AK); Brian.Godman@strath.ac.uk (BG)
[15]Department of Pharmacology, College of Pharmacy, Hawler Medical University, Erbil 44001, Iraq
[16]Center of Research and Strategic Studies, Lebanese French University, Erbil 44001, Iraq
[17]Central Medical Stores, Ministry of Health, Gaborone, Botswana. Email: bparamadhas@gov.bw
[18]Faculty of Medicine, Department of Internal Medicine, University of Botswana, Gaborone, Botswana
[19]Destiny Medical and Research Solutions Proprietary Limited, Gaborone, Botswana. Email: godfreyrwegerera@gmail.com
[20]Pharmacy Department, Eswatini Medical Christian University, Mbabane, Kingdom of Eswatini. Email: amuadefolarin@emcu.ac.sz
[21]School of Pharmaceutical Sciences, College of Health Sciences, University of Kwazulu-natal (UKZN), Durban, South Africa. Email: favourbibi@gmail.com

This is a peer-reviewed, accepted author manuscript of the following research article: Sono, T. M., et. al. (2023). Current rates of purchasing of antibiotics without a prescription across sub-Saharan Africa; rationale and potential programmes to reduce inappropriate dispensing and resistance. *Expert Review of Anti-infective Therapy*.

[22]East Central and Southern Africa Health Community, Arusha, Tanzania. Email: wesangulaeva@gmail.com
[23]Pharmacy Department, Kamuzu University of Health Sciences (KUHeS) (formerly College of Medicine), Blantyre, Malawi. Email: ichikowe@medcol.mw; fkhuluza@kuhes.ac.mw
[24]Department of Pharmacology and Therapeutics, Ekiti State University, Ado Ekiti 362103, Nigeria; joseph.fadare@eksu.edu.ng
[25]Department of Medicine, Ekiti State University Teaching Hospital, Ado Ekiti 360211, Nigeria
[26]Department of Pharmacology, Therapeutics and Toxicology, Lagos State University College of Medicine, Ikeja, Lagos 100271, Nigeria. Email: olayinka.ogunleye@lasucom.edu.ng
[27]Department of Medicine, Lagos State University Teaching Hospital, Ikeja 100271, Nigeria
[28]Department of Pharmacology & Therapeutics, Busitema University, Mbale P.O. Box 236, Uganda. Email:kibuulefamily@yahoo.co.uk
[29]Department of Pharmacy Practice and Policy, School of Pharmacy, Faculty of Health Sciences, University of Namibia, Namibia. Email: ehango@unam.na
[30]Department of Pharmacology, Faculty of Health Sciences, University of Pretoria, Pretoria 0084, South Africa. Email: natalie.schellack@up.ac.za
[31]Department of Clinical Pharmacology and Therapeutics, Hurbert Kairuki Memorial University, 70 Chwaku Road Mikocheni, Dar Es Salaam P.O. Box 65300, Tanzania. Email: amos.massele@hkmu.ac.tz
[32]Africa Center of Excellence for Infectious Diseases of Humans and Animals, University of Zambia, Lusaka P.O. Box 32379, Zambia.
[33]Department of Pharmacy, Faculty of Medicine, University of Medicine Tirana, Albania. Email: iris.hoxha@umed.edu.al. ORCID numbers: 000-0001-7312-1952
[34]South African Vaccination and Immunisation Centre, Sefako Makgatho Health Sciences University, Molotlegi Street, Garankuwa, Pretoria 0208, South Africa

* Correspondence: brian.godman@strath.ac.uk

Abstract

Introduction: Antimicrobial resistance (AMR) is a global concern. Currently, the greatest mortality due to AMR is in Africa. A key driver continues to be high levels of dispensing of antibiotics without a prescription. **Areas covered**: A need to document current rates of dispensing, their rationale and potential ways forward including antimicrobial stewardship programmes (ASPs). A narrative review was undertaken. The highest rates of antibiotic purchasing were in Eritrea (up to 89.2% of antibiotics dispensed), Ethiopia (up to 87.9%), Nigeria (up to 86.5%), Tanzania (up to 92.3%) and Zambia (up to 100% of pharmacies dispensing without a prescription). However, considerable variation with no dispensing in a minority of countries and situations. Key drivers of self-purchasing included high co-payment levels for physician consultations and antibiotic costs, travel costs, convenience of pharmacies, patient requests, limited knowledge of antibiotics and AMR and weak enforcement. ASPs have been introduced in some African countries along with quality targets to reduce inappropriate dispensing, centring on educating pharmacists and patients. **Expert Opinion**: ASP activities need accelerating among community pharmacies alongside quality targets, with greater monitoring of pharmacists' activities to reduce inappropriate dispensing. Such activities, alongside educating patients and HCPs, should enhance appropriate dispensing of antibiotics and reduce AMR.

Key words: Africa; Antibiotics; Antimicrobial resistance; Antimicrobial stewardship programmes; AWaRe classification; Community pharmacies; Health policy; Over-the-counter purchasing; Quality indicators; utilisation patterns

Article highlights

- There is still considerable purchasing of antibiotics without a prescription across Africa, with 100% of community pharmacies in some African countries dispensing antibiotics without a prescription

- However, rates of dispensing vary considerably both within and across countries. It is important to address current high rates typically for self-limiting conditions to reduce AMR, which is a major issue across sub-Saharan Africa (currently the continent with the highest prevalence rate of AMR globally) and an important part of National Action Plan activities to reduce AMR

- High rates of purchasing are exacerbated by issues of affordability (cost of medicines and physician costs as well as travel costs to facilities) among the population as well as possible loss of earnings with long waiting times to see a professional in healthcare facilities. Community pharmacists are more convenient

- Educating pharmacists and patients can reduce inappropriate dispensing of antibiotics. The instigation of quality indicators as part of antimicrobial stewardship programmes also helps reduce inappropriate dispensing

- With the publication of the AWaRe book, it is increasingly likely that future quality indicators will be based on its content. Alongside this, there will be an increasing use of information technology and mobile telephones to monitor future antibiotic dispensing patterns against agreed indicators

- The curricula in universities for healthcare professionals will also need to be upgraded to make sure they are fully competent to appropriately counsel patients on the optimal management of their infectious disease/ those of their children post qualification, backed up by continuous professional development activities

1. Introduction

There are growing concerns globally regarding the increase in antimicrobial resistance (AMR), which has resulted in increased morbidity, mortality, and costs [1-5]. A recent study estimated that in 2019 there were up to 4.95 million (95% uncertainty intervals (UI) 3·62–6·57) deaths worldwide associated with bacterial AMR, with an estimated 1.27 million (95% UI 0·911–1·71) deaths directly attributable to bacterial AMR [2]. The costs associated with AMR are also considerable [3,6,7]. The World Bank estimated in 2017 that the loss of world output due to AMR could possibly be as high as US$3.4 trillion annually if not addressed [8]. As a result, AMR is increasingly seen as the next global pandemic unless inappropriate practices are addressed [9]. Concerns regarding the costs and health impact of AMR have resulted in an appreciable number of international, regional and local activities to reduce inappropriate prescribing and dispensing of antibiotics due to the correlation with AMR. As a result, subsequently reduce the burden of AMR [10-12]. A crucial area of focus among key stakeholders is ambulatory care among humans as this currently accounts for approximately 90 to 95% of antibiotic utilisation worldwide, with the highest rates seen in low- and middle-income countries (LMICs) [13,14].

A critical continent in the goal to reduce AMR globally is Africa, which currently has the highest prevalence of infectious diseases and associated prescribing of antimicrobials globally [15-19]. In addition, the greatest burden of AMR globally is currently in Western sub-Saharan Africa, where AMR rates continue to rise [2,20]. Recent initiatives across Africa to address concerns with rising AMR include the instigation of National Action Plans (NAPs), building on the World Health Organisation's (WHO) initiative with their Global Action Plan to reduce AMR [21-24]. However, there are many challenges with implementing NAPs across Africa, with African countries at different stages of their development and implementation as well as surveillance and monitoring of agreed activities, which depends on available resources and personnel [19,22,25,26]. For instance in Ghana, there are still concerns due to the lack of available resources and commitment to fully progress their NAP [27], which is similar to other African countries with limited resources and technologies allocated to AMR mitigation [28].

A recognized concern across LMICs, especially among African countries, is the appreciable self-purchasing of antibiotics without a prescription, often for self-limiting viral infections including upper respiratory tract infections (URTIs) [29-39]. This activity, if left unchallenged, will continue to drive up AMR in Africa [35,38-41]. Such activities have been exacerbated by the COVID-19 pandemic with a resultant increase in antibiotic utilization, especially among LMICs, despite limited evidence of bacterial co-infections or bacterial secondary infections over time [40,42-48].

Overall, a number of systematic reviews have been undertaken to document the extent of dispensing of antibiotics without a prescription especially in LMICs despite local legislation banning this practice [38,49]. Ocan et al. (2015) that overall 38.8 % of all antibiotics were dispensed without a prescription among a number of LMICs (95 % CI: 29.5-48.1) [50]. Nepal et al. (2018) documenting similar figures

for the World Health Organisation (WHO) Southeast Asian Region , with an average prevalence of 42.64% (range: 7.3% to 85.59%) of antibiotics dispensed [35]. Batista et al. (2020) in their global systematic review (with most studies coming from LMICs) documented that typicaly over 60% of antibiotics were dispensed without a prescription [51]. Torres et al. (2021) documented a higher rate of purchasing of antibiotics without a prescription among adults in LMICs, with a pooled prevalence rate of 78% (95% CI: 65–89%; range 50-93.8%) of antibiotics dispensed [29]. More recently, Li et al (2023) in their systematic review documeneted a pooled prevalence of 63·4% (95% CI 59·6–67·1) of antibiotics dispensed without a prescription, with the highest number of papers coming from sub-Saharan African countries [38]. Similar to other studies, Li et al. found the prevalence of dispensing of antibiotics without a prescription was significantly higher in lower income countries versus high-income countries [38,52].

In a recent systematic review involving children in LMICs, nearly half of the antibiotics given to them were without a prescription [53]. This was typically for acute respiratory tract infections (ARIs) including coughs and fever as well as acute diarrhoea [53]. In this systematic review, higher rates of dispensing without a prescription were seen in studies that involved simulated children with infectious diseases at 56% (95%CI: 49 – 62%) as opposed to the rates seen with other methodologies [53].

With respect to systematic reviews just involving African countries, Yeika et al. (2021) documented a median prevalence of 55.7% (IQR 41 - 75%); range 12.1% to 93.9% [36], which is similar to Li et al (2023) [38]. The highest reported rate of antibiotics being dispensed without a prescription was seen in Western Africa at 70.1% (IQR 48.3 - 82.1%) followed by Northern Africa at 48.1% (IQR 41.1 - 64.3%) [36]. Belachew et al. (2021) documented higher rates in sub-Saharan Africa, with a pooled rate of 69% (95% CI 58 -80) [37], which is again similar to Li. et al (2023) with a pooled rate of 70.7% among included sub-Saharan African countries [38]. URTIs as well as acute diarrhoea were among the most frequent conditions among patients purchasing antibiotics for themselves or their children in both studies [37,38]. In their study involving six LMICs, 3 in Africa and 3 in Asia, Do et al. (2021) also found appreciable variation in the extent of purchasing of antibiotics without a prescription in the 3 African countries contained in their review. Prevalence rates ranged from 36.1% of occasions in Ghana to just 8.0% in Mozambique and 1.2% in South Africa [33]. These differences reflected differences in public healthcare facilities with medicines provided free-of-charge in Mozambique and South Africa as well as greater monitoring of the regulations surrounding antibiotic dispensing in South Africa [33]. In addition, higher co-payments as well as convenience of pharmacies in Ghana especially among patients without insurance [33,54].

Typically, among African countries, the purchasing of antibiotics without a prescription is illegal (Supplementary Table S1), which is similar to other continents [35,38,49,55-63]. Whilst the purchasing of antibiotics without a prescription may possibly occur in Botswana, this is believed to be very limited due to current regulations issued by the Botswana Medicines Regulatory Authority (BOMRA), which are enforced. Access to free healthcare, including medicines as part of Universal Health Coverage, also helps negate the need and expense of purchasing of antibiotics without a prescription in Botswana. Alongside this, at all levels of the public healthcare system, which covers over 85% of the population in Botswana [64,65], only prescribed medicines can be dispensed. The strict regulations in Botswana through BOMRA, which are followed up, coupled with medicines being provided free-of-charge in the public healthcare sector as part of UHC, has severely limited the dispensing of antibiotics without a prescription in the country.

Similarly in Namibia, there was no evidence of the purchasing of antibiotics without a prescription in two recent studies for respiratory and other infections, aided by strict legal regulations in the country, the monitoring of pharmacies to help enforce the regulations as well as the training of pharmacists on antibiotics and AMR whilst attending University [66-68]. The strict regulations banning the purchasing of antibiotics without a prescription in South Africa also limited such activities in the studies of Do et al. (2021) and Anstey Watkins et al. (2016) in rural South Africa [33,69]. The findings from these two publications are in direct contrast to those of Mokwele et al. (2022). Mokwele et al. found that antibiotics were being sold without a prescription in a number of privately-owned pharmacies in specific rural pharmacies in one Province in South Africa; however, this was not seen in any corporate (franchised) pharmacies that mystery shoppers visited [70]. The findings in Botswana, Namibia and South Africa contrast markedly with the situation in Zambia, where at one stage 100% of community pharmacies dispensed antibiotics without a prescription [71].

Overall although the findings are heterogeneous, there currently appears to be appreciable purchasing of antibiotics without a prescription across sub-Saharan Africa [36-38,41]. There are a plethora of reasons for continuing high rates of dispensing of antibiotics without a prescription across Africa (Box 1).

Box 1 – Documented reasons for the purchasing of antibiotics without a prescription in Africa (adapted from [33,41,54,63,72-88])

- Patient demand and expectations
- Weak enforcement and monitoring of current regulations surrounding the dispensing of antibiotics without a prescription
- Economic factors among community pharmacists and medicine vendors
- Patient convenience and economics especially if there are extensive co-payments (both to see a physician and to subsequently purchase prescribed medicines) and appreciable distances and costs to travel to public healthcare clinics – alongside potential loss of pay with time of work
- Trust in community pharmacists alongside ease of access compared with sometimes long waiting times to see a healthcare professional in public ambulatory care clinics
- Pharmacists may be the only healthcare professional available to treat patients especially in more rural areas
- Lack of knowledge of antibiotics and AMR among dispensing staff including both pharmacists and patients
- Poor attitudes towards antibiotics especially among patients in terms of not conserving them for bacterial infections as opposed to requesting them for self-limiting viral infections including colds, coughs and sore throats

Lack of knowledge regarding antibiotics and AMR among pharmacy personnel in some of the African countries starts in the universities and continues post-qualification [79,80]. This needs to be addressed going forward. Encouragingly, educational, and other interventions, including dissemination of guidelines, have enhanced appropriate dispensing of antibiotics in the community among LMICs [31,57,63,89,90]. In Kenya, there was little or no purchasing of antibiotics without a prescription among community pharmacies linked with the University of Nairobi, which were superintended by pharmacists, including during the recent COVID-19 pandemic [91,92]. This is particularly important at this time when, as mentioned, there has been an appreciable increase in antibiotic utilization among LMICs to treat patients with COVID-19 despite limited prevalence of bacterial co-infections or secondary infections, which could lead to increasing AMR [40,43,48,93-97].

Given the priority to reduce AMR across sub-Saharan Africa, exacerbated by high rates of purchasing of antibiotics without a prescription, we believe there is a need to update the evidence base of current rates of the purchasing of antibiotics without a prescription across the continent coupled with their rationale and potential ways forward [36,37,41,98,99]. This is especially important if this involves considerable dispensing of 'Watch' antibiotics as their increasing use is likely to drive up resistance rates [60,100-102]. There should be limited prescribing and dispensing of antibiotics in the "Watch" group across countries as these antibiotics are considered to have greater resistance potential and toxicity than those in the 'Access' group [103-105]. Alongside this, there should be no prescribing or dispensing of antibiotics of "Reserve" antibiotics in ambulatory care since these are considered antibiotics of last resort and should be reserved for hospital use only [103-105].

Various activities have been implemented across Africa and other LMICs to decrease inappropriate purchasing of antibiotics without a prescription [89]. Activities include the instigation of antimicrobial stewardship programmes (ASPs) [57,106]. The instigation of such activities to reduce inappropriate dispensing of antibiotics is important as it can be morally challenging to effectively ban the purchasing of antibiotics without a prescription especially in rural areas in Africa. This is because physician numbers are often limited in rural areas of Africa. There can also be considerable travel costs and time for patients in rural areas to see a healthcare professional (HCP) in a public healthcare clinic in urban settings potentially offset by trust in community pharmacists. Alongside this, there can be high co-payments to see a physician, which can be unaffordable on top of the cost of medicines [37,75,82,84,85]. For instance in their study, Khuluza and Heide (2017) found that the cost of 83.3% of common antibiotics and antimalarials exceeded the daily wage of a low-paid government worker in Malawi, and were thus considered as unaffordable for the majority of the population [107]. In addition, there have been situations where policies to reduce the purchasing of antibiotics without a

prescription have failed to achieve the desired results [49,57]. There was only a modest impact in Columbia following the initial law banning the purchasing of antibiotics without a prescription [55,108]. However, lax monitoring of the law resulted in limited impact some five years later [55]. In Zimbabwe, strict enforcement of the regulations banning the purchasing of antibiotics in the early 2000s resulted in limited sales despite pressure from patients. However, considerable changes in the economic circumstances of patients have resulted in most patients in Zimbabwe now obtaining their antibiotics from the informal market despite current regulations [37,85,109-111]. A recent study in Vietnam also demonstrated the limited impact of current regulations banning the purchasing of antibiotics without a prescription with only limited sanctions for pharmacist who abuse the regulations [58].

Consequently, the aim of this paper is to consolidate the current evidence base regarding the extent of antibiotics being purchased without a prescription across Africa, building on the many systematic reviews in LMICs which include Africa as well as focusing on Africa [29,36,38,39,50,51]. Alongside this, the rationale behind self-purchasing as well as potential ways forward, building on successful ASPs among LMICs to limit this practice as well as the learnings from unsuccessful ASPs including in Africa. This will be achieved by undertaking a narrative review of the literature with senior-level personnel throughout sub-Saharan Africa providing expert input. Expert input will also inform suggestions for potential ways forward. We believe the findings and suggestions can subsequently be used by all key stakeholders across Africa and beyond to guide future activities to reduce inappropriate purchasing and dispensing of antibiotics without a prescription focusing on ‘Watch’ antibiotics.

2. Body of the Paper

2. 1 Materials and Methods

The principal approach was a narrative review of key areas building on the considerable knowledge of the co-authors.

Several systematic reviews and meta-analyses have been performed documenting the extent of purchasing of antibiotics without a prescription in recent years, including among children and specifically for Africa [29,34-37,51,53,78]. However, a number of these contained references going back several decades, and circumstances will have changed among the studied African countries since then. For instance, in Zimbabwe, recent changes in the economic circumstances have resulted in most patients now obtaining their antibiotics from the informal market [85]. This is very different from the situation in the early 2000’s where there was strict monitoring of pharmacy practice coupled with appreciable consequences for pharmacists for abuse of the regulations [37,109,110]. In South Africa, the moves towards universal healthcare in recent years should negate any co-payments associated with the use of medicines. Consequently, reducing the need to purchase antibiotics without a prescription, although this does still happen [70,112].

As a result, we concentrated on published studies from 2016 onwards. 2016 was chosen as we believed this would still provide a rich source of published studies without including circumstances that may be outdated. In addition, this was the year the WHO Global Action Plan to reduce AMR was launched [23,113]. Where pertinent, a summary of the methodology was included in the Tables along with a summary of the key findings, in line with published reviews [29,35-37]. The publication year was also included given likely variation in prevalence rates over time in countries as circumstances change.

We are also aware that some local African publications would not necessarily be included in a systematic review, especially if the reviews only concentrated on papers published in Pub Med or Web of Science. For instance, data on the extent of purchasing of antibiotics without a prescription could be contained within papers discussing key stakeholders’ attitudes and perceptions towards antibiotics and AMR [114-119]. Alongside this, we were aware that in some African countries there may not be any data on current prevalence rates for the purchasing of antibiotics without a prescription either because strictly enforced laws prevent this; consequently, this is not studied, e.g., as seen in Botswana. Alternatively, no specific prevalence data appears to exist, e.g., from Benin and Burkina Faso. These countries would have been missed in systematic reviews just documenting current prevalence rates for the purchasing of antibiotics without a prescription if we only examined published papers.

However, we acknowledge that this approach may lead to bias. To minimize bias, and maximise relevant information included in the narrative review, the co-authors included in this narrative review and its implications have considerable experience among African countries and beyond researching and dealing with key issues surrounding the purchasing of antibiotics without a prescription. Alongside this, experience with implementing policies to improve appropriate dispensing of antibiotics, which includes the development of pertinent quality indicators as well as researching and implementing ASPs. Finally, the principal aim of the paper is to suggest potential ways forward for all key stakeholder groups across Africa to reduce inappropriate dispensing of antibiotics given its current extent, building on knowledge of key drivers, quality targets and ASPs. In view of this, data on current purchasing rates and legislation is included in Supplementary material rather than being included as a critical component of the paper.

Our chosen approach mirrors similar studies undertaken by the co-authors across a number of African countries and beyond when providing future guidance regarding the management of both infectious and non-infectious diseases, as well as more general approaches, and is in line with institutional guidance [19,31,42,120-130].

In most situations, the African countries have been broken down by income levels based on the World Bank classification included in the publication of Adekoya et al (2021) when reviewing antibiotics based on the AWaRe (Access, Watch and Reserve) classification among 138 countries [131]. This is because the provision of universal healthcare with its free-of-charge healthcare, including medicines, combined with improved functioning of healthcare systems, can reduce the purchasing of medicines without a prescription [132,133]. The only exception concerns ASPs. In this situation, we were looking to document examples across LMICs to provide future guidance as were unaware of many examples in Africa. In addition, we wanted to document examples where ASPs had failed to reach their desired objective of limiting the purchasing of antibiotics without a prescription, and the possible reasons for this, to also provide future direction.

Where pertinent, the antibiotics dispensed were broken down by their AWaRe classification of ‘Access’, ‘Watch’’ or ‘Reserve’. As discussed, the ‘Access’ group of antibiotics are considered as first- or second-line antibiotics for up to 26 common or severe clinical syndromes, typically with a narrow spectrum and a low resistance potential. The ‘Watch’ group of antibiotics have a higher resistance potential and side-effects; consequently, community pharmacists and others should carefully consider their dispensing especially when an ‘Access’ antibiotic maybe more suitable for the condition if an antibiotic is needed. This is in line with the recommendations in the AWaRe book [13,104,105]. The ‘Reserve’ group should rarely, if ever, be dispensed in the community and only prescribed as last resort antibiotics in hospitals [13,103,105,134].

As mentioned, potential future activities to reduce inappropriate dispensing of antibiotics across Africa were based on the considerable experience of the co-authors across a range of African countries and beyond. This approach using senior-level co-authors has been successfully used by us when recommending future activities to reduce inappropriate use of antibiotics across sectors in Africa and other LMICs as well as improve the management of non-communicable diseases [19,31,57,120,123,126,129,130].

2.2. Principal findings

It is imperative that African countries seek to reduce inappropriate dispensing of antibiotics without a prescription given that ambulatory care accounts for up to 95% of human use in LMICs, and up to 100% of pharmacies in some African countries currently dispense antibiotics without a prescription [13,14,71].The key issues to discourage inappropriate dispensing of antibiotics without a prescription start with a thorough knowledge of current prevalence rates, and the principal drivers such activities, before moving to debate potential ways forward among all key stakeholder groups. Potential activities should be part of general activities across Africa and beyond to enhance the appropriate use of antibiotics in humans as part of NAPs, thereby helping to reduce AMR [19,21]. This has already started in Africa regarding their use in hospitals, building on the progress of NAPs across Africa [19,130].

The initial steps involving change start with collecting evidence regarding current prevalence rates for the purchasing of antibiotics without a prescription across sub-Saharan Africa from 2016 onwards. Activities include identifying principal disease areas where antibiotics are being dispensed without a prescription and key factors that contribute to this practice. Subsequently, documenting activities and programs that have been initiated by health authorities and other organizations across Africa and beyond to combat inappropriate dispensing of antibiotics without a prescription as well as their impact. This section will also include activities that have been instigated by governments and others to reduce the purchasing of antibiotics without a prescription but failed to achieve the desired result, and the possible rationale for this failure. Documentation of the potential reasons for failure can offer considerable guidance to health authorities and others as they plan their future initiatives. Possible quality measures to reduce inappropriate dispensing and their effectiveness will also be documented and analyzed.

The collective findings can subsequently be used, along the co-authors' considerable knowledge, to provide guidance to all key stakeholders across Africa and beyond on potential approaches to reduce future inappropriate dispensing of antibiotics without a prescription. The guidance will be divided into macro, meso and micro levels in line with recent studies [135,136].

2.2.1. Current extent of purchasing of antibiotics without a prescription across Africa

Table 2S in Supplementary Material documents current rates of the purchasing of antibiotics without a prescription among a range of sub-Saharan African countries. This builds on recent systematic reviews involving LMICs including African countries [29,34,36-38,50,51]. One problem is that these studies typically included published studies earlier than 2016, with the earliest being 1989. Overall, the lowest pooled rate among the systematic reviews was in 2015, at 38.8 % of all antibiotics dispensed (95 % CI: 29.5-48.1) [50]. Cameroon, Ethiopia, Nigeria, Sudan and the West African countries were included in the review [50]. A higher pooled rate was seen in another systematic review published in 2021, which included Nigeria, with a pooled prevalence rate of 78% (95% CI: 65–89%; range 50-93.8%) of antibiotics dispensed without a prescription [29].

As seen (Table S2 Supplementary Material), there was also appreciable variation in the extent of the purchasing of antibiotics without a prescription among and within African countries. The variation in the rates of purchasing seen among the various African countries appeared to be largely independent of income levels. Some of the highest rates seen were in Eritrea (up to 89.2%), Ethiopia (up to 87.9%), Mozambique (93.75%), Nigeria (up to 86.5%), Tanzania (up to 92.3%) and Zambia (up to 100% of pharmacies dispensing antibiotics without a prescription). Some of the lowest rates were seen in Kenya (as low as 0%), Mozambique (as low as 1.4%), Namibia (as low as 0%), South Africa (as low as 0%) and Zimbabwe (very little).

Appreciable variation in the prevalence rates for the purchasing of antibiotics without a prescription seen within African countries (Supplementary Table S2) include Eritrea (9.8% to 89.2%), Kenya, (0% to 52%) Mozambique (1.4% to 93.75), South Africa (0% to 47%) and Zimbabwe (very little to patients typically obtaining their antibiotics from the informal market place). These differences may be due to differences in the stakeholders approached, their location and circumstances including economic circumstances, the methodology involved as well as the timing of the study. However, it is difficult to say this with any certainty. In any event, there was appreciable purchasing of antibiotics without a prescription among a number of African countries, which needs to be urgently addressed to reduce AMR in Africa in the future.

In their systematic review involving 10 African countries (Cameroon, Ethiopia, Eritrea, Kenya, Malawi, Sudan, Tanzania, Uganda, Zambia and Zimbabwe), Belachew et al. (2021) found that upper respiratory tract infections (URTIs) and/ or acute diarrhoea were the most common reasons for the purchasing of antibiotics without a prescription, with amoxicillin ('Access') and co-trimoxazole ('Access') the most frequently dispensed antibiotics [37]. Another study found that the most common indications for the dispensing of antibiotics without a prescription were URTIs, gastrointestinal (GI) symptoms including diarrhoea and fever or febrile illnesses [36]. Batista et al. (2020) in their worldwide review also found that the indications for which antibiotics were most purchased without a prescription were RTIs (100.0%), diarrhoea (40.0%) and urinary tract infections (UTIs) (30.8%), with the most purchased antibiotics being amoxicillin (86.9%) ('Access'), azithromycin (39.3%) ('Watch'), ciprofloxacin (39.3%) ('Watch') and co-amoxiclav (39.3%) ('Access') [51].

Overall, within an appreciable number of African countries, many antibiotics were purchased without a prescription for RTIs, acute diarrhoea and UTIs, with 'Access' antibiotics (penicillins, cotrimoxazole and metronidazole) being the most commonly dispensed. This was followed by the macrolides, including azithromycin ('Watch') and the quinolones ('Watch') (Table S2).

Table 3S documents the African countries where currently there does not appear to be any published data regarding the extent of purchasing of antibiotics without a prescription. However, this occurs in some but not all of these countries.

2.2.2. Key factors driving self-purchasing of antibiotics across Africa

Table 1 documents key factors driving the purchasing of antibiotics among the various African countries and their income-levels building on Box 1, with Table 2 documenting the overall knowledge of antibiotics and AMR, or lack of it, including concerns, among key stakeholder groups across Africa. This includes dispensers and patients.

Key factors driving the purchasing of antibiotics without a prescription across Africa, especially sub-Saharan Africa, include issues of convenience with community pharmacies, especially among working personnel, enhanced by the length of time to see a HCP in public facilities and the travel costs involved, exacerbated if this leads to loss of income especially among informal workers. Alongside this, the additional co-payments to see HCPs in their clinics alongside the costs of any medicine dispensed. These combined costs can have catastrophic consequences for some patients [137,138], with issues of poverty negatively impacting on antibiotic misuse [86,139].

Table 1 - Key factors driving the purchasing of antibiotics without a prescription across Africa

Countries	Author and year	Key factors and drivers increasing the purchasing of antibiotics without a prescription
Multiple African countries		
Multiple African Countries	Belachew et al., 2021 [74]	• Systematic review and meta-analysis involving multiple Africa countries among LMICs • The African countries involved in the review included: Cameroon, Ethiopia, Eritrea, Kenya, Malawi, Sudan, Tanzania, Uganda, Zambia and Zimbabwe • Four key drivers regarding the purchasing of antibiotics were identified. These included: o Business model – resulting in tensions between professionalism and commercial necessity o Pressures due to customers' demand and their expectations based on previous practices and outcomes o Absence of, or a limited enforcement, of any regulations banning the self-purchasing of antibiotics o Limited knowledge and/or poor attitudes regarding antibiotics among staff in community outlets
	Yieka et al., 2021 [36]	• Systematic review and meta-analysis involving countries among 19 African countries (including sub-Saharan African countries): Algeria, Cameroon, DR Congo, Egypt, Eritrea, Ethiopia, Ghana, Ivory Coast, Kenya, Libya, Malawi, Mozambique, Namibia, Nigeria, Rwanda, Senegal, Sudan, Tanzania, and Uganda • Common reasons for purchasing included: o No education or limited education among patients o Low income or currently unemployed o Remoteness of healthcare facilities and perceived long waiting times at healthcare facilities to see a healthcare professional versus the convenience of medicine outlets including community pharmacies
	Li et al., 2023 [38]	• Mixed-method systematic review including 40 papers (25% of the total) from sub-Saharan African countries • Common major reasons for purchasing included: o Strong customer demand for non-prescription antibiotics o Lack of relevant knowledge among patients regarding antibiotics and AMR o Pharmacy/ drug seller staff motivated by financial reasons or personal viewpoints o Alternative health-care services are expensive especially where high co-payments are involved or they are inconvenient especially if this involves time of work/ considerable queues to see a healthcare professional o Irregular prescribing practices/ lack of consistency o Weak social, industry, and legal regulations
3 East African Countries: Kenya, Uganda and Tanzania	Green et al, 2023 [86]	• Mixed method approach including a questionnaire among 6827 patients with UTIs and in-depth interviews among 82 patients • Reasons for purchasing antibiotics without a prescription included: o Long travel distances, long queues to see a HCP, and perennial antibiotic stock –outs in public health facilities o Lack of curtesy and disrespectful clinical staff in public health facilities o Preference to work rather than losing a day's wages to see a HCP coupled with affordability issues (travel costs, costs of HCP visit and medicine costs) o Cash-flow issues o Familiarity with antibiotics o Ease of unregulated access to antibiotics
3 African countries (Ghana, Mozambique, South Africa)	Do et al., 2021 [33]	• Quantitative and qualitative assessments of antibiotic access and use across 3 African countries involving exit interviews and interviews with households • Common reasons for purchasing included: o Less time consuming and cheaper o Overall, more convenient than accessing treatment including antibiotics through health-care facilities o Disease severity and whether the antibiotic was intended for a child
Low-Income Single African Countries*		

Eritrea	Bahta et al., 2021 [140]	• Focus group discussions and key informant interviews among 36 pharmacists and assistants • Key reasons for dispensing without a prescription included: ○ Economic reasons (pharmacists and patients) ○ Inadequacy and inaccessibility of healthcare services ○ Prescribers ordering patients to take antibiotics without a prescription ○ Long queues to see healthcare professionals in healthcare facilities when available as well as scarcity of available medicines in healthcare facilities ○ Previous successful experiences with antibiotics ○ Weak regulations
	Russom et al., 2021 [118]	• 2477 interviews with adults using a structured questionnaire • Principal reasons for self-medication with antibiotics included: ○ The non-seriousness nature of the disease (39.0%) ○ The need for quick relief (33.9%) ○ Pevious successful experiences with antibiotics (16.1%) No time to visit a health facility (15.0%) and typically long queues at health facilities (14.0%)
Ethiopia	Gebretekle et al., 2016 [141]	• Qualitative interviews among personnel in 5 community pharmacies in Adia Ababa • Common reasons for purchasing included: ○ Limited resources among patients and lower education of patients ○ Patient pressure ○ Pharmacists looking to maximise revenue (vs. professional role) and weak regulatory systems
	Erku et al., 2018 [142]	• 2-phased mixed-method study including 100 simulated patient visits to drug retail outlets • Key drivers for dispensing without a prescription included: ○ Perceived financial benefits, high expectations and/or demand from patients ○ Competition among pharmacies for patients
	Bogale et al., 2019 [143]	• Cross sectional study involving 595 household respondents • Key factors for purchasing without a prescription included: ○ Age of the patient ○ Knowledge/ educational status ○ Income/ affordability to see a healthcare professional/ purchase medicines
	Demissie et al., 2022 [144]	• Community-based cross-sectional design study involving 826 respondents using a pre-tested questionnaire • Key drivers for purchasing included: being male, having no health insurance scheme and the availability of antibiotics in drug outlets
	Edessa et al., 2022 [145]	• Community-based cross-sectional study involving 100 simulated cases • Insufficient knowledge of retailers regarding AMR was significantly associated with inappropriate dispensing of antibiotics without a prescription
Malawi	Sambakunsi et al., 2019 [146]	• Cross sectional study, mixed-methods study design involving 2 focus groups and a structured questionnaire among a total of 120 respondents • Key reasons for purchasing without a prescription included: ○ Concerns with the availability of medicines in public healthcare facilities ○ Personnel in the public system (with patients sometimes advised to obtain their medicines from retail pharmacies) ○ Long distances to travel to healthcare facilities • These multiple factors make patients lose confidence in the public system and resort to self-medication
	Machongo et al, 2022 [147]	• Interviews with 16 caregivers of children • Patients frequently use antibiotics inappropriately believing they are effective in treating coughs and colds in children
Mozambique	Mate et al., 2019 [115]	• Cross-sectional study among 1091 adults using a semi-structured questionnaire • Principal reasons for purchasing included: ○ Perception that there is no need to attend a health facility for e.g., an ARI (26.8%), someone else's advice (7.7%) and symptoms were similar to a previous episode (6.2%)

		○ General poor quality of care in health facilities (6.7%) and long waiting times in public facilities (4.3%)
	Torres et al., 2020 [148]	• Cross-sectional study involving both individual and group interviews among 32 pharmacy clients and 17 pharmacists • Principal reasons for purchasing included: ○ Patients' demands and expectations, and their beliefs in the healing power of antibiotics ○ Physician prescribing practices ○ Pressure on profits and fragile law enforcement/ absence of accountability mechanisms
Rwanda	Tuyishimire et al., 2019 [149]	• Structured questionnaire among 570 undergraduate students • The principal reason for purchasing was that the illness was not considered serious enough to have a consultation (50.72%)
Tanzania	Mboya et al., 2018 [150]	• Cross-sectional descriptive study involving 152 adults • Participants with poor knowledge of antibiotics had appreciably higher odds of using antibiotics irrationally, including purchasing without a prescription, versus those with good knowledge • Participants without health insurance had higher odds of using antibiotics irrationally compared to those with health insurance
	Emgård et al., 2022 [151]	• Eight focus group discussions with mothers of children < 5 years • Principal reasons for purchasing of antibiotics without a prescription included: ○ Antibiotics are perceived as universal treatments for common diseases ○ Often long wait at facilities and disrespectful treatment at healthcare facilities ○ Transport costs with often husbands not providing the necessary financial support ○ Often healthcare facilities do not stock the suggested medicines and patients have to pay for them at community pharmacies ○ Pharmacies and pharmacy staff seen as more trustworthy and convenient
	Mabilika et al., 2022 [152]	• Cross-sectional study involving 430 respondents using a digital questionnaire • Key reasons for purchasing included: • Being single • Having health insurance • Distances to a health facility (reduced distances reduces self-purchasing)
Uganda	Kibuule et al, 2016 [153]	• Cross-sectional survey among 200 households treating children < 5 years with ARIs using a developed questionnaire • Key factors for purchasing included: ○ Level of education of the guardian/parents; confidence of parents/ guardians to self-diagnose ARIs, prior ability to treat ARIs appropriately ○ Source and access to antibiotics, e.g., community pharmacy or drug store
Low-Middle Income Single African Countries*		
Cameroon	Amin et al., 2019 [154]	• Cross-sectional survey using a structured questionnaire among 329 patients attending for outpatients in 2 hospitals • The principal reasons for self-medication were: ○ Cost cutting (40.9%) ○ Past experience from similar symptoms (29.3%)
Congo	Shembo et al., 2022 [155]	• Semi-structured in-depth interviews with 18 participants in households • Key reasons for purchasing without a prescription included: ○ Relying on previous experiences with antibiotics ○ Financial reasons – difficult to afford to see physicians every time feel unwell ○ Attract a 'spirit of sickness' if go to healthcare facilities every time feel unwell
Ghana	Afari-Asiedu et al., 2018 [72]	• 32 in-depth interviews with Licensed Chemical Sellers (LCS) as well as focus group discussions with 40 community members • Key factors for purchasing included: ○ Patient demand with previous knowledge of effectiveness of some antibiotics ○ Delays in seeking care at health facilities and distance/ cost to health facilities ○ Financial constraints among patients and poor implementation of current regulations

	Ahiabu et al., 2018 [156]	• Recall visits among 12 households • Key factors for purchasing included: ○ Lack of controls, community knowledge and poverty ○ Perceived barriers to formal healthcare
	Mensah et al., 2019 [157]	• Questionnaire among 361 participants • Key factors for purchasing without a prescription included: ○ Influence from others - friends and relations (32.7%) ○ Bureaucracy of health/hospital system (23.0%) ○ Cost savings (22.2%) and mild severity of the illness (17.7%)
	Afari-Asiedu et al., 2020 [158]	• 15 in-depth interviews among healthcare professionals and eight focus group discussions among 55 community members • Inappropriate antibiotic use/ purchasing of antibiotics without a prescription were influenced by a number of factors including a general lack of knowledge on antibiotics, e.g., tetracyclines and metronidazole were poured into 'akpeteshia' (a local gin) to treat hernia and perceived stomach sores
	Kretchy et al., 2021 [159]	• Community-based cross-sectional survey using a semi-structured questionnaire among 350 adults in a rural area • Key reasons for purchasing without a prescription included: ○ Past successful experience (47% of those surveyed) ○ Ease of purchasing of antibiotics from medicine outlets ○ Convenience of community pharmacies (36%) ○ Patients living in a rural area were also more likely to purchase antibiotics without a prescription due to more limited education
	Amponsah et al., 2022 [160]	• Interviews among 337 students (163 pharmacy and 174 nonpharmacy) • An increase in the study level of students reduced the likelihood of both pharmacy and non-pharmacy students to purchase antibiotics without a prescription
Ghana	Nyarko et al., 2023 [161]	• Interviewer-administered questionnaire among 200 staff members in medicines outlets • Stronger preference among interviewees for not dispensing antibiotics and referring patients to a doctor if they have certain symptoms including a high fever, fatigue or sinusitis • Interviewees were also less likely to dispense antimicrobials without a prescription for children or the elderly with severe infections and refer them
Nigeria	Khakid et al., 2019 [162]	• 217 pharmacy students participated in an online survey with a validated questionnaire • The principal reasons for purchasing antibiotics were previous knowledge (40.4%) and convenience with no time to see a doctor or pharmacist (27.5%)
	Abubakar et al., 2020 [163]	• Cross-sectional study involving 98 community pharmacists using a validated self-administered questionnaire • Pharmacists with < 5 years of working experience (66.7%) were significantly more likely to dispense antibiotics without a prescription 5 times or more in a day compared to those with > 5 years community pharmacy experience
Sudan	Hussain et al., 2023 [164]	• Cross-sectional study design involving 1492 patients • The key reasons for purchasing antibiotics without a prescription were: ○ Convenience (63.3%) ○ Cost-saving (34.8%)

NB: AMR: Antimicrobial resistance; ARIs: Acute Respiratory Illness; *World Bank classification based on Adekoya et al 131]

Table 2 shows there is currently variable knowledge regarding antibiotics and AMR among key stakeholder groups across Africa. Overall, there are considerable concerns regarding the wide-spread beliefs across Africa that antibiotics are effective in treating viral infections as well as the general lack of knowledge regarding AMR and its implications among key stakeholder groups. However, this is not universal. Alongside this, acceptance of self-medication with antibiotics among key stakeholders. Consequently, there is an urgent need to address the lack of knowledge among all key stakeholder groups to reduce inappropriate dispensing of antibiotics and associated AMR across Africa.

Table 2 - Knowledge of key stakeholder groups regarding antibiotics and AMR across a range of African countries and income levels

Country	Author and year	Key findings
Multiple Countries		
3 East African countries (Kenya, Tanzania and Uganda)	Lubwama et al., 2021 [80]	• Self-administered questionnaire among 328 final year medical and pharmacy students • There were concerns among final year students including Pharmacy students among these three African countries • In general, students had low scores regarding their knowledge of AMR and antibiotic use in clinical scenarios, exposing gaps in their training. This needs to be addressed going forward
3 East African countries – Kenya, Tanzania and Uganda	Green et al., 2023 [86]	• Mixed method approach including a questionnaire among 6827 patients with UTIs and in-depth interviews among 82 patients • Individuals who are more familiar with antibiotics were more confident and most likely to engage in self-medication
Low Income Single African Countries*		
Eritrea	Ateshim et al., 2019 [165]	• Face-to-face interviews with 577 participants (99.5% response rate) using a structured questionnaire • 29.3% of interviewees believed that self-medication with antibiotics is acceptable practice • 84.7% of interviewees had inadequate knowledge regarding antibiotics, with only 15.3% found to be knowledgeable
	Bahta et al., 2021 [140]	• Focus group discussions and key informant (KI) interviews among 36 pharmacists and assistants • Some KIs believed some dispensers were not knowledgeable regarding new clinical • Knowledge and did not have adequate knowledge regarding their contribution to fighting AMR
	Russom et al., 2021 [118]	• 2477 interviews with adults (97.4% response rate) using a structured questionnaire • 73.3% and 39.0% of the study population were aware of the term 'antibiotic' and antibiotic resistance, with 78.2% correctly reporting that antibiotic resistance is an issue that could affect them and their family • However, less than half of the study population correctly reported indications of antibiotics for common illnesses with 63.4% that antibiotics can be used to treat viral infections, 61.8% that antibiotics can be used to treat watery diarrhoea, 58.9% for a common cold and 54.2% for a dry cough
Ethiopia	Seid et al., 2018 [166]	• Self-reported structured questionnaire among 323 graduates paramedical students • Despite the majority of students viewing antimicrobial resistance as a preventable public problem if appropriate strategies are introduced, among the students, including pharmacy students, there were concerns with poor knowledge regarding AMR
	Bogale et al., 2019 [143]	• Cross sectional study involving a questionnaire among 595 household respondents in Ethiopia (98.3% response rate) • Household respondents generally had inadequate knowledge and inappropriate practices towards the rational use of antibiotics
	Belachew et al., 2022 [83]	• Cross-sectional survey among 276 staff in 270 drug outlets using a validated self-administered questionnaire • The majority of the 276 participants in drug outlets demonstrated good levels of knowledge about antibiotics use (77.9%) and AMR (76%) in a cross-sectional survey • Participants who did not perceive they were competent to supply non-prescribed antibiotics were less likely to report they dispensed antibiotics without a prescription
	Demissie et al., 2022 [144]	• Community-based cross-sectional design involving 826 respondents using a pre-tested questionnaire

		• The most common sources of information for self-medication were self-decision without any information (46.81%), promotion about medicines (24.45%) and relatives (18.75%)
	Edessa et al., 2022 [145]	• Community-based cross-sectional study among 100 simulated cases regarding childhood diarrhoea among drug retail outlets • A considerable proportion of retailers in community drug outlets had insufficient knowledge regarding antibiotics as well the emergence and spread of AMR • Insufficient knowledge of retailers regarding antibiotics and AMR was significantly associated with inappropriate dispensing of antibiotics
Malawi	Sambakunsi et al., 2019 [146]	• Cross sectional study involving 2 focus groups and a structured questionnaire among 105 respondents • Discussion group respondents had limited knowledge of antimicrobials, their use or AMR • 74% of participants were unable to differentiate antimicrobials from other categories of medicines • 92.4% felt antimicrobials could be used to stop a fever, 54% wrongly believed that antimicrobials are effective in treating common colds and 53% would use antimicrobials to treat URTIs
	Machongo et al., 2022 [147]	• Interviews with 16 caregivers of children • Overall, caregivers of children had limited knowledge regarding antibiotics and their use as well as AMR • Most caregivers were currently using antibiotics inappropriately through self-medication to treat viral infections including URTIs
Mozambique	Mate et al, 2019 [115]	• Cross-sectional study among 1091 adults using a semi-structured questionnaire • 52.4% of adults surveyed had poor knowledge regarding antibiotics, with only 46.4% having reasonable knowledge about the use of antibiotics
	Cambaco et al., 2020 [32]	• Most patients had never heard of the term AMR; however, they were familiar with the phenomenon • Surveyed patients often understood the term ‘resistance’ as treatment failure and likened this to non-compliance, ineffective treatment, disease resistance or an inability of the physical body to respond to the infection
	Torres et al., 2020 [167]	• Qualitative interviews among 17 pharmacists • Patients’ behaviour and beliefs on the curative power of antibiotics, e.g. many patients believe “antibiotics cure everything”, enhances requests for antibiotics without a prescription from community pharmacists
Rwanda	Nisabwe et al., 2020 [114]	• Descriptive cross-sectional study conducted among 282 medical, dental and pharmacy students • Concerns among healthcare students including pharmacy students included: ○ 83% (n = 191) were unfamiliar with the concept of AMS - with 49% not yet discussing AMR as part of their education ○ 38% did not believe that antibiotics were overused in Rwanda ○ 23% did not agree that inappropriate antimicrobial use contributed to AMR
Tanzania	Mboya et al., 2020 [168]	• Cross-sectional descriptive study involving 152 adults visiting pharmacies or accredited drug stores • Among these adults, only 25% had adequate knowledge about the use of antibiotics • Higher levels of education and having health insurance were associated with better levels of knowledge concerning antibiotics and their use in various illnesses • Overall, 50.7% of respondents thought it acceptable to share antibiotics with others • Sore throat and influenza were felt by 62.5% and 46.1% of the respondents respectively as diseases that can be treated with antibiotics • Higher levels of education and having health insurance were associated with better levels of knowledge concerning the use of antibiotics in various illnesses
	Simon et al., 2020 [84]	• Cross-sectional study among 730 parents/ caregivers of children < 5 years of age using a structured interview guide

		• Overall, there was low level of knowledge regarding antibiotics among parents/ caregivers of children < 5 years of age
	Sindato et al., 2020 [169]	• Semi-structured questionnaire among 828 participants • Among the 828 participants, there was moderate knowledge, attitude and practices regarding the use of antibiotics and AMR • Participant's age and their level of education were significantly associated with knowledge of antibiotics and AMR
	Gabriel et al., 2021 [170]	• Cross-sectional study assessing knowledge regarding the rational use of antibiotics among 960 patients/ consumers • 50.7% of patients who purchased antibiotics without a prescription from pharmacies believed influenza could be treated with an antibiotic, 61.4% a sore throat and 60.5% a urinary tract infection • 42.3% of patients were willing to use the same antibiotic if a friend or family member used the antibiotic previously to treat similar signs and symptoms
	Emgård et al., 2022 [151]	• Eight focus group discussions with mothers of children < 5 years • Overall, considerable belief that antibiotics are a universal treatment, used to prevent or treat most symptoms or diseases among children • Antibiotics were also perceived as protecting the child's body or strengthening the • children's immune system – further helping to combat infectious diseases
	Nkinda et al., 2022 [171]	• Simulated clients among 672 accredited drug outlets and community pharmacies • Among prescribers and dispensers there was adequate knowledge regarding antibiotics • Encouragingly among prescribers: ○ Only 14.8% agreed and strongly agreed that prescribing antibiotics which a patient does not need does not contribute to resistance ○ Only 17% agreed and strongly agreed that antibiotics can treat viral infection ○ Only 7% agreed and strongly agreed antibiotics can be stopped when symptoms resolve
Low-Middle Income Single Countries *		
Cameroon	Amin et al., 2019 [154]	• Cross-sectional survey using a structured questionnaire among 329 patients attending hospital outpatients • Out of the 225 patients who resorted to self-medication with antibiotics in to treat their health problems - 43.1% (95% CI 36.5- 49.9) sought no advice while 38.2% (95% CI 31.8- 44.9) obtained their advice from non-medical personnel
	Elong Ekambi et al., 2019 [172]	• Interviews among 1,192 customers in community pharmacies using a structured questionnaire • The vast majority of interviewees (88.3%) believed that all microbes can be treated with antibiotics (88.3%) • In addition, the belief that antibiotics were appropriate for bacterial infections was more common among those with a higher level education (OR = 4.03, 95% CI:1.89–8.57, p<0.0001) and among public/private servants (OR = 2.47, 95%CI:1.21–5.08, p = 0.013)
Congo	Shembo et al., 2022 [155]	• Semi-structured in-depth interviews with 18 participants in households • Household participants were familiar with the term "antibiotics"; however, limited knowledge of the indications and risks of antibiotics including AMR • Inappropriate use of antibiotics was common reflecting limited knowledge of key areas
Ghana	Abbey et al. (2016) [173]	• Structured interviews (N = 501) and eight focus group discussions including 56 caregivers of children < 5 years and e8 community key informants • Typically, low awareness and inadequate recognition of pneumonia among studied participants in a rural setting in Ghana
	Afari-Asiedu et al., 2021 [174]	• 10 in-depth interviews among staff of Ghana health services, pharmacy council and the association of over-the-counter medicine sellers (OTCMS) at district and regional levels • There were concerns with the knowledge of OTCMS in Ghana, who are permitted to sell cotrimoxazole without a prescription, regarding antibiotics and AMR

		• Currently as well OTCMS dispense a greater range of antibiotics than the current regulations enhanced by a lack of monitoring of practices, which increases AMR • It is suggested that the Ghana Health Service and MoH appreciably extend approved health facilities especially to rural communities to enhance appropriate access as well as use of antibiotics to reduce reliance on OTCMS and the current abuse of the system to improve patient care. This is seen as more productive with improving antimicrobial use in Ghana than spending considerable resources training OTCMS personnel
	Sefah et al., 2022 [79]	• Cross-sectional survey among 160 fifth-year pharmacy, medical students and fourth (final)-year nursing and physician assistantship students • Variable knowledge of antibiotic use, AMR, and AMS among surveyed healthcare students • Good knowledge was associated with the study course and years of study ($p < 0.001$), with differences seen in the level of knowledge among the different healthcare students and their years of study • Efforts must be made to enhance the curricula in these important areas
Kenya	Omulo et al., 2017 [175]	• Two-hundred households were interviewed at entry into the study of which 149 were also interviewed at exit. • 80% of household personnel surveyed felt antibiotics should not be shared or discontinued following alleviation of symptoms • However, 66% and 74% of respondents respectively considered antibiotics effective for treating colds and flu • Clinicians and community pharmacists were highly trusted source of information regarding the management of diseases including infectious diseases
	Muloi et al., 2019 [176]	• Cross-sectional study among 40 personnel, principally pharmacy technicians, in drug stores • More than 2/3rds of community pharmacy personnel were aware of the terms “antibiotic resistance” and “drug resistance” • However, >50% had heard of the terms “AMR” and “super bugs” and >80% believed AMR occurs when their body becomes resistant to antibiotics rather than the bacteria themselves developing resistance
Nigeria	Badger-Emeka et al., 2018 [177]	• Cross-sectional study among 400 adults using a semi-structured self-administered questionnaire • Patients typically lacked knowledge and awareness regarding the hazards associated with self-purchasing of antibiotics
	Ajibola et al., 2018 [178]	• Structured questionnaire administered among 1230 undergraduate students and community members • Concerns with the knolwedge of both undergraduate students and community members • 53% and 42.4% of undergraduate and community members respectively felt that antibiotics cannot cure all infections, 57.5% and 55.3% respectively that antibiotics cannot be used for colds and 68.4% and 62.9% respectively that the unnecessary use of antibiotics could make them ineffective • In addition, only 32.6% of undergraduate students and 42.2% of community members felt that self-medication with antibiotics could lead to AMR
	Chukwu et al., 2020 [116]	• Cross-sectional study using a validated questionnaire among 482 respondents from across Nigeria • Overall poor understanding of AMR and/or proper use of antibiotics among 482 members of the public • Essential that more holistic public programs are undertaken to increase awareness of appropriate antibiotic use and AMR to lower resistance rates
	Akande-Sholabi et al., 2021 [179]	• Cross-sectional study among 866 healthcare students including pharmacy students • Among the surveyed healthcare students who completed the questionnaire, there was only moderate knowledge of AMR

		• This confirms the need to enhance the teaching of antibiotics and AMR among students and subsequently ensure there are strict policies in Nigeria to regulate their subsequent use
	Abdu-Aguye et al., 2022 [180]	• Descriptive cross-sectional study using a paper-based questionnaire among 164 final year pharmacy students • Among the surveyed students: ○ Most had some knowledge of antibiotics and AMR - however several misconceptions were identified ○ Only 48.8% indicated that they knew what AMS was ○ Less than half of the respondents agreed their current knowledge of antibiotics, AMR or AMS was adequate for their future careers ○ Over 90% agreed they would like more education on these key areas prior to qualification
Sudan	Hussain et al., 2023 [164]	• Cross-sectional study design involving 1492 patients • More than half of the surveyed patients (55.1%) stopped taking the antibiotics when their symptoms disappeared due to lack of knowledge • Only about 10% of surveyed patient consulted either a physician or the pharmacist before stopping their antibiotics
Zambia	Mudenda et al., 2021 [119]	• Structure questionnaire among 144 community pharmacists • Whilst there was good knowledge among the 144 community pharmacists surveyed (93.8%), with 67% of those surveyed having positive attitudes regarding AMR and AMS, there were appreciable concerns • 75% demonstrated poor practices towards AMR and AMS, with high rates of dispensing of antibiotics without a prescription
	Mudenda et al., 2022 [181]	• Structured self-administered questionnaire among 172 pharmacy students • Among the 172 pharmacy students surveyed, most had good knowledge and positive attitudes towards antibiotics (90% and 84% average scores respectively); however, suboptimal practices (64% average score) about the use of antibiotics and AMR • However, the prevalence of self-medication with antibiotics was 41% • Despite some encouraging scores, there is a need to improve the pharmacy curriculum regarding antibiotics, AMR and ASPs
High-Middle Income Single African Countries*		
South Africa	Mokoena et al., 2021 [182]	A survey among 83 minibus drivers revealed the following: • A common misconception was that antibiotics can be used to treated cold/influenza and fever • 75% believed AMR occurred in the human body and 64% believed it was OK to share antibiotics

NB: AMS = Antimicrobial stewardship, AMR = Antimicrobial Resistance; ASPs = Antimicrobial Stewardship Programmes; *World Bank classification based on Adekoya et al [131]

2.2.3 Activities across Africa and beyond to reduce inappropriate purchasing of antibiotics without a prescription

Suggested activities to enhance appropriate dispensing of antibiotics, including without a prescription, incorporate the development and implementation of indicators. The agreed indicators can subsequently be used to determine improvements in appropriate dispensing of antibiotics without a prescription across Africa. The agreed and chosen indicators can also subsequently be incorporated into ASPs to determine their effectiveness in reducing inappropriate antibiotic use.

There are three principal types of quality indicators that can be developed as part of activities to improve medicine utilisation (Supplementary Table S4). There must always be a clear purpose for their development as well as their use in practice to improve appropriate dispensing, especially when this is without a prescription. While different indicators have been used, for instance, to improve antimicrobial prescribing in hospitals across Africa [130,183-186], any indicator that is being considered in ambulatory care among community pharmacists must have clarity and be feasible to implement. This is especially important for community pharmacies located in rural areas across Africa.

Alongside this, easy-to-use and reliable tools must be introduced for valid data collection and management. These tools are important to enhance the implementation of potential quality indicators and their subsequent use across African and beyond [130,187-189] (See Supplementary Table S4 for more details including explanations). Without easy-to-use tools, continually monitoring the appropriateness of dispensing will be challenging and likely to fail in the long-term. In addition, any indicators that will be used in practice must be developed and agreed upon among all key stakeholder groups so they all have a sense of ownership. Otherwise, a lack of ownership will compromise their use in practice.

Table 3 describes the limited number of indicators that have been used to date among LMICs, including African countries, to assess the appropriateness of dispensing of antimicrobials among community pharmacies and drug sellers across LMICs, providing future direction. These indicators include the extent of dispensing without a prescription as well as their appropriateness.

Table 3 – Indicators used to assess the appropriate dispensing of antibiotics without a prescription including among African countries

Indicator	Reference
Overall antibiotic consumption in DIDs (DDDs per one thousand inhabitants per day)/ total units before and after ASP interventions	[56,190-192]
ATC groups of antibiotics dispensed, e.g., % Penicillins versus total antibiotics dispensed; % cephalosporins versus total antibiotics dispensed; % fluoroquinolones versus all antibiotics dispensed	[92]
Number of clients dispensed an antibiotic without a prescription and %s	Table S2
% adherence to current agreed guidelines	[193]
% of children receiving appropriate treatment for uncomplicated ARIs, malaria, and non-bloody diarrhoea	[193]

NB: ARIs = Acute respiratory infections; ATC: Anatomical, Therapeutic, Chemical classification [194]; ASP: Antimicrobial Stewardship Programme

Table 4 documents a number of indicators that can potentially be discussed among key stakeholder groups across Africa before implementation. These potential indicators are based on current indicators being used in practice (Table 3) combined with those contained within the WHO AWaRe Book and the Drive-AB suggested list [13,195]. These possible indicators are in addition to the potential instigation of strict regulations regarding which antibiotics, if any, can be sold without a prescription especially in rural areas of Africa where there are currently high patient co-payments. Alternatively, in more urban areas where there are currently long waiting times to see a physician alongside appreciable costs. Costs, in addition to the costs of any medicines, include pertinent travel costs, co-payment costs where there is no universal healthcare, as well as loss of income (indirect costs) from taking time off work. Alongside this, ambulatory healthcare clinics are often out-of-stock of medicines requiring patients to visit pharmacies and other medicine sellers anyway for any prescribed antibiotics causing frustration. This is beginning to change in countries such as South Africa with new systems in place to better manage medicine stocks [196].

Potential indicators are in addition to enforcing existing regulations across Africa regarding the dispensing of antibiotics without a prescription (Supplementary Table S1) where pertinent and not appreciably detrimental to patients. These include a number of structure as well as process measures including % dispensed based on AWaRe guidance (Table 4).

Alongside this, as mentioned, there needs to be regular monitoring regarding the extent of antibiotics dispensed per day or week through mobile and other technologies [82,127,197]. Such activities are important alongside the instigation of any quality indicators to be able to constantly monitor the situation and give ‘real time’ feedback.

The instigation of indicators is important since, as mentioned, limited access to prescribers and associated costs such as travel costs, especially in rural areas where there are also high co-payments, can be seen by some as morally challenging if strict regulations banning the dispensing of antibiotics without a prescription are enforced [37,82,198,199]. Community pharmacists can play a key role in this situation as a trusted source for information and potential treatment suggestions, which builds on their activities during the recent COVID-19 pandemic [63,66,75,92,200-203]. The increasing

recognition of the potential role of community pharmacists is one of the reasons behind changes in the UK, which will allow pharmacists to prescribe antibiotics in clearly designated conditions [204].

Table 4 – Possible quality indicators that could be used to date to improve the appropriateness of dispensing of antibiotics without a prescription across Africa

Indicator	Reference
Structure	
% of antibiotics dispensed correctly labelled, e.g., dose, length of course, etc.	[195]
% of antibiotics dispensed correctly recorded	
% of antibiotics dispensed chosen from an essential medicines list	[195]
% of antibiotics dispensed from an agreed list of antibiotics for the setting vs. all antibiotics dispensed	[13]
% of antibiotics purchased/ dispensed broken down by agreed 'Access' vs. 'Watch' and 'Reserve' antibiotics (pack/ unit based)	[103,105]
% of injectable antibiotics purchased without a prescription vs all injectables dispensed (packs) where injectable antibiotics are being dispensed in community pharmacies	[13]
% of antibiotics dispensed without a prescription vs. all antibiotics dispensed (packs)	Table S2
% adherence to antibiotics dispensed based on the AWaRe guidance for common infections seen in community pharmacies across Africa, e.g., URTIs, UTIs and STIs	[13,105]
Process	
% of dispensing where patients are asked about key issues including allergies and any renal impairment	[13]
% of community pharmacies/ drugs stores with point-of-care facilities or guidelines readily available to assist patients with diagnosis and appropriate treatment	[13,63]
% of antibiotics dispensed based on the AWaRe guidance for common infections seen in community pharmacies across Africa such as URTIs, UTIs and STIs, e.g., is the condition self-limiting or not and are there more suitable alternatives?	[13,105]

NB: STIs = Sexually Transmitted Infections; URTIs = Upper Respiratory Tract Infections; UTIs = Urinary Tract Infections; AWaRe Guidance - [104].

A number of ASPs and other activities have been undertaken across Africa and beyond to improve the appropriate management of infectious diseases in ambulatory care, including reducing inappropriate purchasing of antibiotics for self-limiting conditions such as ARIs. Community pharmacists and medicine vendors are key targets for ASPs to reduce inappropriate dispensing of antibiotics without a prescription [52,63,203,205]. Examples of ASPs that have been instigated in Africa and in other LMICs to reduce inappropriate dispensing are documented in Table 5. African and non-African countries have been combined in Table 5 to increase the number of documented exemplars since all LMICs typically share similar challenges regarding the instigation of ASPs [206].

Examples among African countries include educational activities linked to the Pharmacy Undergraduate Programme in Kenya, which resulted in low levels of dispensing of antibiotics without a prescription [92]. The low levels seen in the study of Mukokinya et al. (2018) contrast with appreciably higher rates in the study of Muloi et al. (2019) among pharmacies not allied to the university [176]. A similar situation was seen during the recent COVID-19 pandemic regarding the dispensing of antibiotics without a prescription for patients with actual or suspected COVID-19 [91,207]. In Uganda, multiple interventions including educational programmes, enhanced the appropriate management of children with uncomplicated malaria, pneumonia and non-bloody diarrhoea [193].

Table 5 - Summary of ASPs and other activities to reduce inappropriate dispensing of antibiotics without a prescription across Africa and beyond

Country and reference	Intervention and Aims	Impact of the Intervention
Bangladesh [208]	• Drug sellers in Dhaka participated in 6 standardized role-playing scenarios • An ARI guideline was developed following the role-play alongside a one-day educational course concerning appropriate management of ARIs • The guidelines only recommended antibiotics for children with complicated ARI	Mixed results were seen: • In children, the dispensing of antibiotics for uncomplicated ARIs decreased (30% baseline vs. 21% post-intervention; p = 0.04) • However, drug sellers were equally likely to dispense antibiotics for complicated ARIs and referrals to physicians for complicated ARIs decreased (70% baseline vs. 58% post-intervention; p = 0.03) • For adults, dispensing of antibiotics without a prescription remained similar for uncomplicated ARI (48% baseline vs. 40% post-intervention; p = 0.1) but increased among those with complicated ARI (44% baseline vs. 78% post-intervention; p < 0.001)
Brazil [190-192]	• In public pharmacies in Brazil, there have always been restrictions on the dispensing of antibiotics without a prescription and generally impossible for pharmacists to sell antibiotics without a prescription • In 2010, the law was applied to private pharmacies	• Moura et al. (2015) found no difference in antibiotic utilisation among public pharmacies between 2008 and 2012 • However in private pharmacists, Moura et al. (2015) documented a decrease in antibiotic use of 1.87 DDD/TID (p < 0.001) immediately after restrictions banning the sales of antibiotics without a prescription (from 2008 to 2012). The authors also found a greater decrease in the more developed regions as well as in the State Capitals • Lopes-Junior et al. (2015) also found that sales of amoxicillin among private pharmacies fell by approximately 30% post legislation despite a general growth in the pharmaceutical market. The authors also found decreased sales of other popular antibiotics including tetracyclines (30.5% decrease), sulfonamides (28.5% decrease) and macrolides (25.0% decrease) • Mattos et al. (2017) observed an increase in antibiotic utilisation from 2008 to 2011 (cephalosporins - 216.8%, quinolones - 170.9% and aminopenicillins - 140.9%), followed by a decrease in 2012 (cephalosporins – minus 19.4%, quinolones – minus 12.7% and aminopenicillins – minus 11.1%)
China [209]	• Multiple initiatives were introduced in Shaanxi Province in China to reduce the purchasing of antibiotics without a prescription given rising concerns. These included: ○ Stricter regulations for dispensing antibiotics, and improving pharmacists' education ○ Stipulating there must be a qualified pharmacist's present to dispense antibiotics ○ Increased frequency of unannounced pharmacy inspections and punishments for abuse	• These multiple measures resulted in decreased antibiotic sales between 2011 and 2017 • There was decreased dispensing of antibiotics without a prescription for a 5-year-old child with diarrhoea between 2011 and 2017 - from 72.3% to 50.2% (p<0·0001) – simulated patients • There was similar reduction for simulated patients with URTIs – down from 95.8% to 69.5% (p<0·0001)
Kenya [19, 91, 92, 176, 207, 210]	• Activities included: ○ Education among pharmacists linked to the Pharmacy Undergraduate programme at the University of Nairobi (UoN)	• There was a low level of dispensing of antibiotics without a prescription (94.1% of antibiotics dispensed with a valid prescription) in the study of Mukokinya et al. (2018) among pharmacies allied to the UoN • These contrasts with pharmacies not allied to the university and not superintended by pharmacists. In the study of Muloi

	○ Regular interaction with University staff and students regarding key issues surrounding antibiotics and AMR ○ The University recently launching and implementing an AMS curriculum for undergraduate pharmacy students as part of its NAP to reduce AMR	et al (2019), 52% of surveyed pharmacists not allied to the University had sold antibiotics without a prescription • In the study of Opanga et al. (2021) at the start of the COVID-19 pandemic, there was no purchasing of antimicrobials without a prescription among patients with actual or suspected COVID-19 among community pharmacies allied to the UoN. These community pharmacists typically recommended alternative treatments • This compares with the study of Kimathi et al. (2022) who found that 23.4% of respondents had self-medicated with antibiotics during the pandemic, 60.6% at the onset of COVID-19 symptoms before confirmatory tests, with 51.5% self-medicating more than once
Mexico [56,211]	• The government implemented a number policies in 2010 to enforce existing laws whereby antibiotics could only be dispensed to patients presenting with a prescription • As part of the policies, antibiotic prescriptions had to be retained and registered in pharmacies, with fines imposed for non-compliance	• Antibiotic utilisation decreased by 22.9% (10.5 to 7.5 DDD/TID) between 2007 and 2012, with the trend accelerating after greater enforcement of the legislation • There were significant changes in the dispensing of penicillins and sulfonamides: −0.86 DDD/TID ($p<0.00$) and −0.17 DDD/TID ($p=0.07$) respectively • There was also an appreciable seasonal reduction in the use of penicillins in Mexico after greater enforcement of the legislation
Namibia [42, 66, 67, 122]	• Key activities included: ○ Education among pharmacists starting in universities and continuing post qualification ○ Implementation of regulations banning the purchasing of antibiotics without a prescription ○ Activities of community pharmacies regularly monitored	• In a survey among 100 households in Namibia, typically cold/flu medication, paracetamol, and decongestants were used to treat adults or their children with ARIs including for common colds and influenza. There was no purchasing of antibiotics without a prescription • There was a similar situation during the COVID-19 pandemic with no change in antibiotic utilization patterns early in the pandemic among 55 community pharmacies surveyed compared with other African countries including Nigeria
Nigeria [212]	• Randomised trial to assess if access to C-reactive protein (CRP) test kits coupled with staff training on how to use these RTI management • In private community pharmacies, pharmacists can reduce non-prescription antibiotic dispensing for RTIs	Antibiotic dispensing decreased by 15.66% (209/300 [intervention] vs 256/300 [control]) in the adjusted analysis
Republic of Srpska [63, 213]	• Activities included: ○ Education of pharmacists regarding the appropriate management of diseases including ARIs together with the production of guidelines for the 42 most frequent diseases and conditions seen in everyday practice in community pharmacies in the Republic ○ Greater enforcement of the regulations banning the dispensing of antibiotics without a prescription together with possible fines for violation of laws (Euro500–1500 for pharmacy directors and Euro500–750 for pharmacy technicians) ○ Special attention given to the importance of adequate communication and skills among pharmacists starting in	• The dispensing of antibiotics without a prescription decreased from 58% to 18.5% of pharmacies of pharmacies surveyed (simulated patients) • OTC therapy to alleviate symptoms was offered in 72.3% of pharmacies in 2015 up from 67.2% in 2010 • OTC medication dispensed included throat and nasal sprays, decongestants, oral expectorants, analgesics and antihistamines • Significantly fewer pharmacies dispensed an antibiotic without a prescription where OTC medicines were offered • Encouragingly, the most common reason for not dispensing to simulated clients was that antibiotics cannot be dispensed without a prescription

	University and continuing post qualification	
Thailand, 2015 [214]	• Activities included: o Principally education involving a multidisciplinary intervention among grocery stores in a rural province in Thailand o Trained community leaders were used to reduce the extent of antibiotic availability in village grocery stores	• There were 87% fewer antibiotics available post-intervention compared with pre-intervention • Grocery stores in the control group saw only an 8% reduction in antibiotic availability between the two time periods
Uganda, [193]	Four-part intervention to improve the management of paediatric febrile illness among drug sellers: • Training and work activities • Provision of information, education, information and communication • Supply activities including diagnostics and medicines • Monthly support supervision via supervisors trained in either pharmacy or clinical medicine	• The intervention increased the appropriate treatment of children with uncomplicated malaria, pneumonia symptoms and non-bloody diarrhoea by 80.2% (95% CI 53.2–107.2), 65.5% (95% CI 51.6–79.4) and 31.4% (95% CI 1.6–61.2) respectively versus the pre-intervention period • Adherence to guidelines during the intervention phase was high without causing excessive prescribing of antimicrobial medicines

In their study, Lubogo et al. (2021) found that training and workshop activities among drug sellers in rural Uganda, including the provision of information, education and communication, was cost-effective at US$6/ trained drug seller to improve the quality of treatment, complimenting similar activities among healthcare workers [90]. This is important in Uganda given current high resistance rates to recommended and prescribed antibiotics for the treatment of common infections [215].

We are aware, as mentioned, that there have been situations among LMICs where Government or health insurance company interventions have failed to produce the desired result. These are discussed in Table 6 to give guidance of possible pitfalls for key stakeholders across Africa and beyond to avoid in the future if they wish to reduce inappropriate purchasing of antibiotics without a prescription.

Table 6 - Summary of activities that have been unsuccessful to appreciably reduce inappropriate dispensing of antibiotics without a prescription

Country and references	Intervention and Aim	Impact of the Intervention
Chile [56]	• Regulations limiting self-purchasing of antibiotics in Chile were implemented in 1999 • These regulations were reinforced with an educational campaign and the involvement of community pharmacists.	• Initially the policies were effective in reducing antibiotic consumption with antimicrobial consumption decreasing from 12.3 DID before the intervention to 8.5 DID just after the enforcement (in 2000) • However, these activities were not sustained and possibly because of this antibiotic consumption increased from 2002 onwards
Columbia [55,108]	Introduction of a law in 2005 banning the self-purchasing of antibiotics combined with initial enforcement	• The initial enforcement of the law had a modest impact on overall antibiotic sales in the first three years (-1.00 DDDs/ 1000 inhabitants per day) • A follow-up study five years after implementation found that a high number of pharmacies (80.3%) were still not complying with the law as a result of lax monitoring • This prompted calls for a greater enforcement of the law to reduce the purchasing of antibiotics without a prescription
Venezuela [55]	• The government implemented policies to try and limit the dispensing of three antibiotic groups without a prescription	• As a consequence, there was no decrease in antibiotic utilization levels in the country

	• However, there were no public awareness campaigns and the 'enforcement' was only via government publications with no formal follow up of the regulations	• In fact, the opposite happened and there was an increase in antibiotic utilisation in the country despite the policies
Vietnam [58]	• Strict regulations banning the dispensing of antibiotics without a prescription along with constant supervision from the pharmaceutical regulatory authorities • However, limited sanctions for community pharmacists in Vietnam when dispensing antibiotics without a prescription, with a fine of only US$15-25 per documented violation • In addition, potential for extensive co-payments for medical services for patients besides the cost of medicines – which could end up costing the patient considerably more than purchasing medicines directly from community pharmacies • Going straight to pharmacists is seen as typically more convenient and does not waste time waiting to see a physician, which may decrease daily wages	• 487 out of 1,626 participants taking part in the study involving community pharmacies and drug sellers were able to purchase antibiotics without a prescription • 81.7% were able to purchase antibiotics without a prescription involving 29 different antibiotics • In 86.4% of the situations, participants were prescribed antibiotics by drug sellers • Most antibiotics were sold to treat RTIs (61.4%)

NB: ARIs = Acute Respiratory Tract Infections; RTIs = Respiratory Tract Infections

We are also aware that there are several online pharmacies globally including across Africa. There needs to be additional regulations surrounding this activity especially given increasing concerns about substandard and falsified (SF) medicines across Africa and the implications for AMR [216-218], coupled with the lack of advice to patients with online pharmacies. The implications of these activities will be explored in a follow-up paper as this is outside the scope of this paper.

2.2.4 Potential future activities to reduce inappropriate purchasing of antibiotics without a prescription

Community pharmacists and their assistants are a key stakeholder group to reduce inappropriate dispensing of antibiotics. Ideally, community pharmacists and their assistants can provide information about the medicines dispensed as well as give therapeutic advice. These activities build on their considerable role helping patients during the recent COVID-19 pandemic, as well as wider role in countries such as the UK [66,200,201,204,219]. Pharmacists' activities can include advice on alternative treatments to antibiotics for self-limiting infections including URTIs or acute diarrhoea. Activities can also include advice on dosing and storage requirements when antibiotics are deemed necessary based on the balance of risk, as well as discussions on allergies and potential side-effects [92,203]. Alongside this, we have seen antimicrobial stewardship as a key identified Continuous Professional Development (CPD) need among community pharmacists as recently seen in Zambia. Alongside this, the need for regulatory compliance and a culture for monitoring of pharmacy practices must become mainstream among Universities in Africa traning pharmacists to safeguard future patient safety away from a philosophy of commercial gain [220].

As part of this, community pharmacy personnel must acknowledge unique patient considerations when speaking with them. Considerations includes the education and literacy levels of patients, their cultural beliefs and their native language as well as their physical and mental capacity. An important consideration is also the ethnic diversity within a country [221]. If a country is ethnically diverse, this requires additional skills from the pharmacist or assistant in mitigating risk factors associated with antibiotic use including AMR. Such considerations are important as sub-Saharan Africa is one of the most ethnically diverse continents [222]. As a result, as mentioned, community pharmacy personnel need to acknowledge unique patient considerations when speaking with them. In addition, be

cognisant of their potential education and literacy levels, their cultural beliefs and their native language, and where possible their physical and mental capacity. Good listening and questioning skills are also essential to help with a diagnosis as well as ascertain any potential drug-drug interactions with any current medicines. This also includes any herbal medicines to guide possible alternative treatments for their infectious disease [182,223]. Generally, when patients have good guidance of how to use the medicines dispensed, they tend to use them correctly.

Community pharmacists can also track trends in the dispensing of antibiotics, as well as trends in local resistance patterns, through information provided by the Ministry of Health or local hospitals. Community pharmacists can subsequently use this information along with local health authority personnel to develop additional communication and other campaigns to reduce inappropriate dispensing of antibiotics and subsequently AMR. Overall, education and training of HCPs, including community pharmacists and licensed drug sellers, as well as patients or their guardians, is critical to reduce inappropriate dispensing of antibiotics and with it AMR.

Table 7 provides suggestions for all key stakeholder groups in the short to medium term to improve appropriate dispensing of antimicrobials given rising concerns across Africa and the implications for continuing AMR.

Table 7 – Suggested activities in the short to medium term to reduce inappropriate dispensing of antibiotics without a prescription

Key Group	Suggested activities
Health authorities (operating more at a macro level)	**A) Patients** • Improve existing communication with patients to improve their knowledge of antibiotics and AMR. This includes knowledge regarding the lack of effectiveness of antibiotics for essentially viral infections coupled with concerns with their over use including adverse reactions enhancing AMR • Potential channels for effective communication with patients include physicians, pharmacists/ drug stores, schools, billboards and social media outlets • In the case of social media outlets – need to address current misinformation as this can be counter productive as seen with COVID-19 and misinformation regarding possible treatments including hydroxychloroquine and ivermectin as well as vaccines [224-227] • Longer term – seek to introduce universal healthcare building on the agreed SDGs as recent activities have been compromised by the recent COVID-19 pandemic [228-230] **B) Pharmacists/ health authorities** • Work with universities to ensure the curriculum is adequately covered surrounding the management of infectious diseases, AMR and ASPs and continued post-qualification through CPD activities [220]. This includes the clear obligation of all HCP groups to reduce inappropriate purchasing and dispensing of antibiotics without a prescription • Instigate potential ASPs surrounding key advice and guidelines to share with patients. This includes suggested treatments for common presented infections included within the WHO AWaRe book [13,105], as well as potential enforcement of regulations severely limiting inappropriate dispensing of antibiotics especially those in the 'Watch' and 'Reserve' groups among community pharmacies and other medicine outlets • Work with community pharmacists when developing and implementing agreed indicators, including structure and process indicators, to enhance their acceptance and subsequent use. Agreed indicators can incorporate agreed OTC medicines and certain antibiotics, with the consultation of local health authorities, especially surrounding certain 'Access' antibiotics that may be dispensed by community pharmacist without a prescription where pertinent/ expedient and when the risk and benefits to patients have been fully evaluated. This builds on recent activities for instance in the UK [204] • Make sure in time that appropriate systems are in place, including appropriate IT systems, to monitor the availability of antibiotics in pharmacies and reduce shortages, especially in public healthcare facilities dispensing medicines, as

	shortages can be counter-productive if they increase the purchasing of antibiotics in drug stores/ shops • Monitor current antibiotic dispensing practices, especially for 'Watch' and 'Reserve' antibiotics vs. agreed 'Access' antibiotics as part of agreed indicators/ restrictions especially given concerns with the rising utilisation of 'Watch' antibiotics among LMICs in recent years [101]. We have seen in Tanzania that the mass distribution of azithromycin increases resistance rates [102] • Alongside this, local and regional health authorities must ensure that comprehensive awareness campaigns are instigated among patients to reduce requests for antibiotics for essentially self-limiting conditions. This along with capacity building activities among community pharmacy and medicine outlet personnel to improve the management of clients or their children presenting with infectious diseases • In addition, where pertinent health authorities need to provide details of registered medical practitioners currently practicing to enable pharmacists to rapidly verify the validity of the prescriptions through contacts where pertinent. In this way, help improve antibiotic dispensing generally **C) Universities** • Make sure HCPs including future community pharmacists are fully aware of the current regulations surrounding the dispensing of antibiotics without a prescription in their country during their training, as well as core concepts including AMS and ASPs, by critically examining current curricula especially given concerns with the training of pharmacy students during the pandemic [125] • Work with key personnel in the Pharmacy departments of universities to research and monitor dispensing activities among community pharmacies • Subsequently, work with universities and community pharmacists to develop potential interventions (ASPs) including agreed indicators. Subsequently introduce these and monitor their impact. Following this, refine the ASPs if needed, i.e. not achieving the desired impact (Table 6)
Pharmacists/ Pharmacist Associations or Council (typically operating at all levels with pharmacists typically at the meso and micro level))	• Work with health authorities and universities to design optimal communication strategies to limit patients' expectations that they will be dispensed an antibiotic for a self-limiting condition; however, they will be offered effective alternatives • Use this opportunity to cement the role of pharmacists and their assistants in the community as the preferred first contact HCP for a number of ailments including URTIs and UTIs – this builds on their expanding role as part of the COVID-19 pandemic with proactivity across LMICs [66,200,201,203] • As part of this, take part in ongoing CPD activities including surrounding the 'AWaRe' book [13,105], and its implications, to optimize the care of patients with infectious diseases in the community and reduce subsequent AMR • Seek to introduce systems that can better monitor the flow of antibiotics through shops and stores including mobile technologies – imperative as part of the development of appropriate quality indicators • Work with health authorities and others to reduce potential shortages of medicines, especially if this means necessarily dispensing 'Watch' vs. 'Access' antibiotics • Work with health authorities to introduce pertinent indicators to improve the appropriate dispensing of antibiotics – even without a prescription. As part of this, Pharmacy Councils across Africa need to work closely with health authorities regarding the introduction of pertinent IT systems to monitor antibiotic use – this can increasingly be mobile technologies in Africa given their networks and current problems with landlines in Africa • Leverage the needs and opportunities to provide relevant CPD, AMR education and antibiotic guidelines to community pharmacists and medicines seller. Mobile Apps can increasingly be used to provide high-impact (and cost-effective) advice and guidance [231,232]
Universities (typically operating at	• Refine the curriculum to make sure it covers all essential aspects of antibiotics, AMR and the AWaRe classification of antibiotics/ AWaRe book of conditions

the macro and meso level)	• Alongside this, refine CPD activities to help improve the appropriate dispensing of antibiotics in the future • Work with key stakeholder groups regarding the messaging and channels to patients to lower their expectations for an antibiotic to treat self-limiting conditions • Work with key stakeholder groups to develop and refine possible indicators to improve the dispensing of antibiotics, especially without a prescription
Regulatory authorities and policy makers (typically operating at the macro level)	• Develop capacity to help enforce appropriate legislation for public protection • Strengthen the medicine policy and regulatory frameworks that enhance the rational use of antibiotics including appropriate dispensing • Progress One-Health approaches and strategies to further mitigate AMR risks • Ensure coordinated multisectoral collaboration, including private sector participation, in reducing inappropriate dispensing of antibiotics without a prescription
Patients and Patient Associations (Patients typically operating at the micro level)	• Work with all key stakeholder groups to ensure that any messaging to patients is understandable given the extent of misconceptions currently regarding antibiotics and their use as well as AMR. This includes animations for children and patient engagement to reduce unnecessary requests [233] • Work with health authorities and others to use social media to rapidly spread key messages regarding antibiotics and their use as well as AMR • Work with health authorities and others to address key misconceptions circulating with respect to antibiotics and their uses as well as AMR – especially for essentially self-limiting conditions • Work with key groups including university personnel to enhance the communication skills of future pharmacists and assistants especially surrounding infectious diseases likely to be seen in ambulatory care as well as misconceptions surrounding antibiotics and AMR • Work with health authorities and others regarding the development of pertinent future dispensing/ quality indicators
Pharmaceutical companies and the private sector (typically operating at the macro and meso level)	• Promote a responsible behaviour through the different key stakeholder groups, i.e., producers, distributors and pharmacies in the value chain delivering antibiotics to the population through awareness activities • Involve key groups, e.g. biotech firms, laboratories and clinics that have legitimate commercial interests into promoting antibiogram tests to improve future empiric prescribing of antibiotics • Employ good manufacturing practice (GMP) and good distribution practice (GDP) to ensure that marketed antibiotics in Africa are of quality, including deploying robust post-marketing surveillance of their marketed antibiotics

Tribal authorities can also assist with meetings to educate their community where pertinent, and social media can be a powerful tool of passing information to the public. However, care is needed to address possible misinformation. For instance, there was considerable misinformation regarding the prevention and treatment of patients with COVID-19 including vaccines during the early waves of the pandemic [224,225,227,234,235].

Underpinning future activities is the obligation and the responsibility of the competent institutions, e.g., the Ministry of Health and Governments, for enacting precise, clear and strict regulations regarding prescription only medicines, including antibiotics, with appropriate penalties and fines. There is a clearly defined obligation of every HCP in this process, and the obligation of continuous monitoring and inspections by official institutions. HCPs should be aware of their obligations starting in university and continuing post qualification. As part of this, patients and public/media must be aware of the current regulations surrounding prescription-only medicines, the rationale for this classification and how they can help community pharmacists in their activities. However, there also needs to be some flexibility especially in more rural areas where there are greater distances and costs to visit HCPs in healthcare centres, and where community pharmacists and their assistants may be the only HCP available. In addition, where the costs of medicines combined with co-payment costs of visiting HCPs in clinics is clearly unaffordable for most workers and their families [107]. Trained community pharmacists can guide patients on appropriate management choices building on the examples in Kenya and Namibia (Table 7). Such activities build on their role in the NAPs to reduce AMR across Africa as well as their increasing role in countries such as the UK [19,204].

2.3. Discussion of the findings and the implications

Reducing the burden of AMR is a high priority across Africa in view of its impact on lives lost across the continent, the increasing burden on the healthcare system especially post-COVID-19 as well as associated costs [2,3,10,236]. Rising AMR rates have been enhanced by the growing use of 'Watch' antibiotics across LMICs including among African countries [101].

As mentioned, a critical area to address to reduce AMR is the inappropriate use of antibiotics in ambulatory care. This is because ambulatory care currently accounts for approximately 90% or more of overall antibiotic utilisation globally especially in LMICs, which includes among African countries [13,14]. Within total ambulatory care utilisation, the purchasing and dispensing of antibiotics without a prescription, often for self-limiting conditions such as URTIs, contributes an appreciable proportion of overall antibiotic use across Africa (Table S2) [29,31,36,37]. Consequently, there was an identified need to comprehensively document current practices across Africa and the rationale behind the purchasing of antibiotics without a prescription among both patients and dispensers. Alongside this, potential ways forward to limit inappropriate dispensing behaviour. Possible activities to reduce inappropriate dispensing of antibiotics include the introduction of quality indicators (Tables 4 and 5) that can be used in practice along with accompanying ASPs. As a result, help to reduce AMR. Documenting potential activities including possible quality indicators and ASPs was the rationale behind this study, culminating in suggested ways forward for all key stakeholder groups across Africa to reduce AMR (Table 7). Suggested activities build on the considerable experiences of the senior-level co-authors.

The findings from this narrative review shows that there is still considerable purchasing of antibiotics without a prescription across a number of African countries despite government legislation banning the sales of antibiotics without a prescription (Tables S1 to S3). Countries with the highest rates of purchasing without a prescription include Eritrea Ethiopia, Nigeria, Mozambique, Tanzania and Zambia, and build on earlier systematic reviews including those of Belachew et al. (2021) [37]. and Yeika et al. (2021) [36], as well as systematic reviews among LMICs including African countries [29,38,41,50,51,53]. However, there are some African countries, as well as some situations within African countries, where there is little of no purchasing of antibiotics without a prescription. African countries include Botswana and Namibia where the introduction strict regulations, coupled with regular monitoring of pharmacists, limits the dispensing of antibiotics without a prescription. In addition, in certain circumstances including Kenya among pharmacists linked to the University of Nairobi and among rural settings in South Africa [33,92]. These countries and situations provide exemplars for the future.

Encouragingly, the penicillins (typically in the Access group), metronidazole (Access), cotrimoxazole (Access) and tetracyclines (Access) were among the most dispensed antibiotics without a prescription across Africa where this data was available (Table S2), with more limited dispensing of macrolides, quinolones and cephalosporins. Alongside this, limited if any dispensing of 'Reserve' antibiotics without a prescription among the studied African countries. The antibiotic dispensing patterns seen across Africa (Supplementary Table S2) are perhaps not surprising with ARIs, UTIs and acute diarrhoea among the most common complaints when antibiotics were dispensed without a prescription. Alongside this, the "Reserve" group of antibiotics are typically very expensive compared with other antibiotics. Consequently, may well be unaffordable to the majority of patients who pay "out of pocket" for their healthcare.

The reasons for high rates of purchasing of antibiotics without a prescription seen in recent years across Africa (Tables 1 and 2) include patient demand, economic factors including high patient co-payments for healthcare as well as medicines, travel costs to see HCPs in healthcare facilities as well as time away from work, i.e., opportunity costs, exacerbated by long waiting times to see an HCP in a public healthcare facility. In addition, previous experiences of patients with similar infectious diseases as well as limited knowledge about antibiotics and AMR among all key stakeholder groups, including patients and pharmacists. Alongside this, weak monitoring and enforcement of current regulations.

Addressing inappropriate dispensing of antibiotics is critical as part of NAPs across Africa to reduce increasing rates of AMR [19]. We have seen several indicators used across Africa as part of ASPs to reduce inappropriate dispensing of antibiotics, with more suggested (Tables 3 and 4). There have

also been a number of ASPs introduced among African countries and beyond to reduce inappropriate dispensing of antibiotics, especially for ARIs (Table 5). This is encouraging as there have been concerns with the introduction of ASPs among LMICs including African countries due to resource and other issues [206]. However, this has changed recently in Africa especially in hospitals [237-241]. Such activities are important to help to reduce AMR across Africa as part of agreed NAPs [19]. Potential ASP activities include educational initiatives among all key stakeholder groups as well as greater enforcement of current legislation. Greater education among all key stakeholder groups includes patients. The introduction of legislation, and/ or greater enforcement of current legislation combined with possible fines, should potentially emphasize 'Watch' antibiotics along with agreed indicators. We have seen in a number of South American countries, as well as Malawi (Tables 1 and 2) and Vietnam (Table 6), that enforcement of any regulation, alongside potential fines, needs to be followed through. Otherwise, these initiatives and activities will fail to achieve the desired results. These combined findings resulted in a number of suggestions for all key stakeholder groups in Africa going forward to reduce future inappropriate dispensing of antibiotics without a prescription (Table 7).

The suggested activities recognise the increasing role of community pharmacists post COVID-19 as key players in the healthcare system managing self-limiting conditions including ARIs, UTIs and acute diarrhoea [66,75,200-202]. Community pharmacists also had an increasing role combating false information and its consequences during the recent pandemic, which resulted in requests for ineffective antimicrobials causing side-effects as witnessed with hydroxychloroquine and ivermectin [42,202,227,242]. Alongside this, providing advice on preventative measures including PPE and hand washing to limit the spread of the virus [66,200,201].

Education of key stakeholder groups, alongside the development of appropriate indicators associated with ASPs, can be based on the recent AWaRe guidance, which encourages the appropriate use of antibiotics based on risk assessments. Educational activities can include encouraging the appropriate dispensing of Access antibiotics where these are indicated [13,105]. This is especially important in rural areas of Africa where, as mentioned, there can be limited access to prescribers with community pharmacists often the principal HCP. Totally banning the dispensing of antibiotics without a prescription in urban areas can also be potentially morally challenging where there are high co-payments to see a physician or nurse and purchase medicines coupled with long waiting times to see them and the resultant implications [37,82,107,198,199]. We will continue to monitor activities across Africa, including the development of potential indicators surrounding the AWaRe book, building on developments in information technology. This includes the use of mobile telephones to track and monitor dispensing patterns [197]. In addition, interventions that have recently been implemented but too early to assess their impact.

We are aware of a number of limitations with this paper. These include the fact that we did not undertake full systematic reviews for each area for the reasons given. However, we have documented an appreciable number of papers discussing the current situation regarding the purchasing of antibiotics without a prescription across Africa, the rationale and potential ways to address this. The latter has been achieved with the considerable knowledge and input from senior level co-authors from across Africa and beyond. Despite these limitations, we believe our findings and suggestions for the future with all key stakeholder groups are robust given the number of exemplars and suggestions going forward.

3. Conclusions

In conclusion, there is still extensive purchasing of antibiotics without a prescription across Africa. This is a concern given rising AMR across Africa, with the implications for increased morbidity, mortality and costs. A number of ASPs have been undertaken across Africa and beyond to reduce inappropriate dispensing of antibiotics acting as exemplars. Successful activities typically involve comprehensive activities among all key stakeholder groups with education a key component. We will continue to monitor the situation given its current urgency and the need to reduce AMR across Africa as part of ongoing NAPs.

4. Expert Opinion

In order to appreciably reduce AMR globally and the associated implications, it is essential to reduce inappropriate dispensing of antibiotics without a prescription across Africa. This is because the

highest consumption of antibiotics globally, as well as mortality due to AMR, is in sub-Saharan Africa. Alongside this, over 90 to 95% of antibiotic utilisation across Africa is currently in ambulatory care as opposed to hospital in-patients, with the purchasing of antibiotics for essentially self-limiting conditions such as ARIs and acute diarrhoea currently constituting an appreciable proportion of overall antibiotic utilisation. Typically across Africa, the purchasing of antibiotics without a prescription is banned. However, there is weak enforcement among many African countries. Such legislation is also counter-productive in rural areas where community pharmacists maybe the only healthcare professional available. Alongside this, in many African countries, there can be high prohibitive costs to see an HCP in a healthcare facility in addition to any travel costs alongside potential loss of income from seeing physicians within working hours especially with long waiting times. The cost of any antimicrobial can also be a concern. Consequently, the way forward in these situations is to enhance the appropriateness of any antibiotics dispensed in community pharmacies and drug stores. This can be achieved through offering suitable alternatives for essentially self-limiting conditions. In addition, reducing the extent of any dispensing of 'Watch' antibiotics through legislation as well as subsequent close monitoring of antibiotics dispensed among community pharmacists through mobile technologies and other approaches.

Any antibiotic dispensed should subsequently be based on a thorough risk assessment of the patient. This can be through implementing treatment suggestions and agreed quality targets based on the indications listed in the recently published AWaRe book and classification of antibiotics. The AWaRe book guidance has been endorsed by the WHO. As such, providing a universally globally accepted guideline source in place of multiple local, national and international guidelines which can be contradictory. As a result, reducing the potential for different guidelines being used within and among the different African countries, which only causes confusion.

Alongside these activities, there also needs to be improved education of all key stakeholder groups regarding antibiotics and AMR to reduce inappropriate requests. The need for additional education reflects identified concerns concerning the current knowledge of antibiotics and antimicrobial resistance among key stakeholder groups across Africa. Key stakeholder groups include students, practicing physicians, nurses in healthcare facilities and pharmacists as well as patients. Improving knowledge of these HCPs starts in universities and continues post qualification. Educated pharmacists, especially those allied to universities in Kenya and Namibia, has limited the purchasing of antibiotics without a prescription. As a result, providing exemplars to other countries. Patients are also a key target for educational activities as they drive requests for antibiotics. However, to be successful with patients, community pharmacists and their assistants need to acknowledge the education and literacy level of patients in their communication with them alongside any cultural beliefs of their patients. In addition, where possible, speak to patients in their native language to improve any communication between community pharmacists and assistants with patients. Such considerations are important because there can be considerable misinformation and misunderstanding surrounding terms such as AMR and the implications. Such activities are especially important in sub-Saharan Africa as this is one of the most ethnically diverse continents globally. Good listening and questioning skills can also help ascertain any current medicines patients are taking, including any herbal medicines, in case of potential drug-drug interactions. Finally, community pharmacists should also be increasingly able to keep track of local resistance patterns with the help of local health authorities as country surveillance activities and knowledge. Improved knowledge base of local resistance patterns is essential when discussing pharmacists or their assistants are discussing possible treatment alternatives with client customers regarding their infectious diseases and the rationale.

Future research should be centred on possible ASPs among community pharmacists and drug sellers to improve appropriate dispensing of antibiotics given limited examples to date across Africa. This includes the development and monitoring of robust processes and quality indicators based around the AWaRe book. A necessary pre-requisite is robust systems in place to monitor the dispensing of antibiotics in community pharmacists and drug stores, increasingly linked to a diagnosis. In addition, researching cost-effective ways of communicating with patients to reduce unnecessary requests for antibiotics especially surrounding social media avenues. These are likely developments in the next five to ten years across Africa to meet the goals within each country's NAPs as well as global action plan goals to reduce AMR, and we will continue to monitor the situation.

Conflicts of interest: Some of the co-authors work for national or regional health authorities or are advisers to them. There are no other conflicts of interest to declare.

Funding. There was no funding for this paper. However, A.C. and C.E.M. are funded by the Welcome Trust (222051/Z/20/Z) for the ADILA project.

Supplementary Material and Tables

Tables

Table S1 – Regulations regarding the purchasing of antibiotics without a prescription among African countries

Country and Reference	Comment
Benin [243]	• In Benin, the informal selling of medicines, including antibiotics, is banned • However, smuggling of medicines across the borders continues and because selling of medicines is often unregulated, informal drug selling offers a livelihood especially where there a few other employment options • This is a concern with rising resistance rates to common infections [244]
Botswana [64,65,245]	• Currently in Botswana over 85% of the population receives health care services free-of-charge as part UHC initiatives • Only prescribed medicines can be dispensed from public sector health facilities and these are provided free-of-charge • Alongside this, Botswana Medicines Regulatory Authority (BoMRA) strictly enforces regulations that direct health care workers, including pharmacists/pharmacy owners, to ensure that antibiotics are only dispensed to patients presenting with a prescription.
Eritrea [140,246]	• In 2019, the National Medicines and Food Administration in Eritrea in collaboration with all key stakeholders developed a medicines schedule guide. Under this schedule, antibiotics must be dispensed with a prescription and their availability in drug retail outlets should be regularly assessed • However, previous weak enforcement of regulations and monitoring in the past has resulted in high rates of dispensing without • This is important given rising antimicrobial resistance rates in Eritrea including methicillin-resistant staphylococcus aureus as well as multidrug-resistant pathogens [247,248] • As a result, the Ministry of Health has made antibiotics as prescription-only medicines with greater enforcement of the regulations from January 2020 onwards
Eswatini [249,250]	• The need to register pharmacies, especially those importing medicines into the Kingdom of Eswatini, coupled with the need to comply the regulations outlined in the Application for fear of losing their licence, should limit the sales of antibiotics without a prescription • However, limited inspection of facilities coupled with patient and commercial pressures reduces compliance in reality
Ghana [161,174,251,252]	• Over-the-counter medicine sellers are not permitted to sell dispense antibiotics without a prescription, the only exception is cotrimoxazole • In practice they sell different classes of antibiotics with or without a prescription with weak enforcement of the regulations • The Health Professions Regulatory Body Act, 2013, Act 857 indicates that only physicians, physician assistants, pharmacists, midwives and nurse prescribers are eligible to prescribe and dispense registered antibiotics • However registered pharmacies may dispense certain antibiotics including amoxicillin (**A**), ampicillin (**A**), ciprofloxacin (**W**), doxycycline (**A**), erythromycin (**W**), flucloxacillin (**A**), norfloxacin (W) and tetracycline (**A**) based on the recommendation of a practicing pharmacist, with the National Health Insurance Scheme recently classifying antbiotics by the level of prescriber/ dispenser
Kenya [176,253,254]	• Pharmacy and Poisons' Act prohibits the sale of all medicines, including antibiotics. without a prescription • However, currently enforcement and penalties are weak and antibiotics are readily available over-the counter

	• This needs to be addressed given concerns with rising antimicrobial resistance rates in Kenya including multi-drug resistant bacteria [255-257]
Malawi [258,259]	• Medicines are regulated by Pharmacy and Medicines Regulatory Authority Act 9 of 2019 in Malawi and should not be dispensed without a valid prescription from an authorized prescriber • Pharmacies must have a part-time or full-time registered pharmacist who are allowed to stock antibiotics, whereas "drug stores" can be managed by "pharmacy personnel" and they are not designated to sell antibiotics • Pharmacies and pharmacy personnel selling prescription only medicines (including antibiotics) without a valid prescription are violating the Act and liable to a minimum fine of US$1,000 and one year imprisonment • However, despite these regulations, there is still considerable purchasing of antibiotics without a prescription in Malawi enhanced by weak enforcement of the regulations
Mozambique [148,167,260]	• Regulations for prescription-only medicines including antibiotics are embedded in the Drug Law 12/2017 • However, despite establishing penalties for abuse, the lack of penalties has resulted in high rates of purchasing of antibiotics without a prescription in some studies
Namibia [66,67,261]	• Strict regulations among community pharmacists, coupled with the monitoring of pharmacies alongside the training of pharmacists on antibiotics and AMR whilst at the University, has limited the purchasing of antibiotics in reality in Namibia • This is an improvement on the situation in 2013 where 15% of patients surveyed reported self-medication with antibiotics, principally obtained from community pharmacists without a prescription
Nigeria [163,262]	• The dispensing of antibiotics without a prescription is illegal in Nigeria • However, this is common practice with limited follow-up of the regulations in reality
South Africa [70,263]	• South African regulations currently prohibit the dispensing of antibiotics in pharmacies without a prescription, with potentially Community Pharmacists losing their licence for abuse
Sudan [87,164]	• Antibiotics in Sudan are listed as prescription only medicines • However, lax monitoring results in high rates of purchasing of antibiotics without a prescription due to costs savings and convenience of pharmacists • This is a concern with rising rates of antimicrobial resistance including multi-drug resistant bacteria [264]
Tanzania [265-268]	• Antibiotics are typically listed as prescription only medicines within certain laws and regulations. However, certain antimicrobials can be dispensed by registered pharmacies and stores including antimicrobials for malaria • Despite these laws and regulations, there is appreciable purchasing of antibiotics without a prescription in Tanzania enhanced by weak enforcement of current regulations
Zimbabwe – Hongoro et al., 2000 [109]; Kumaranayake et al., 2000 [110]; Nyazema et al. 2007 [111]; Belachew et al., 2021 [37]; Dixon et al., 2021 [85]	• There were low sales of antibiotics without a prescription in Zimbabwe in the early 2000s, again confirmed in the study of Nyazema et al., due to the strict enforcement of laws in the country at that time prohibiting the sales of antibiotics without a prescription coupled with the revoking of licences for abuse despite patient pressure • However, this has changed in recent years with ambulatory care patients now typically obtaining their antibiotics from the informal market place due the costs and time involved with seeking help from healthcare professionals in public clinics as well as obtaining medicines from community pharmacies

NB: 'A' and 'W' refer to 'Access' and 'Watch' antibiotics under the AWaRe classification (see Methodology)

Table S2 – Current rates of purchasing of antibiotics without a prescription among a range of African countries and income levels

Country	Author and Year	Study design and population	Summary of the findings including indications and antibiotics dispensed where mentioned
Low Income Countries*			
Burkina Faso	Sariola et al., 2022 [243]	Household survey – 'drug bag' method	• No details of the number of households approached • Sources of antibiotics among households to treat infections included PHCs (34%), informal sellers (27%), private sellers including pharmacies (29%) and hospital drug stores (12%) • To conserve costs, it was common for patients when purchasing antibiotics to stop taking them when they recovered ready for use the next time
Eritrea	Ateshim et al., 2019 [165]	Face-to-face interviews with 577 participants (99.5% response rate) using a structured questionnaire	• 45.1% prevalence rate of self-medication with antibiotics among interviewed participants • Principal conditions for self-medication with antibiotics included wound infections - 17.9%, sore throats - 13.9%, aches and pains - 12.5%, tonsillitis - 12.41% and coughs - 9.2% • Most used antibiotics for self-medication were amoxicillin (**A**) - 84.1%, ciprofloxacin (**W**) - 6.7% and tetracycline **(A**) - 2.51%
	Bahta et al., 2020 [246]	• Simulated client methodology among 88 drug outlets in Eritrea • Case histories were uncomplicated UTIs and acute watery diarrhoea	• The extent of dispensing antibiotics without prescription was 87.6% among simulated clients – higher for those with UTIs (89.2%) than acute watery diarrhoea (86.1%) • Most dispensed antibiotics were co-trimoxazole (A) for acute watery diarrhoea (53.6%) and ciprofloxacin (W) for UTIs (56.7%)
	Bahta et al., 2021 [140]	Focus group discussions and key informant interviews among 36 pharmacists and assistants	• There is considerable dispensing of antibiotics without a prescription principally for economic reasons (pharmacists and patients) • In addition, long queues to see healthcare professionals in healthcare facilities as well as scarcity of available medicines in healthcare facilities
Eritrea	Russom et al., 2021 [118]	2477 interviews with adults (97.4% response rate) using a structured questionnaire	• 9.8% had purchased antibiotics without a prescription principally from a drug retail outlet (83.6%) • Principal reasons for self-medication with antibiotics included the non-seriousness nature of the disease (39.0%), the need for quick relief (33.9%), previous successful experiences with antibiotics (16.1%), having no time to visit a health facility (15.0%) and typically long queues at health facilities (14.0%)
Ethiopia	Erku et al., 2016 [269]	• Simulated patients among 59 community drug outlets • One group asking specifically for co-amoxiclav (among other medicines) • One group requesting a medicine when presenting with a URTI	• Where co-amoxiclav was available, this was dispensed on request in 87.9% of dispensaries • Antibiotics were obtained in 75.9% of dispensaries when patients presented with a URTI • The most common dispensed antibiotics were amoxicillin (A) - 93.2% (**A**), co-amoxiclav 72.7% (**A**) and azithromycin - 50% (**W**) • Only 4.5% of dispensaries asked about drug allergies
	Gebretekle et al., 2016 [141]	• Qualitative interviews among personnel in 5 community pharmacies in Adia Ababa • One pharmacy professional was interviewed in each pharmacy using a semi-structured questionnaire	• Antibiotics are frequently dispensed without a prescription with the trend increasing • Non-prescription sales are common for amoxicillin (**A**), ciprofloxacin (**W**) and cotrimoxazole (**A**) • The poor, less educated and younger groups more frequently request antibiotics without a prescription than other populations

			• Key reasons for dispensing antibiotics without a prescription including economics, pressure from patients and weak regulations
	Gelayee, 2017 [270]	Self-administered questionnaire among 385 social science students (85%) in North West Ethiopia	• The prevalence of self-medication was 32.7% • A headache (69.1%) was the primary complaint for self-medication - with analgesics the most used medicine (53.2%) • This was followed by antimicrobials (39.7% of students)
	Erku et al., 2018 [142]	• 2-phased mixed-method study • 100 simulated patient visits to drug retail outlets for two childhood infections – acute diarrhoea and URTIs followed by interviews	• 86% of simulated patients were provided with one or more medicines • Metronidazole (**A**) was dispensed in 15 cases out of 50 acute diarrhoea (30%) • Among antibiotics dispensed without a prescription for URTIs, amoxicillin (**A**) was the most common antibiotic (23/50 patients) followed by co-amoxiclav (**A**) (19/50) and azithromycin (**W**) (15/50)
	Bogale et al., 2019 [143]	• Cross sectional study • Questionnaire among 595 household respondents in Ethiopia (98.3% response rate)	• 67.3% of the respondents reported purchasing antibiotics without a prescription in the past 6 months • Self-medication with antibiotics was significantly associated with age, educational status, and average monthly income
	Koji et al., 2019 [271]	• 262 simulated encounters in medicine retail outlets • Simulated children across a range of diseases including URTIs, acute diarrhoea, pneumonia and meningitis alongside verbal requests for an antibiotic	• Of the 262 verbal requests for an antibiotic, 63.4% of encounters ended with the dispensing of an antibiotic without a prescription • The likelihood of being dispensed an antibiotic was significantly higher for children with acute diarrhoea or pneumonia and when the dispenser queried about the symptoms
	Belachew et al., 2022 [83]	Cross-sectional survey among 276 staff in 270 drug outlets using a validated self-administered questionnaire	• 58% of drug outlet staff stated they had dispensed antibiotics without a prescription • Dispensers who were less confident about antibiotics and supplying them were less likely to report non-prescription dispensing
	Demissie et al., 2022 [144]	• Community-based cross-sectional design • 826 respondents took part using a pre-tested questionnaire	• 38.9% of respondents stated they had purchased antibiotics without a prescription in the past 12 months • Having no health insurance was one of the key reasons for self-purchasing
	Edessa et al., 2022 [145]	Community-based cross-sectional study among 100 simulated cases regarding childhood diarrhoea among drug retail outlets	67% of simulated cases were dispensed an antibiotic despite the absence of evidence supporting an infectious aetiology
Malawi	Chikowe et al., 2018 [258]	• Covert shoppers attempting to buy amoxicillin from private pharmacies and drug stores in the township area (56 stores) • This was part of a study assessing the quality of amoxicillin sold	• 45 of the 56 private pharmacies and drug stores stocked amoxicillin • Out of the 45 stores, only 2 pharmacies refused to sell antibiotics without a prescription (4.4%) and in one pharmacy the pharmacists was out so no sale • Overall where possible, 95% of the sellers that were approached sold amoxicillin without a prescription
	Sambakunsi et al., 2019 [146]	• Cross sectional study, mixed-methods study design	• Self-medication was common • 39% had self-medicated in the past 3-months

		• Involving 2 focus groups and structured questionnaire among 105 respondents (105 out of 110 approached)	• Over 60% who self-medicate do so with antibiotics with coughs (21%), malaria (21%) and fever (18%) the most common reasons for this
	Machongo et al., 2022 [107,147]	Interview guides to conduct in-depth interviews with 16 caregivers of children	• Caregivers typically indulged in self-medication with antibiotics • Sources of antibiotics included buying antibiotics from a store (hawker, drug store or pharmacy) without a prescription, using leftover antibiotics at home and sharing the antibiotics with friends and relatives • Using leftover antibiotics as well as sharing outside of the public system is enhanced by their high costs versus average wages
Mozambique	Mate et al, 2019 [115]	Cross-sectional study among 1091 adults using a semi-structured questionnaire	• 20.9% of participants surveyed had used non-prescribed antibiotics • Most of the non-prescribed antibiotics were purchased in pharmacies (87.3%) • The proportion of adults purchasing non-prescribed antibiotics was higher when antibiotics were obtained from informal markets (82.6%) and home stores (66.7%) compared to pharmacies (24.6%) (p = 0.000) • Principal reasons for purchasing without a prescription included no need to visit the clinic for the condition (26.8%), poor quality of care in health clinics (6.7%) and symptoms similar to previous episodes (6.2%)
	Rodrigues, 2020 [260]	• Mixed method approach • First phase included 7 focus groups and a household survey (265 people) • Second phase – more in-depth interviews with 17 participants as well as 10 key informants including practitioners	• 20.8% of respondents mentioned the use of antibiotics within one month prior to the survey • Of those who reported having ever used antibiotic, 26% said that the last time they had done so was based on their own initiative • Combining the studies, while antibiotics did not seem to be the first choice among patients when self-managing their common symptoms such as diarrhoea or URTIs, the relatively high percentage of self-medication with antibiotics indicates their ready availability and use when there is a perceived need
	Torres et al., 2020 [148]	Cross-sectional study involving both individual and group interviews among 32 pharmacy clients and 17 pharmacists	• 93.75% of pharmacy clients (30/32) frequently purchased antibiotics without a prescription • 88.2% (15/17) of pharmacists surveyed admitted dispensing antibiotics without a prescription • The most commonly dispensed antibiotics were amoxycillin (**A**), cotrimoxazole (**A**) and co-amoxiclav (**A**) • A concern was that patients requested antibiotics in smaller quantities than current recommendations • ARIs, UTIs and vaginal discharge were the most common conditions where antibiotics were purchased
	Torres et al., 2020 [167]	Qualitative study involving face-to-face interviews with 17 pharmacists in 9 private pharmacies	• 88% of pharmacists interviewed (15/17) admitted dispensing antibiotics without a prescription with only 2 pharmacists requesting to see a prescription before dispensing an antibiotic • Overall, dispensing antibiotics without a prescription is a common practice with patients frequently requesting non-prescribed antibiotics for their infectious diseases
	Do et al., 2021 [33]	Quantitative and qualitative assessments of antibiotic access and use involving customer mapping, exit interviews and household	• Low rates of self-medication with antibiotics - occurring in only 8.0% of occasions on exit interviews. The figure was reduced to 1.4% in the second survey • Low rates facilitated by limited access to community pharmacies and provision of free healthcare in public

		surveys (650 in Mozambique)	healthcare facilities (PHCs) - 80.9% of household members surveyed went to PHCs in Mozambique for mild illnesses with trust also a common reason for going to PHCs with even mild illnesses • Patients had to pay for antibiotics in community pharmacies if unavailable at PHCs
Rwanda	Tuyishimire et al., 2019 [149]	Structured questionnaire among 570 undergraduate students	• 12.1% (n=69) practiced self-medication with antibiotics. The principal reason for self-medication with antibiotics was the perception that the illness was not serious enough to have a consultation (50.7%) • Diseases being treated with antibiotics included URTIs including a common cold, cough or fever (47.8%) • The most common antibiotic dispensed was amoxicillin (**A**) - 59.4%
	Nisabwe et al., 2020 [114]	Descriptive cross-sectional study conducted among 282 medical, dental and pharmacy students	49% of healthcare students reported they were able to purchase antibiotics without a prescription
Tanzania	Embrey et al., 2016 [272]	Mixed- method approach This involved surveying 1185 households and auditing 96 dispensing outlets and 84 health facilities In addition, mystery shoppers visiting 306 drug dispensing outlets with mystery shoppers with 3 scenarios	• 99% of mystery shoppers presenting a pneumonia scenario received an antimicrobial (54%), a referral (90%), or both (45%) – recommended practices for managing paediatric pneumonia • However, 1/3rd of dispensers needlessly sold antibiotics for colds and 85% sold an antibiotic on request • Only 44% of dispensers asked mystery shoppers about danger signs potentially associated with pneumonia in children
	Horumpende et al., 2018 [265]	Cross-sectional survey using simulated clients among 82 pharmacies overall	• 92.3% of retailers dispensed antibiotics without a prescription • The antibiotics most commonly dispensed without a prescription were ampiclox (**A**) for a cough and azithromycin (**W**) for painful urination • Only 5.9% of retailers gave instructions for medicine use voluntarily
	Mboya et al., 2018 [150]	Cross-sectional descriptive study involving 152 adults visiting pharmacies or accredited drug stores	• 76.3% of purchases for antibiotics were without a prescription with 23% purchasing an incomplete course of < 5 days • URTIs were the most common presenting complaint (48%) followed by UTIs (17.8%) and diarrhoea (9.9%) • The most common antibiotics purchased were ampiclox (**A**) - 27%, amoxicillin (**A**) - 18.4%, metronidazole (**A**) - 8.7%, and ciprofloxacin (**W**) - 8.1%
	Simon et al., 2020 [84]	Cross-sectional study among 730 parents/ caregivers of children < 5 years of age using a structured interview guide	• The proportion of parental self-purchasing of antibiotics for children under-five was 47.7%, with low knowledge regarding antibiotics among interviewees • Amoxicillin (**A**) was the most commonly purchased antibiotic (62.0%)
	Ndaki et al., 2021 [268]	Mystery shoppers asking directly for amoxicillin without a prescription among 1148 community pharmacies and accredited drug dispensing outlets	• Dispensing of amoxicillin (**A**) without a prescription was common - 88.2% of outlets – typically without asking any questions • The majority of outlets were happy to sell half a course of amoxicillin without a prescription, which is a concern
	Emgård et al., 2022 [151]	Eight focus group discussions with mothers of children < 5 years	There can be appreciable purchasing of antibiotics without a prescription as: • Antibiotics are perceived as universal treatments for common diseases • Often long wait at facilities and disrespectful treatment at healthcare facilities

			• Transport costs with often husbands not providing the necessary financial support • Often healthcare facilities do not stock the suggested medicines and patients have to pay for them at community pharmacies • Pharmacies and pharmacy staff seen as more trustworthy and convenient
	Mabilika et al, 2022 [152]	Cross-sectional study involving 430 respondents using a digital questionnaire	• The prevalence of purchasing antibiotics without a prescription was 23.6% among rural respondents and 23.4% among urban respondents - mostly for a cough (76.3%/ 82% - rural and urban) or fever (63.2%/ 39.7% - rural and urban) • Amoxycillin (**A**) was the most commonly dispensed antibiotic across both settings (47.3% rural, 41% urban) • Having health insurance and shorter distances to a facility reduces self-purchasing
	Ndaki et al., 2022 [273]	Simulated clients among 672 accredited drug outlets and community pharmacies	• 89.43% of sellers in the 2 outlets recommended antibiotics to clients who described UTI-like symptoms but had no prescription • 58.93% were willing to sell less than the minimum recommended course • The most commonly suggested antibiotics for UTIs were azithromycin – 35.4% (**W**) and ciprofloxacin – 20.5% (**W**)
Uganda	Kibuule et al., 2016 [153]	Cross-sectional survey among 200 households treating children < 5 years with ARIs using a developed questionnaire	• 43% of households purchased antibiotics without a prescription for the management of young children with ARIs • The most commonly purchased antibiotics were penicillins (mainly amoxicillin) – 43% (**A**), and sulphonamides including co-trimoxazole – 40% (**A**)
	Ocan et al., 2017 [274]	Cross-sectional study using a pre-tested questionnaire conducted among 390 randomly selected children in the community	• The prevalence of non-prescription antimicrobial medicines was 44.8% (38.3-52.2) • The most common symptoms among children were ARIs (influenza – 84.9%; cough – 83.1%) and undefined fever (69.7%) • Antibiotics dispensed included amoxicillin (**A**) – 18.9% - and co-trimoxazole (**A**) – 18.5%
	Kirraga et al., 2023 [40]	Extracting data from community pharmacies in Kampala, Uganda, pre- and during COVID-19	• There was a significant increase in the purchasing of azithromycin (**W**) and erythromycin (**W**) for self-medication during the COVID-19 pandemic
3 countries – Kenya, Tanzania and Uganda	Green et al., 2023 [86]	Mixed methods approach including investigating the association between poverty and self-reported antibiotic self-medication and non-adherence in 6827 patients with UTIs	Rates of antibiotic self-medication (self-reported): • Tanzania-219/2970 (7.4%) • Kenya -115/1675 (6.9%) • Uganda – 72/1700 (4.2%)
Low-Middle Income Countries*			
Cameroon	Ngu et al., 2018 [275]	Structured questionnaire among 308 participants with diagnosed RTIs attending a Baptist Hospital	• The prevalence of purchasing antibiotics without a prescription was 41.9% • Patients with a history of pulmonary tuberculosis were less likely to self-medicate • Pharmacies were the most common source of antibiotics without a prescription - 62% • Cotrimoxazole - 38.8% (**A**), and amoxicillin - 26.4% (**A**) were the most common antibiotics purchased for RTIs
	Penda et al., 2018 [276]	Cross-sectional and prospective study involving using a closed-ended questionnaire among 295	• Self-medication was the initial most widely used option among 74.2% of children before being admitted to hospital in Cameroon

		children before admission to hospital	• The principal origin of these medicines, which included antibiotics, were the family pharmacy box (64%), bought in pharmacies (22%) and purchased in the street (14%)
	Amin et al., 2019 [154]	Cross-sectional survey using a structured questionnaire among 329 patients attending hospital outpatients	• 68.4% of patients had self-medicated with antimicrobials • Community pharmacists were the main source of antimicrobials (55.1%) • Penicillin (dominated by amoxicillin - **A**) was the most self-medicated antimicrobial (32.4%) - principally used to treat ARIs (74.4%) • Antimalarials (all arthemeter/lumefantrine) were also highly purchased- 31.1% of patients • Lowering costs was the principal reason for purchasing antibiotics without a prescription (40.9%)
	Elong Ekambi et al., 2019 [172]	Interviews among 1,192 customers in community pharmacies using a structured questionnaire	• 33.7% of interviewees had recently purchased antibiotics, and of these 47% had purchased without a prescription • The indication for an antibiotic being dispensed was 7 times more likely in those being dispensed an antibiotic versus those patients without a prescription
Congo	Shembo et al., 2022 [155]	Semi-structured in-depth interviews with 18 participants in households	• Self-purchasing of antibiotics was common, driven by financial pressures • This included being dispensed for a range of non-indicated conditions including menstruation
Ghana	Afari-Asiedu et al, 2018 [72]	32 in-depth interviews with Licensed Chemical Sellers (LCS) as well as focus group discussions with 40 community members	• Despite current legislation, LCS sell all types of antibiotics in addition to co-trimoxazole • Reasons include patient demand, economic incentives and poor implementation of current regulations
	Ahiabu et al., 2018 [156]	• Recall visits to 12 households • Detailed notes taken and answers analysed using thematic analysis	• 40% of medicine-use events involved antibiotics, often without a prescription • The number of antibiotic transactions without a prescription was significantly higher in rural medicine outlets (n = 139, 27.4%) vs. urban pharmacies (n = 140, 13.5%) • Penicillins were the most commonly dispensed antibiotic - constituting 30% of antibiotic sales in urban outlets and 46% in rural ones
	Mensah et al., 2019 [157]	Questionnaire among 361 participants who completed the questionnaire	• Antibiotics (32.1%) and analgesics (21.0%) were the most common medicines purchased without a prescription • Antibiotics were mostly obtained from licensed chemical sellers (32.5%) • One of the main reasons for self-medication was the influence from family and friends
	Do et al., 2021 [33]	Quantitative and qualitative assessments of antibiotic access and use among 3 African countries including Ghana	• Self-medication with antibiotics was widespread in Ghana - 36·1% of all antibiotics dispensed • This was helped by less time consuming and cheaper to purchase antibiotics without a prescription
	Kretchy et al., 2021 [159]	Community-based cross-sectional survey using a semi-structured questionnaire among 350 adults in a rural area	• Overall prevalence of purchasing of antibiotics without a prescription was 36% helped by ease of purchase • The predominant reasons for self-purchasing were GI problems (46%), fever (11%) and skin problems (9%) • Amoxicillin (**A**) was the predominant antibiotic purchased (53.4% of occasions) followed by ampicillin - (23.3% (**A**), and tetracycline – 21% (**A**)
	Owusu-Ofori et al, 2021 [277]	Cross-sectional survey using a self-administered questionnaire among 264 first year healthcare students (who completed the questionnaire)	• 56.2% of surveyed students had previously purchased antibiotics without a prescription • Amoxicillin (78% - **A**) was the most frequently purchased antibiotic

	Amponsah et al., 2022 [160]	Interviews among 337 students (163 pharmacy and 174 nonpharmacy) Students using a structured questionnaire	• Whilst self-medication was common among students, self-medication with antibiotics was lower • Self-medication with antibiotics –was 10.6% among non-pharmacy students and 6.1% among pharmacy students
Ghana	Nyarko et al., 2023 [161]	Interviewer-administered questionnaire among 200 staff members in medicine outlets	• Stronger preference among interviewees for not dispensing antibiotics and referring patients to a doctor if they have certain symptoms including a high fever, fatigue or sinusitis • Interviewees were also less likely to dispense antimicrobials without a prescription for children or the elderly with severe infections and refer them
Kenya	Mukokinya et al, 2018 [92]	• Cross-sectional survey conducted in 3 pharmacies allied to the University of Nairobi • Quality of dispensing assessed against WHO criteria	• Low level of dispensing of antibiotics without a prescription with 94.1% of antibiotics dispensed with a valid prescription • The most common antibiotics dispensed were the penicillins (over 50%) (**A**), the cephalosporins - 12.6%, and the fluoroquinolones - 11.7% (**W**)
	Muloi et al., 2019 [176]	Cross-sectional study among 40 personnel, principally pharmacy technicians, in drug stores	• 52% of surveyed pharmacists (21/40) had sold antibiotics without a prescription • Penicillins (**A**) – 93%, metronidazole (**A**) – 65%, fluoroquinolones (W) – 63%, and first and second-generation cephalosporins (43%) were the four most commonly sold antibiotic classes among community pharmacies
	Opanga et al., 2021 [91]	Cross-sectional survey among 6 community pharmacists linked to the University of Nairobi in the early staged of COVID-19 pandemic	• There was no self-purchasing of antimicrobials among patients with actual or suspected COVID-19 in the early stages of the pandemic • Pharmacists typically recommended alternative treatment approaches
	Kimathi et al., 2022 [207]	Cross-sectional survey using phone-based interviews among 280 COVID-19 confirmed cases	• 23.4% of respondents had self-medicated with antibiotics, 60.6% at the onset of symptoms before confirmatory tests, with 51.5% self-medicating more than once • Common antibiotics purchased were azithromycin - 40.0% (**W**) and amoxycillin - 23.3% (**A**)
	Sado et al. (Preprint 2023) [278]	Questionnaire among 6827adults with UTIs	In terms of treatment seeking behaviour, Kenyan patients with UTIs are more likely to visit pharmacies and drug sellers before visiting public health facilities compared to patients in Tanzania and Uganda
Nigeria	Badger-Emeka et al,, 2018 [177]	Cross-sectional study among 400 adults using a semi-structured self-administered questionnaire	• 86.5% of participants had frequently taken non-prescribed antibiotics within the last 2–3 months • Principal conditions were a cold and cough (42.7%), sore throat (13.8%) or fever (16%) • Penicillins - 58% (**A**), quinolones - 22% (**W**) and tetracycline - 20.75% (**A**) were the most frequently purchased antibiotics
	Ajibola et al., 2018 [178]	• Structured questionnaire administered among 1230 undergraduate students and community members • 84.8% response rate	• Self-medication with antibiotics is highly prevalent in Northwest Nigeria • Most antibiotics were purchased from unlicensed stores. These included patent medicine stores and local drug hawkers • Common self-diagnosed illnesses treated with antibiotics among undergraduates were malaria (14.5%), typhoid (13.1%), stomach pains (12.7%) and diarrhoea (11.9%). Among community members this was dysentery (19%), infection (17%) and typhoid (13%) • The most common antibiotics purchased among undergraduate students were metronidazole - 18% (**A**), co-

			amoxiclav - 16.8% (**A**), ampicillin/cloxacillin 14.8% (**A**) and cotrimoxazole - 12% (**A**) • Among community members, the most commonly purchased were ampicillin/cloxacillin - 23.5% (**A**), ciprofloxacin - 18.7% (**W**), ampicillin - 12.5% (A) and tetracycline - 11.4% (**A**)
	Khakid et al., 2019 [162]	• 217 pharmacy students participated in an online survey with a validated questionnaire • 100% completion rate of the questionnaire	• 92.2% had purchased antibiotics without a prescription once in their lifetime. The principal reasons for this were previous knowledge (40.4%) and convenience with no time to see a doctor or pharmacist (27.5%) • Amoxicillin - 32.6% (**A**), co-amoxiclav - 32.1% (**A**), ampicillin/cloxacillin - 21.7% (**A**) and ciprofloxacin - 22.6% (**W**) were the most commonly purchased antibiotics • Cough, diarrhoea, typhoid, and wounds were the most infectious diseases for antibiotics • Patent medicine vendors (75.4%) and community pharmacies (29.4%) were the common sources of purchased antibiotics
	Abubakar et al., 2020 [163]	• Cross-sectional study involving 98 community pharmacists using a validated self-administered questionnaire • Response rate – 75.3%	• 39.7% of community pharmacists indicated that they dispensed antibiotics without a prescription 5 or more times a day • The antibiotics dispensed were for UTIs (83.7%), typhoid fever (83.7%) and STIs (66.3%) • Pharmacist's confidence in their knowledge regarding antibiotics was the most common reason they dispensed antibiotics without a prescription
	Chukwu et al., 2020 [116]	Cross-sectional study using a validated questionnaire among 482 respondents from across Nigeria	• 66.8% of respondents had taken antibiotics in the last 6 months - out of which 31.3% were purchased without a prescription – mainly from pharmacy stores and chemists • The most commonly use antibiotics by respondents were ampicillin/cloxacillin - 54.4% (**A**), ampicillin - 41.7% (**A**), ciprofloxacin – 39.4% (**W**) and metronidazole – 35.9% (A)
	Akande-Sholabi et al., 2021 [117]	Cross-sectional study among 866 healthcare students including pharmacy students	• Prevalence of self-medication among students was 473 (54.6%) • Reasons for purchasing antibiotics included malaria (16.9 %), cough (16.3 %) or a sore throat (164; 15.9 %) • Overall, analgesics (353; 30.1%), antimalarials (352; 30.0%) and antibiotics (182; 15.5%) were the commonest classes of medicine purchased
	Akpan et al., 2021 [262]	• Simulated patients visiting 75 pharmacists • Information was recorded in a developed data collection form after each visit	• 68% of pharmacists recommended an antibiotic for a common cold – with azithromycin (**W**), co-amoxiclav (**A**) and cotrimoxazole (**A**) at 43%, 24% and 20% respectively the most frequently dispensed antibiotics • 72% of pharmacists dispensed one antibiotic for acute diarrhoea with 15% dispensed more than one antibiotic. The most frequently dispensed antimicrobial for this condition was metronidazole - 82% (**A**)
	Isabel et al., 2021 [279]	Descriptive cross-sectional study conducted in 8 community pharmacies in Benin City involving 450 clients or patients	• More than half (64.22%) of the respondents replied that they sometimes obtained antibiotics without a prescription for their infectious diseases • 45.6% purchase antibiotics directly from community pharmacists when similar symptoms present
Sudan	Abdelrahman Hussain et al., 2022 [87]	Cross-sectional descriptive study using a semi-structured questionnaire among 1217 community pharmacists	• 67%of pharmacists surveyed would dispense an antibiotic without a prescription for patients presenting with tonsilitis 62.9% for wound infections and 54% for UTIs, 44.2% for acute sore throats • Low economic status was the principal factor behind purchasing antibiotics directly

	Elmahi et al., 2022 [280]	Cross-sectional study among 1100 medical students using a validated questionnaire	• 60.8% of medical students had self-medicated with antibiotics in the previous year – mostly purchased from community pharmacies • Antibiotics were commonly used to treat RTIs (38.1%) and a cough (30.4%) • The most common antibiotics used without prescription were azithromycin (**W** - 29.9%), co-amoxiclav **(A** - 26.8%) and erythromycin (**A** - 12.9%).
	Hussain et al., 2023 [164]	Cross-sectional study design involving 1492 patients	• 71.3% utilize purchased antibiotics without a prescription principally from community pharmacies (92.1%) • Tonsillitis being the most common condition (55.5% of situations) followed by a cough (45%) • The most commonly dispensed antibiotics were co-amoxiclav (**A** – 32.5%), amoxicillin (**A** – 26.5%), metronidazole (**A** – 25.3%) and azithromycin – (**W** – 25.3%) • Key reasons included convenience and cost savings
Zambia	Kalungia et al., 2016 [71]	Structured questionnaire among 73 community pharmacies	• 97% stated that patients frequently requested non-prescribed antibiotics • 100% of pharmacists stated that they do dispense non-prescribed antibiotics including for RTIs and UTIs • Commonly dispensed antibiotics included amoxicillin - 52% (**A**), cotrimoxazole - 25% (**A**) and metronidazole - 23% (**A**)
	Mudenda et al., 2021 [119]	Structure questionnaire among 144 community pharmacists	• All community pharmacists dispensed antibiotics without a prescription • This is despite 69.4% of community pharmacists agreeing that AMR is a public health problem in Zambia
	Mudenda et al., 2022 [181]	Structured self-administered questionnaire among 172 pharmacy students	• 41% prevalence rate of purchasing of antibiotics without a prescription among pharmacy students • This was despite positive attitudes towards antibiotics and AMR
Upper-Middle Income Countries*			
Namibia	Kamati et al., 2019 [67]	• Mixed-method approach among 100 households using an open-ended questionnaire • At least one member in the household had suffered an ARI in the past 6 months	• 60% of those surveyed used self-medication for ARIs in children < 5, which includes cold/flu medication, paracetamol, and decongestants • There was no purchasing of antibiotics without a prescription
	Kibuule et al., 2021 [66]	Questionnaire survey among 55 public and private pharmacies (10 out of the 14 regions) at the start of the COVID-19 pandemic	• Encouragingly in Namibia there was typically no change in the utilisation of antibiotics and antimalarials in the initial months following the pandemic and no purchasing of antibiotics without a prescription • This was helped by the government regularly monitoring pharmacies and pharmacists' awareness of current regulations banning the purchasing of antibiotics without a prescription in Namibia
South Africa	Anstey Watkins et al., 2016 [69]	Cross-sectional study involving 60 participants regarding antibiotic access and use in a rural setting	No account of illegal purchasing of antibiotics without a prescription was seen in this study
	Do et al., 2021 [33]	Quantitative and qualitative assessments of antibiotic access and use across 3 African and 3 Asian countries including South Africa (rural – including exit	• Limited self-purchasing of antibiotics at only 1.2% of antibiotics dispensed in this rural population • This low rate enhanced by patients typically seeking treatment from public healthcare clinics where healthcare, including medicines, is provided free-of-charge

		interviews and interviews with 600 households)	
	Mokwele et al., 2022 [70]	Simulated patients among privately owned (n=20) and corporate (franchised, n=14) community pharmacies	• Oral antibiotics were sold without a prescription in 16 (16/34,47%) of the community pharmacies – however, only for UTIs with no antibiotics dispensed for URTIs in any visited pharmacies • Antibiotics were also only sold in private pharmacies (mostly found in townships) with no corporate (franchised) pharmacy dispensing an antibiotic without a prescription • For URTIs - pharmacy personnel typically recommended OTC medicines including paracetamol, codeine, acetylcysteine, and cetirizine as well as guaifenesin for colds and coughs

NB: PHCs = Primary Healthcare; URTIs = Upper Respiratory Tract Infections; UTIs = Urinary Tract Infections; STIs = Sexually transmitted infections; 'A' and 'W' refer to 'Access' and 'Watch' antibiotics under the AWaRe classification (see Methodology); *World Bank classification based on Adeyoka et al [131]

Table S3 – Estimations of the extent of purchasing of antibiotics without a prescription among African countries where currently there appears a lack of published data

Country	Findings
Benin [243]	• In Benin, the informal selling of medicines, including antibiotics, is banned • However, smuggling of medicines across the borders continues and because selling of medicines is often unregulated, informal drug selling offers a livelihood especially where there a few other employment options • However, this needs to be urgently addressed given concerns with rising resistance rates in Benin [244]
Botswana [65,245,281-284]	Whilst the purchasing of antibiotics without prescription may occur in Botswana, it is believed that currently there is little or no purchasing of antibiotics without a prescription as: • All antibiotics are classified as Schedule 2 Medicines requiring a prescription for an antibiotic to be dispensed and the pharmacy must be under the control of a registered pharmacist, with pharmacies regularly monitored to prevent abuse of the regulations given concerns with resistance rates in the country. • Over 85% of the population in Botswana currently receive free healthcare provided by the Government. At all levels of the public healthcare system, medicines can only be dispensed upon a prescription, and this is free-of-charge • The remaining population have subscriptions to various private Medical Aid/Insurances and receive healthcare from private healthcare facilities. Previously private GPs have dispensed high volumes of antibiotics inappropriately for acute respiratory tract infections. However, the practice model is evolving from private GP practices towards the establishment medical centres with an attached laboratory, pharmacy, sonography/radiography and physiotherapy, which allows for patients to be referred/seen by a doctor before an antibiotic is prescribed and dispensed
Burkina Faso – Sariola et al., 2022 [243] and Valia et al., 2022 [285]	• In their study, Sariola et al. ascertained that sources of antibiotics among households to treat infections included PHCs (34%), informal sellers (27%), private sellers including pharmacies (29%) and hospital drug stores (12%). However, there were no details regarding the extent of purchasing of antibiotics without a prescription • In their study, Valia et al. also ascertained that antibiotics are available over-the-counter in markets as well as in drug stores in Burkina Faso, where these can be purchased without a prescription. However, again no details of the extent
Eswatini - Adefolarin A Amu personal communication	Evidence of the purchasing of antibiotics without a prescription is driven by: • Long queues to see healthcare professionals at public healthcare facilities, medicine shortages in the facilities, and patient pressure • Commercial pressures in pharmacies coupled with limited monitoring and inspections of pharmacies • Insufficient knowledge generally regarding antibiotics and AMR among key stakeholder groups
Zimbabwe – Hongoro et al., 2020 [109]; Kumaranayake et al., 2000	• In their mixed-method study involving a 'drug bag' survey tool and interviews among 436 households between April 2018 and December 2020, Dixon et al. documented that patients were increasingly purchasing their antibiotics from the informal market place due to increasingly steep user fees alongside waiting for hours at public clinics to see a healthcare professional only to receive 'piece of paper' telling them which antibiotic to obtain. Alongside this,

[110];; Nyazema et al. (2007) [111]; Belachew et al., 2021 [37]; Dixon et al., 2021 [85]	the increasingly high costs of medicines even in retail pharmacies • Consequently, patients in Zimbabwe are increasingly bypassing clinics and pharmacies, and typically using their experiences and other sources of information to drive their choice of treatment obtained from informal sellers including antibiotics • This contrasts with comments from Belachew et al. (2021) in their systematic review, who documented there had been low sales of antibiotics without a prescription in Zimbabwe in the early 2000, with similar findings from Nyazema et al. in their paper published in 2007. This followed the strict enforcement of laws in the country at that time prohibiting the sales of antibiotics without a prescription coupled with the revoking of licences for abuse, with limited sales despite patient pressure • The differences in the findings may reflect appreciable changes in economic circumstances over the years among the population in Zimbabwe

Table S4 - Points to always consider when prescribing or dispensing antibiotics and their development into possible indicators (adapted from [13])

Activity	Consideration
Diagnosis	• What is the clinical diagnosis? • Is the condition self-limiting?
Decision	• Are antibiotics really needed on the balance of risks? • Are point-of-care facilities available to rapidly assist with diagnosis; what about treatment algorithms?
Drug (medicine)	• Which antibiotic to prescribe, e.g., based on the WHO AWaRe Book? • Is it an Access, Watch or Reserve antibiotic? • Are there any allergies, interactions or other contraindications?
Dose	• What dose should be prescribed and how many times a day? • Are any dose adjustments needed, e.g., due to renal impairment?
Delivery	• What formulation should be prescribed? • Is the quality of the antibiotic being prescribed assured? • If intravenous treatment is needed initially, when is step down to an oral formulation possible?
Duration	• For how long to prescribe?
Discuss	• Are the patientsroutinely informed regarding their diagnosis, likely duration of symptoms as well as any likely adverse reactions? • Are alternative OTC and other medicines routinely discussed for self-limiting/ viral infections?
Document	Are antibiotics dispensed routinely recorded in electronic systems alongside any prescription?

Prescribing/ Quality Indicators including those for ambulatory care

Any prescribing/ quality indicator that is instigated within healthcare systems must be within the context of strategies to develop and sustain high-quality, patient safety and patient centred focused health care. This involves “the right care, at the right time, responding to the service users’ needs and preferences, while minimizing harm and resource waste” [286]. Such a focus requires parallel systemic strategies and interventions at the macro-meso-micro level for embedding and strengthening the building blocks to optimise the quality of care including for key priority areas such as reducing AMR [286].

Given the limited indicators that have been used in practice to assess the extent and appropriateness of dispensing antibiotics without a prescription in Africa and beyond, any indicator proposed must adhere to the attributes of good indicators. Key attributes include having clarity, being feasible, and having easy-to-use reliable and consistent (preferably computerized) tools for valid data collection and management, which can be an issue [187-189,287]. This is because the utilisation of indicators in practice requires data that are consistently and easily available, which can be a challenge for a number of low- and middle-income countries including African countries.

Conflicts of interest and funding

There was no fu0nding for this paper. However, Aislinn Cook and Catrin Moore are funded by the Welcome Trust (222051/Z/20/Z) for the ADILA project.

E Yeika, SA. Opanga, ZU Mustafa, V Marković-Peković, A Kurdi, BD Anand Paramadhas, E Wesangula, E Hango, N Schellack, S Mudenda, I Hoxha and JC Meyer have either worked for national or regional government agenices or are advisers to them on key issues surrounding AMR including the development and monitoring of NAPs. In addition, S Opanga received a grant from Kenya AIDS Vaccine Institute -Institute of Clinical Research and Institut Merieux for tackling AMR in Kenya and GM Rwegerera also works for Destiny Medical and Research Solutions Proprietary Limited, Gaborone, Botswana. The authors have no other relevant affiliations or financial involvement with any organization or entity with a financial interest in or financial conflict with the subject matter or materials discussed in the manuscript apart from those disclosed.

REFERENCES

1. Cassini A, Högberg LD, Plachouras D et al. Attributable deaths and disability-adjusted life-years caused by infections with antibiotic-resistant bacteria in the EU and the European Economic Area in 2015: a population-level modelling analysis. Lancet Infect Dis. 2019;19(1):56-66.
2. Global burden of bacterial antimicrobial resistance in 2019: a systematic analysis. Lancet. 2022;399(10325):629-55.
** Of considerable interest as comprehensively documents current mortality rates from AMR
3. Dadgostar P. Antimicrobial Resistance: Implications and Costs. Infect Drug Resist. 2019;12:3903-10.
4. World Bank Group. Pulling Together to Beat Superbugs Knowledge and Implementation Gaps in Addressing Antimicrobial Resistance. 2019. : Available at URL: https://openknowledge.worldbank.org/bitstream/handle/10986/32552/Pulling-Together-to-Beat-Superbugs-Knowledge-and-Implementation-Gaps-in-Addressing-Antimicrobial-Resistance.pdf?sequence=1&isAllowed=y (Accessed 5 April 2023)
5. Aiken AM, Rehman AM, de Kraker MEA et al. Mortality associated with third-generation cephalosporin resistance in Enterobacterales bloodstream infections at eight sub-Saharan African hospitals (MBIRA): a prospective cohort study. Lancet Infect Dis. 2023.
6. O'Neill J. TACKLING DRUG-RESISTANT INFECTIONS GLOBALLY: FINAL REPORT AND RECOMMENDATIONS - THE REVIEW ON ANTIMICROBIAL RESISTANCE. 2016 Available at URL: https://amr-review.org/sites/default/files/160525_Final%20paper_with%20cover.pdf (Accessed 20 March 2023)
7. Poudel AN, Zhu S, Cooper N et al. The economic burden of antibiotic resistance: A systematic review and meta-analysis. PLoS One. 2023;18(5):e0285170.
8. The World Bank. Final Report - DRUG-RESISTANT INFECTIONS. A Threat to Our Economic Future March 2017. Available at URL: http://documents1.worldbank.org/curated/en/323311493396993758/pdf/final-report.pdf (Accessed 20 March 2023)
9. Gautam A. Antimicrobial Resistance: The Next Probable Pandemic. JNMA. 2022;60(246):225-8.
10. OECD Health Policy Studies. Stemming the Superbug Tide. 2018. Available at URL: https://www.oecd-ilibrary.org/sites/9789264307599-en/index.html?itemId=/content/publication/9789264307599-en&mimeType=text/html (Accessed 21 March 2023)
11. WHO implementation handbook for national action plans on antimicrobial resistance: guidance for the human health sector. 2022 Available at URL: https://www.who.int/publications/i/item/9789240041981 (Accessed 20 March 2023)
12. Willemsen A, Reid S, Assefa Y. A review of national action plans on antimicrobial resistance: strengths and weaknesses. Antimicrob Resist Infect Control. 2022;11(1):90.
13. WHO. The WHO AWaRe (Access, Watch, Reserve) antibiotic book. 2022 Available at URL: https://www.who.int/publications/i/item/9789240062382 (Accessed 19 March 2023)
14. Duffy E, Ritchie S, Metcalfe S et al. Antibacterials dispensed in the community comprise 85%-95% of total human antibacterial consumption. J Clin Pharm Ther. 2018;43(1):59-64.
15. Nkengasong JN, Tessema SK. Africa Needs a New Public Health Order to Tackle Infectious Disease Threats. Cell. 2020;183(2):296-300.

16. Bell D, Schultz Hansen K. Relative Burdens of the COVID-19, Malaria, Tuberculosis, and HIV/AIDS Epidemics in Sub-Saharan Africa. Am J Trop Med Hyg. 2021;105(6):1510-5.
17. Dwyer-Lindgren L, Cork MA, Sligar A et al. Mapping HIV prevalence in sub-Saharan Africa between 2000 and 2017. Nature. 2019;570(7760):189-93.
18. Williams PCM, Isaacs D, Berkley JA. Antimicrobial resistance among children in sub-Saharan Africa. Lancet Infect Dis. 2018;18(2):e33-e44.
19. Godman B, Egwuenu A, Wesangula E et al. Tackling antimicrobial resistance across sub-Saharan Africa: current challenges and implications for the future. Expert Opinion on Drug Safety. 2022;21(8):1089-111
* Documents current state of NAPs across Africa alongside current challenges/ barriers in 2022
20. Venne DM, Hartley DM, Malchione MD et al. Review and analysis of the overlapping threats of carbapenem and polymyxin resistant E. coli and Klebsiella in Africa. Antimicrob Resist Infect Control. 2023;12(1):29.
21. Charani E, Mendelson M, Pallett SJC et al. An analysis of existing national action plans for antimicrobial resistance-gaps and opportunities in strategies optimising antibiotic use in human populations. Lancet Glob Health. 2023;11(3):e466-e474
22. Harant A. Assessing transparency and accountability of national action plans on antimicrobial resistance in 15 African countries. Antimicrob Resist Infect Control. 2022;11(1):15.
23. WHO. Global action plan on antimicrobial resistance - Report by the Secretariat. 2016. Available at URL: https://apps.who.int/gb/ebwha/pdf_files/WHA69/A69_24-en.pdf (Accessed 20 March 2023)
24. WHO. MONITORING AND EVALUATION OF THE GLOBAL ACTION PLAN ON ANTIMICROBIAL RESISTANCE - Framework and recommended indicators. 2019. Available at URL: https://apps.who.int/iris/bitstream/handle/10665/325006/9789241515665-eng.pdf?sequence=1&isAllowed=y (Accessed 21 March 2023)
25. Elton L, Thomason MJ, Tembo J et al. Antimicrobial resistance preparedness in sub-Saharan African countries. Antimicrob Resist Infect Control. 2020;9(1):145.
26. Pallett SJ, Charani E, Hawkins L et al. National action plans for antimicrobial resistance and variations in surveillance data platforms. Bull World Health Organ. 2023;101(8):501-12f.
27. Hein W, Aglanu LM, Mensah-Sekyere M et al. Fighting Antimicrobial Resistance: Development and Implementation of the Ghanaian National Action Plan (2017-2021). Antibiotics. 2022;11(5):613.
28. Kariuki S, Kering K, Wairimu C et al. Antimicrobial Resistance Rates and Surveillance in Sub-Saharan Africa: Where Are We Now? Infect Drug Resist. 2022;15:3589-609.
29. Torres NF, Chibi B, Kuupiel D et al. The use of non-prescribed antibiotics; prevalence estimates in low-and-middle-income countries. A systematic review and meta-analysis. Arch Public Health. 2021;79(1):2.
30. Alhomoud F, Aljamea Z, Almahasnah R 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. Int J Infect Dis. 2017;57:3-12.
31. Godman B, Haque M, McKimm J et al. Ongoing strategies to improve the management of upper respiratory tract infections and reduce inappropriate antibiotic use particularly among lower and middle-income countries: findings and implications for the future. Curr Med Res Opin. 2020;36(2):301-27.
32. Cambaco O, Alonso Menendez Y, Kinsman J et al. Community knowledge and practices regarding antibiotic use in rural Mozambique: where is the starting point for prevention of antibiotic resistance? BMC Public Health. 2020;20(1):1183.
33. Do NTT, Vu HTL, Nguyen CTK et al. Community-based antibiotic access and use in six low-income and middle-income countries: a mixed-method approach. Lancet Glob Health. 2021;9(5):e610-e9.
34. Auta A, Hadi MA, Oga E et al. Global access to antibiotics without prescription in community pharmacies: A systematic review and meta-analysis. J Infect. 2019;78(1):8-18.
35. Nepal G, Bhatta S. Self-medication with Antibiotics in WHO Southeast Asian Region: A Systematic Review. Cureus. 2018;10(4):e2428.
36. Yeika EV, Ingelbeen B, Kemah BL e tal. Comparative assessment of the prevalence, practices and factors associated with self-medication with antibiotics in Africa. Trop Med Int Health. 2021;26(8):862-81.
*Comprehsive review of current rates of the purchasing of antibiotics without a prescription in Africa

37. Belachew SA, Hall L, Selvey LA. Non-prescription dispensing of antibiotic agents among community drug retail outlets in Sub-Saharan African countries: a systematic review and meta-analysis. Antimicrob Resist Infect Control. 2021;10(1):13.
38. Li J, Zhou P, Wang J, Li H et al. Worldwide dispensing of non-prescription antibiotics in community pharmacies and associated factors: a mixed-methods systematic review. Lancet Infect Dis. 2023.
** Good overview of the current rates of purchasing of antibiotics without a prescription including across Africa
39. Sakeena MHF, Bennett AA, McLachlan AJ. Non-prescription sales of antimicrobial agents at community pharmacies in developing countries: a systematic review. Int J Antimicrob Agents. 2018;52(6):771-82.
40. Kiragga AN, Najjemba L, Galiwango R et al. Community purchases of antimicrobials during the COVID-19 pandemic in Uganda: An increased risk for antimicrobial resistance. PLOS Glob Public Health. 2023;3(2):e0001579.
41. Sachdev C, Anjankar A, Agrawal J. Self-Medication With Antibiotics: An Element Increasing Resistance. Cureus. 2022;14(10):e30844.
42. Sefah IA, Ogunleye OO, Essah DO et al. Rapid Assessment of the Potential Paucity and Price Increases for Suggested Medicines and Protection Equipment for COVID-19 Across Developing Countries With a Particular Focus on Africa and the Implications. Front Pharmacol. 2020;11:588106.
43. Langford BJ, So M, Raybardhan S et al. Antibiotic prescribing in patients with COVID-19: rapid review and meta-analysis. Clin Microbiol Infect. 2021;27(4):520-31.
44. Alshaikh FS, Godman B, Sindi ON et al. Prevalence of bacterial coinfection and patterns of antibiotics prescribing in patients with COVID-19: A systematic review and meta-analysis. PLoS One. 2022;17(8):e0272375.
45. Satria YAA, Utami MS, Prasudi A. Prevalence of antibiotics prescription amongst patients with and without COVID-19 in low- and middle-income countries: a systematic review and meta-analysis. Pathog Glob Health. 2022:1-13.
46. Bednarčuk N, Golić Jelić A, Stoisavljević Šatara S et al. Antibiotic Utilization during COVID-19: Are We Over-Prescribing? Antibiotics. 2023;12(2).
47. Sulis G, Batomen B, Kotwani A et al. Sales of antibiotics and hydroxychloroquine in India during the COVID-19 epidemic: An interrupted time series analysis. PLoS Med. 2021;18(7):e1003682.
48. Nino-Orrego MJ, Baracaldo-Santamaría D, Patricia Ortiz C et al. Prescription for COVID-19 by non-medical professionals during the pandemic in Colombia: a cross-sectional study. Ther Adv Drug Saf. 2022;13:20420986221101964.
49. Jacobs TG, Robertson J, van den Ham HA et al. Assessing the impact of law enforcement to reduce over-the-counter (OTC) sales of antibiotics in low- and middle-income countries; a systematic literature review. BMC Health Serv Res. 2019;19(1):536
*Good overview of the impact of law enforcement across countries including where objectives were not achieved
50. Ocan M, Obuku EA, Bwanga F et al. Household antimicrobial self-medication: a systematic review and meta-analysis of the burden, risk factors and outcomes in developing countries. BMC Public Health. 2015;15:742.
51. Batista AD, Rodrigues DA, Figueiras A et al. Antibiotic Dispensation without a Prescription Worldwide: A Systematic Review. Antibiotics. 2020;9(11).
52. Oga-Omenka C, Okafor U, Sulis G. Engaging pharmacists and medicine vendors in antimicrobial stewardship in LMICs. Lancet Infect Dis. 2023;23(7):786-7.
53. Edessa D, Assefa N, Dessie Y, Asefa F et al. Non-prescribed antibiotic use for children at community levels in low- and middle-income countries: a systematic review and meta-analysis. J Pharm Policy Pract. 2022;15(1):57.
54. Sulis G, Gandra S. Access to antibiotics: not a problem in some LMICs. Lancet Glob Health. 2021;9(5):e561-e2.
55. Wirtz VJ, Herrera-Patino JJ, Santa-Ana-Tellez Y et al. Analysing policy interventions to prohibit over-the-counter antibiotic sales in four Latin American countries. Trop Med Int Health. 2013;18(6):665-73.
56. Santa-Ana-Tellez Y, Mantel-Teeuwisse AK, Dreser A et al. Impact of over-the-counter restrictions on antibiotic consumption in Brazil and Mexico. PLoS One. 2013;8(10):e75550.
57. Godman B, Egwuenu A, Haque M et al. Strategies to Improve Antimicrobial Utilization with a Special Focus on Developing Countries. Life. 2021;11(6).
58. Nguyen TTP, Do TX, Nguyen HA et al. A National Survey of Dispensing Practice and Customer Knowledge on Antibiotic Use in Vietnam and the Implications. Antibiotics. 2022;11(8):1091.

59. Kuang L, Liu Y, Wei W et al. Non-prescription sale of antibiotics and service quality in community pharmacies in Guangzhou, China: A simulated client method. PLoS One. 2020;15(12):e0243555.
60. Saleem Z, Hassali MA, Godman B et al. Sale of WHO AWaRe groups antibiotics without a prescription in Pakistan: a simulated client study. J Pharm Policy Pract. 2020;13:26.
61. Bavestrello L, Cabello A, Casanova D. [Impact of regulatory measures in the trends of community consumption of antibiotics in Chile]. Rev Med Chil. 2002;130(11):1265-72.
62. Hoxha I, Malaj A, Tako R, Malaj L. Survey on how antibiotics are dispensed in community pharmacies in Albania. Int J Pharm Pharm Sci. 2015;7:449-50.
63. Marković-Peković V, Grubiša N, Burger J et al. Initiatives to Reduce Nonprescription Sales and Dispensing of Antibiotics: Findings and Implications. J Res Pharm Pract. 2017;6(2):120-5.
64. NBFIRA. 2022 Annual Report Available at URL: https://www.nbfira.org.bw/nbfira-2022-annual-report (Accessed 22 March 2023)
65. Statistics Botswana. 2022 Population Census Available at URL: https://statsbots.org.bw/census-2022 (Accessed 23 March 2023)
66. Kibuule D NL, Sefah IA, Kurdi A et al. Activities in Namibia to limit the prevalence and mortality from COVID-19 including community pharmacy activities and the implications. Sch Acad J Pharm. 2021;5:82-92.
67. Kamati M, Godman B, Kibuule D. Prevalence of Self-Medication for Acute Respiratory Infections in Young Children in Namibia: Findings and Implications. J Res Pharm Pract. 2019;8(4):220-4.
68. Republic of Namibia. Medicines and Related Substances Control Act, 2003 - Act 13 of 2003 Available at URL: https://namiblii.org/akn/na/act/2003/13/eng%402008-08-01 (Accessed 20 March 2023)
69. Anstey Watkins J, Wagner F, Xavier Gómez-Olivé F et al. Rural South African Community Perceptions of Antibiotic Access and Use: Qualitative Evidence from a Health and Demographic Surveillance System Site. Am J Trop Med Hyg. 2019;100(6):1378-90.
70. Mokwele RN, Schellack N, Bronkhorst E 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 Resistance. 2022;4(1).
71. Kalungia AC, Burger J, Godman B et al. Non-prescription sale and dispensing of antibiotics in community pharmacies in Zambia. Expert Rev Anti Infect Ther. 2016;14(12):1215-23.
72. Afari-Asiedu S, Kinsman J, Boamah-Kaali E et al. To sell or not to sell; the differences between regulatory and community demands regarding access to antibiotics in rural Ghana. J Pharm Policy Pract. 2018;11:30.
73. Torres NF, Chibi B, Middleton LE et al. Evidence of factors influencing self-medication with antibiotics in low and middle-income countries: a systematic scoping review. Public Health. 2019;168:92-101.
74. Belachew SA, Hall L, Erku DA, Selvey LA. No prescription? No problem: drivers of non-prescribed sale of antibiotics among community drug retail outlets in low and middle income countries: a systematic review of qualitative studies. BMC Public Health. 2021;21(1):1056
**Good overview of drivers of sales of antibiotics without a prescription across LMICs
75. Chowdhury M, Stewart Williams J, Wertheim H et al. Rural community perceptions of antibiotic access and understanding of antimicrobial resistance: qualitative evidence from the Health and Demographic Surveillance System site in Matlab, Bangladesh. Glob Health Action. 2019;12(sup1):1824383.
76. Davis A, Lembo T, Laurie E et al. How public health crises expose systemic, day-to-day health inequalities in low- and-middle income countries: an example from East Africa. Antimicrob Resist Infect Control. 2022;11(1):34.
77. Afari-Asiedu S, Oppong FB, Tostmann A et al. Determinants of Inappropriate Antibiotics Use in Rural Central Ghana Using a Mixed Methods Approach. Front Public Health. 2020;8:90.
78. Bert F, Previti C, Calabrese F et al. Antibiotics Self Medication among Children: A Systematic Review. Antibiotics. 2022;11(11).
79. Sefah IA, Akwaboah E, Sarkodie E et al. Evaluation of Healthcare Students; Knowledge on Antibiotic Use, Antimicrobial Resistance and Antimicrobial Stewardship Programs and Associated Factors in a Tertiary University in Ghana: Findings and Implications. Antibiotics. 2022;11(12):1679.
80. Lubwama M, Onyuka J, Ayazika KT et al. Knowledge, attitudes, and perceptions about antibiotic use and antimicrobial resistance among final year undergraduate medical and pharmacy students at three universities in East Africa. PLoS One. 2021;16(5):e0251301.

81. Servia-Dopazo M, Figueiras A. Determinants of antibiotic dispensing without prescription: a systematic review. J Antimicrob Chemother. 2018;73(12):3244-53.
82. Basu S, Copana R, Morales R, Jr. et al. Keeping It Real: Antibiotic Use Problems and Stewardship Solutions in Low- and Middle-income Countries. Pediatr Infect Dis J. 2022;41(3s):S18-s25.
83. Belachew SA, Hall L, Selvey LA. Community drug retail outlet staff's knowledge, attitudes and practices towards non-prescription antibiotics use and antibiotic resistance in the Amhara region, Ethiopia with a focus on non-urban towns. Antimicrob Resist Infect Control. 2022;11(1):64.
84. 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. 2020;14:1445-53.
85. Dixon J, MacPherson EE, Nayiga S et al. Antibiotic stories: a mixed-methods, multi-country analysis of household antibiotic use in Malawi, Uganda and Zimbabwe. BMJ Glob Health. 2021;6(11).
86. Green DL, Keenan K, Fredricks KJ et al. The role of multidimensional poverty in antibiotic misuse: a mixed-methods study of self-medication and non-adherence in Kenya, Tanzania, and Uganda. Lancet Glob Health. 2023;11(1):e59-e68.
87. Abdelrahman Hussain M, Osman Mohamed A, Sandel Abkar A et al. Knowledge, Attitude and Practice of Community Pharmacists in Relation to Dispensing Antibiotics Without Prescription in Sudan: A Cross-sectional Study. Integr Pharm Res Pract. 2022;11:107-16.
88. Belachew SA, Hall L, Selvey LA. "Handing out non-prescribed antibiotics is storing up trouble for the next generation!" Unpacking multistakeholder views of drivers and potential solutions in Ethiopia. BMC Health Serv Res. 2023;23(1):830.
89. Afari-Asiedu S, Abdulai MA, Tostmann A et al. Interventions to improve dispensing of antibiotics at the community level in low and middle income countries: a systematic review. J Glob Antimicrob Resist. 2022;29:259-74.
90. Lubogo P, Lukyamuzi JE, Kyambadde D et al. Cost-effectiveness analysis of integrated community case management delivery models utilizing drug sellers and community health workers for treatment of under-five febrile cases of malaria, pneumonia, diarrhoea in rural Uganda. Malar J. 2021;20(1):407.
91. Opanga S, Rizvi N, Wamaitha A et al. Availability of Medicines in Community Pharmacy to Manage Patients with COVID-19 in Kenya; Pilot Study and Implications. Sch Acad J Pharm. 2021;3:36-42.
92. Mukokinya MMA, Opanga S, Oluka M, Godman B. Dispensing of Antimicrobials in Kenya: A Cross-sectional Pilot Study and Its Implications. J Res Pharm Pract. 2018;7(2):77-82.
93. Langford BJ, So M, Raybardhan S et al. Bacterial co-infection and secondary infection in patients with COVID-19: a living rapid review and meta-analysis. Clin Microbiol Infect. 2020;26(12):1622-9.
94. Mustafa ZU, Saleem MS, Ikram MN et al. Co-infections and antimicrobial use among hospitalized COVID-19 patients in Punjab, Pakistan: findings from a multicenter, point prevalence survey. Pathogens and Global Health. 2022;116(7):421-7.
95. Hsu J. How covid-19 is accelerating the threat of antimicrobial resistance. Bmj. 2020;369:m1983.
96. Iwu CJ, Jordan P, Jaja IF et al. Treatment of COVID-19: implications for antimicrobial resistance in Africa. Pan Afr Med J. 2020;35(Suppl 2):119.
97. Suleiman S, Islam M, Akter M et al. A meta-meta-analysis of co-infection, secondary infections, and antimicrobial resistance in COVID-19 patients. Journal of Infection and Public Health. 2023.
98. Rather IA, Kim BC, Bajpai VK, Park YH. Self-medication and antibiotic resistance: Crisis, current challenges, and prevention. Saudi J Biol Sci. 2017;24(4):808-12.
99. Pokharel S, Raut S, Adhikari B. Tackling antimicrobial resistance in low-income and middle-income countries. BMJ Glob Health. 2019;4(6):e002104.
100. Sulis G, Sayood S, Katukoori S et al. Exposure to World Health Organization's AWaRe antibiotics and isolation of multidrug resistant bacteria: a systematic review and meta-analysis. Clin Microbiol Infect. 2022;28(9):1193-202.
101. Klein EY, Milkowska-Shibata M, Tseng KK et al. Assessment of WHO antibiotic consumption and access targets in 76 countries, 2000-15: an analysis of pharmaceutical sales data. Lancet Infect Dis. 2021;21(1):107-15.
102. Doan T, Worden L, Hinterwirth A et al. Macrolide and Nonmacrolide Resistance with Mass Azithromycin Distribution. N Engl J Med. 2020;383(20):1941-50.

103. Sharland M, Gandra S, Huttner B et al. Encouraging AWaRe-ness and discouraging inappropriate antibiotic use-the new 2019 Essential Medicines List becomes a global antibiotic stewardship tool. Lancet Infect Dis. 2019;19(12):1278-80.
104. Zanichelli V, Sharland M, Cappello B et al. The WHO AWaRe (Access, Watch, Reserve) antibiotic book and prevention of antimicrobial resistance. Bull World Health Organ. 2023;101(4):290-6.
** Endorsement of the WHO AWaRe Book
105. Sharland M, Zanichelli V, Ombajo LA et al. The WHO essential medicines list AWaRe book: from a list to a quality improvement system. Clin Microbiol Infect. 2022;28(12):1533-5.
106. Rehman IU, Asad MM, Bukhsh A et al. Knowledge and Practice of Pharmacists toward Antimicrobial Stewardship in Pakistan. Pharmacy. 2018;6(4).
107. Khuluza F, Heide L. Availability and affordability of antimalarial and antibiotic medicines in Malawi. PLoS One. 2017;12(4):e0175399.
108. Vacca CP, Nino CY, Reveiz L. [Restriction of antibiotic sales in pharmacies in Bogota, Colombia: a descriptive study]. Revista panamericana de salud publica = Pan American journal of public health. 2011;30(6):586-91.
109. Hongoro C, Kumaranayake L. Do they work? Regulating for-profit providers in Zimbabwe. Health Policy Plan. 2000;15(4):368-77.
110. Kumaranayake L, Mujinja P, Hongoro C, Mpembeni R. How do countries regulate the health sector? Evidence from Tanzania and Zimbabwe. Health Policy Plan. 2000;15(4):357-67.
111. Nyazema N, Viberg N, Khoza S et al. Low sale of antibiotics without prescription: a cross-sectional study in Zimbabwean private pharmacies. J Antimicrob Chemother. 2007;59(4):718-26.
112. Meyer JC, Schellack N, Stokes J et al. Ongoing Initiatives to Improve the Quality and Efficiency of Medicine Use within the Public Healthcare System in South Africa; A Preliminary Study. Front Pharmacol. 2017;8:751.
113. WHO. Global action plan on antimicrobial resistance. 2016 Available at URL: https://www.who.int/publications/i/item/9789241509763 (Accessed 20 March 2023)
114. Nisabwe L, Brice H, Umuhire MC et al. Knowledge and attitudes towards antibiotic use and resistance among undergraduate healthcare students at University of Rwanda. J Pharm Policy Pract. 2020;13:7.
115. Mate I, Come CE, Gonçalves MP et al. Knowledge, attitudes and practices regarding antibiotic use in Maputo City, Mozambique. PLoS One. 2019;14(8):e0221452.
116. Chukwu EE, Oladele DA, Awoderu OB et al. A national survey of public awareness of antimicrobial resistance in Nigeria. Antimicrob Resist Infect Control. 2020;9(1):72.
117. Akande-Sholabi W, Ajamu AT, Adisa R. Prevalence, knowledge and perception of self-medication practice among undergraduate healthcare students. J Pharm Policy Pract. 2021;14(1):49.
118. Russom M, Bahta M, Debesai M et al. Knowledge, attitude and practice of antibiotics and their determinants in Eritrea: an urban population-based survey. BMJ Open. 2021;11(9):e046432.
119. Mudenda S, Hankombo M, Saleem Z et al. Knowledge, Attitude, and Practices of Community Pharmacists on Antibiotic Resistance and Antimicrobial Stewardship in Lusaka, Zambia. J Biomed Res Environ Sci. 2021; 2(10):1005-14.
120. Godman B, Grobler C, Van-De-Lisle M et al. Pharmacotherapeutic interventions for bipolar disorder type II: addressing multiple symptoms and approaches with a particular emphasis on strategies in lower and middle-income countries. Expert Opin Pharmacother. 2019;20(18):2237-55.
121. Ogunleye OO, Basu D, Mueller D et al. Response to the Novel Corona Virus (COVID-19) Pandemic Across Africa: Successes, Challenges, and Implications for the Future. Front Pharmacol. 2020;11:1205.
122. Haque M, Abubakar AR, Ogunleye OO et al. Changes in Availability, Utilization, and Prices of Medicines and Protection Equipment for COVID-19 in an Urban Population of Northern Nigeria. J Res Pharm Pract. 2021;10(1):17-22.
123. Godman B, Basu D, Pillay Y et al. Review of Ongoing Activities and Challenges to Improve the Care of Patients With Type 2 Diabetes Across Africa and the Implications for the Future. Front Pharmacol. 2020;11:108.
124. Godman B, Basu D, Pillay Y et al. Ongoing and planned activities to improve the management of patients with Type 1 diabetes across Africa; implications for the future. Hosp Pract. 2020;48(2):51-67.
125. Etando A, Amu AA, Haque M et al. Challenges and Innovations Brought about by the COVID-19 Pandemic Regarding Medical and Pharmacy Education Especially in Africa and Implications for the Future. Healthcare. 2021;9(12).

126. Mwita JC, Ogunleye OO, Olalekan A et al. Key Issues Surrounding Appropriate Antibiotic Use for Prevention of Surgical Site Infections in Low- and Middle-Income Countries: A Narrative Review and the Implications. Int J Gen Med. 2021;14:515-30.
127. Godman B, Fadare J, Kwon HY et al. Evidence-based public policy making for medicines across countries: findings and implications for the future. J Comp Eff Res. 2021;10(12):1019-52
128. Gad M, Salem A, Oortwijn W et al. Mapping of Current Obstacles for Rationalizing Use of Medicines (CORUM) in Europe: Current Situation and Potential Solutions. Front Pharmacol. 2020;11:144.
129. Ogunleye OO, Godman B, Fadare JO et al. Coronavirus Disease 2019 (COVID-19) Pandemic across Africa: Current Status of Vaccinations and Implications for the Future. Vaccines. 2022;10(9):1553.
130. Saleem Z, Godman B, Cook A et al. Ongoing Efforts to Improve Antimicrobial Utilization in Hospitals among African Countries and Implications for the Future. Antibiotics. 2022;11(12):1824. *Comprehensive study documenting current rates of antimicrobial prescribing across hospitals in Africa, quality indicators and ASPs
131. Adekoya I, Maraj D, Steiner L et al. Comparison of antibiotics included in national essential medicines lists of 138 countries using the WHO Access, Watch, Reserve (AWaRe) classification: a cross-sectional study. Lancet Infect Dis. 2021;21(10):1429-40.
132. Imran L, Rehan ST, Lee KY. How Universal Health Coverage can curb the escalating antimicrobial resistance in Pakistan: a call to action for the country's healthcare system. Trop Med Health. 2022;50(1):86.
133. Muzzamil M, Mehedi Hasan M, Nisa M, Raza S. Delivering quality health care to people in low-income countries such as Pakistan; the clear link between AMR and UHC. Ann Med Surg (Lond). 2022;81:104490.
134. Sharland M, Pulcini C, Harbarth S et al. Classifying antibiotics in the WHO Essential Medicines List for optimal use-be AWaRe. Lancet Infect Dis. 2018;18(1):18-20.
135. Barasa EW, Molyneux S, English M, Cleary S. Setting Healthcare Priorities at the Macro and Meso Levels: A Framework for Evaluation. Int J Health Policy Manag. 2015;4(11):719-32.
136. Smith T, McNeil K, Mitchell R et al. A study of macro-, meso- and micro-barriers and enablers affecting extended scopes of practice: the case of rural nurse practitioners in Australia. BMC Nursing. 2019;18(1):14.
137. Eze P, Lawani LO, Agu UJ et al. Factors associated with catastrophic health expenditure in sub-Saharan Africa: A systematic review. PLoS One. 2022;17(10):e0276266.
138. Miljeteig I, Defaye FB, Wakim P et al. Financial risk protection at the bedside: How Ethiopian physicians try to minimize out-of-pocket health expenditures. PLoS One. 2019;14(2):e0212129.
139. Iskandar K, Molinier L, Hallit S et al. Surveillance of antimicrobial resistance in low- and middle-income countries: a scattered picture. Antimicrob Resist Infect Control. 2021;10(1):63.
140. Bahta M, Weldemariam DG, Tesfamariam S et al. Determinants of dispensing antibiotics without prescription in Eritrea: a mixed-method qualitative study on pharmacy professionals' perspective. BMJ Open. 2021;11(8):e049000.
141. Gebretekle GB, Serbessa MK. Exploration of over the counter sales of antibiotics in community pharmacies of Addis Ababa, Ethiopia: pharmacy professionals' perspective. Antimicrob Resist Infect Control. 2016;5:2.
142. Erku DA, Aberra SY. Non-prescribed sale of antibiotics for acute childhood diarrhea and upper respiratory tract infection in community pharmacies: a 2 phase mixed-methods study. Antimicrob Resist Infect Control. 2018;7:92.
143. Bogale AA, Amhare AF, Chang J et al. Knowledge, attitude, and practice of self-medication with antibiotics among community residents in Addis Ababa, Ethiopia. Expert Rev Anti Infect Ther. 2019;17(6):459-66.
144. Demissie F, Ereso K, Paulos G. Self-Medication Practice with Antibiotics and Its Associated Factors Among Community of Bule-Hora Town, South West Ethiopia. Drug Healthc Patient Saf. 2022;14:9-18.
145. Edessa D, Sisay M, Hagos B, Amare F. Antimicrobial Use and Management of Childhood Diarrhea at Community Drug Retail Outlets in Eastern Ethiopia: A Matched Questionnaire-Based and Simulated Patient-Case Study. Pediatric Health Med Ther. 2022;13:63-79.
146. Sambakunsi CS, Småbrekke L, Varga CA et al. Knowledge, attitudes and practices related to self-medication with antimicrobials in Lilongwe, Malawi. Malawi Med J. 2019;31(4):225-32.
147. Machongo RB, Mipando ALN. "I don't hesitate to use the left-over antibiotics for my child" practices and experiences with antibiotic use among caregivers of paediatric patients at Zomba central hospital in Malawi. BMC Pediatr. 2022;22(1):466.

148. Torres NF, Solomon VP, Middleton LE. Identifying the commonly used antibiotics for self-medication in urban Mozambique: a qualitative study. BMJ Open. 2020;10(12):e041323.
149. 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. 2019;33:307.
150. Mboya EA, Sanga LA, Ngocho JS. Irrational use of antibiotics in the Moshi Municipality Northern Tanzania: a cross sectional study. Pan Afr Med J. 2018;31:165.
151. Emgård M, Mwangi R, Mayo C et al. Antibiotic use in children under 5 years of age in Northern Tanzania: a qualitative study exploring the experiences of the caring mothers. Antimicrob Resist Infect Control. 2022;11(1):130.
152. 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 Tanzania: a cross-sectional study. Antimicrob Resist Infect Control. 2022;11(1):86.
153. 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):863-72.
154. Njunkeng A. Prevalence of antimicrobial self-medication among patients attending two hospitals in the Buea Health District, Cameroon. Archives of Community Medicine and Public Health. 2019:024-8.
155. Shembo AKP, Musumari PM, Srithanaviboonchai K et al. A qualitative study on community use of antibiotics in Kinshasa, Democratic Republic of Congo. PLoS One. 2022;17(4):e0267544.
156. Ahiabu MA, Magnussen P, Bygbjerg IC, Tersbøl BP. Treatment practices of households and antibiotic dispensing in medicine outlets in developing countries: The case of Ghana. Res Social Adm Pharm. 2018;14(12):1180-8.
157. Mensah BN, Agyemang IB, Afriyie DK, Amponsah SK. Self-medication practice in Akuse, a rural setting in Ghana. Niger Postgrad Med J. 2019;26(3):189-94.
158. Afari-Asiedu S, Hulscher M, Abdulai MA et al. Every medicine is medicine; exploring inappropriate antibiotic use at the community level in rural Ghana. BMC Public Health. 2020;20(1):1103.
159. Kretchy J-P, Adase SK, Gyansa-Lutterodt M. The prevalence and risks of antibiotic self-medication in residents of a rural community in Accra, Ghana. Scientific African. 2021;14:e01006.
160. Amponsah SK, Odamtten G, Adams I, Kretchy IA. A comparative analysis of pattern and attitude towards self-medication among pharmacy and non-pharmacy students in University of Ghana. Pan Afr Med J. 2022;41:254.
161. Nyarko E, Akoto FM, Doku-Amponsah K. Perceived antimicrobial dispensing practices in medicine outlets in Ghana: A maximum difference experiment design. PLoS One. 2023;18(7):e0288519.
162. Khalid GM, Jatau AI, Ibrahim UI et al. Antibiotics self-medication among undergraduate pharmacy students in Northern Nigeria. Medicine Access @ Point of Care. 2019;3:2399202619846847.
163. Abubakar U, Tangiisuran B. Knowledge and practices of community pharmacists towards non-prescription dispensing of antibiotics in Northern Nigeria. Int J Clin Pharm. 2020;42(2):756-64.
164. Hussain MA, Mohamed AO, Abdelkarim OA et al. Prevalence and Predictors of Antibiotic Self-Medication in Sudan: A Descriptive Cross-Sectional Study. Antibiotics. 2023;12(3):612.
165. Ateshim Y, Bereket B, Major F et al. Prevalence of self-medication with antibiotics and associated factors in the community of Asmara, Eritrea: a descriptive cross sectional survey. BMC Public Health. 2019;19(1):726.
166. Seid MA, Hussen MS. Knowledge and attitude towards antimicrobial resistance among final year undergraduate paramedical students at University of Gondar, Ethiopia. BMC Infect Dis. 2018;18(1):312.
167. Torres NF, Solomon VP, Middleton LE. Pharmacists' practices for non-prescribed antibiotic dispensing in Mozambique. Pharm Pract. 2020;18(3):1965.
168. Mboya EA, Davies ML, Horumpende PG, Ngocho JS. Inadequate knowledge on appropriate antibiotics use among clients in the Moshi municipality Northern Tanzania. PLoS One. 2020;15(9):e0239388.
169. Sindato C, Mboera LEG, Katale BZ 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. 2020;9(1):194.
170. Gabriel S, Manumbu L, Mkusa O et al. Knowledge of use of antibiotics among consumers in Tanzania. JAC Antimicrob Resist. 2021;3(4):dlab183.

171. Nkinda L, Kilonzi M, Felix FF et al. Drivers of irrational use of antibiotics among children: a mixed-method study among prescribers and dispensers in Tanzania. BMC Health Serv Res. 2022;22(1):961.
172. Elong Ekambi GA, Okalla Ebongue C, Penda IC et al. Knowledge, practices and attitudes on antibiotics use in Cameroon: Self-medication and prescription survey among children, adolescents and adults in private pharmacies. PLoS One. 2019;14(2):e0212875.
173. Abbey M, Chinbuah MA, Gyapong M et al. Community perceptions and practices of treatment seeking for childhood pneumonia: a mixed methods study in a rural district, Ghana. BMC Public Health. 2016;16(1):848.
174. Afari-Asiedu S, Hulscher M, Abdulai MA et al. Stakeholders' perspectives on training over the counter medicine sellers and Community-based Health Planning and Services facilities to dispense antibiotics in Ghana. J Pharm Policy Pract. 2021;14(1):62.
175. Omulo S, Thumbi SM, Lockwood S et al. Evidence of superficial knowledge regarding antibiotics and their use: Results of two cross-sectional surveys in an urban informal settlement in Kenya. PLoS One. 2017;12(10):e0185827.
176. Muloi D, Fèvre EM, Bettridge J et al. A cross-sectional survey of practices and knowledge among antibiotic retailers in Nairobi, Kenya. J Glob Health. 2019;9(2):010412.
177. Badger-Emeka LI, Emeka PM, Okosi M. Evaluation of the extent and reasons for increased non-prescription antibiotics use in a University town, Nsukka Nigeria. Int J Health Sci (Qassim). 2018;12(4):11-7.
178. Ajibola O, Omisakin OA, Eze AA, Omoleke SA. Self-Medication with Antibiotics, Attitude and Knowledge of Antibiotic Resistance among Community Residents and Undergraduate Students in Northwest Nigeria. Diseases. 2018;6(2).
179. Akande-Sholabi W, Ajamu AT. Antimicrobial stewardship: Assessment of knowledge, awareness of antimicrobial resistance and appropriate antibiotic use among healthcare students in a Nigerian University. BMC Med Educ. 2021;21(1):488.
180. Abdu-Aguye SN, Barde KG, Yusuf H et al. Investigating Knowledge of Antibiotics, Antimicrobial Resistance and Antimicrobial Stewardship Concepts Among Final Year Undergraduate Pharmacy Students in Northern Nigeria. Integr Pharm Res Pract. 2022;11:187-95.
181. Mudenda S, Mukela M, Matafwali SK et al. Knowledge, Attitudes, and Practices towards Antibiotic Use and Antimicrobial Resistance among Pharmacy Students at the University of Zambia: Implications for Antimicrobial Stewardship Programmes. Sch Acad J Pharm, 2022; 8: 117-124.
182. Mokoena TTW, Schellack N, Brink AJ. Driving antibiotic stewardship awareness through the minibus-taxi community across the Tshwane District, South Africa-a baseline evaluation. JAC Antimicrob Resist. 2021;3(3):dlab106.
183. Versporten A, Zarb P, Caniaux I et al. Antimicrobial consumption and resistance in adult hospital inpatients in 53 countries: results of an internet-based global point prevalence survey. Lancet Glob Health. 2018;6(6):e619-e29.
184. van den Bosch CM, Hulscher ME, Natsch S et al. Applicability of generic quality indicators for appropriate antibiotic use in daily hospital practice: a cross-sectional point-prevalence multicenter study. Clin Microbiol Infect. 2016;22(10):888.e1-.e9.
185. van den Bosch CM, Geerlings SE, Natsch S et al. Quality indicators to measure appropriate antibiotic use in hospitalized adults. Clin Infect Dis. 2015;60(2):281-91.
186. Kallen MC, Prins JM. A Systematic Review of Quality Indicators for Appropriate Antibiotic Use in Hospitalized Adult Patients. Infect Dis Rep. 2017;9(1):6821.
187. Campbell SM, Braspenning J, Hutchinson A, Marshall M. Research methods used in developing and applying quality indicators in primary care. Qual Saf Health Care. 2002;11(4):358-64.
188. Campbell SM, Kontopantelis E, Hannon K et al. Framework and indicator testing protocol for developing and piloting quality indicators for the UK quality and outcomes framework. BMC Fam Pract. 2011;12:85.
189. Campbell SM, Godman B, Diogene E et al. Quality indicators as a tool in improving the introduction of new medicines. Basic Clin Pharmacol Toxicol. 2015;116(2):146-57.
190. Moura ML, Boszczowski I, Mortari N et al. The Impact of Restricting Over-the-Counter Sales of Antimicrobial Drugs: Preliminary Analysis of National Data. Medicine (Baltimore). 2015;94(38):e1605.
191. Lopes-Júnior R, de Sá Del Fiol F, Araujo JL et al. Decrease in penicillin Sales in Brazil after over-the-counter restrictions. Antimicrob Agents Chemother. 2015;59(9):5862-3.
192. Mattos KPH, Visacri MB, Quintanilha JCF et al. Brazil's resolutions to regulate the sale of antibiotics: Impact on consumption and Escherichia coli resistance rates. J Glob Antimicrob Resist. 2017;10:195-9.

193. Kitutu FE, Kalyango JN, Mayora C et al. Integrated community case management by drug sellers influences appropriate treatment of paediatric febrile illness in South Western Uganda: a quasi-experimental study. Malar J. 2017;16(1):425.
194. WHO. Anatomical Therapeutic Chemical (ATC) Classification. 2021. Available at URL: https://www.who.int/tools/atc-ddd-toolkit/atc-classification (Accessed 18 March 2023)
195. DRIVE-AB WP1A. QUALITY INDICATORS & QUANTITY METRICS OF ANTIBIOTIC USE. 2014 Available at URL: http://drive-ab.eu/wp-content/uploads/2014/09/WP1A_Final-QMs-QIs_final.pdf (Accessed 23 March 2023)
196. Falco MF, Meyer JC, Putter SJ et al. Perceptions of and Practical Experience with the National Surveillance Centre in Managing Medicines Availability Amongst Users within Public Healthcare Facilities in South Africa: Findings and Implications. Healthcare. 2023;11(13):1838.
197. Kalungia A, Godman B. Implications of non-prescription antibiotic sales in China. Lancet Infect Dis. 2019;19(12):1272-3.
198. Nafade V, Huddart S, Sulis G et al. Over-the-counter antibiotic dispensing by pharmacies: a standardised patient study in Udupi district, India. BMJ Glob Health. 2019;4(6):e001869.
199. Sengupta S, Barman P, Lo J. Opportunities to Overcome Implementation Challenges of Infection Prevention and Control in Low-Middle Income Countries. Current Treatment Options in Infectious Diseases. 2019;11(3):267-80.
200. Cadogan CA, Hughes CM. On the frontline against COVID-19: Community pharmacists' contribution during a public health crisis. Res Social Adm Pharm. 2021;17(1):2032-5.
201. Hedima EW, Adeyemi MS, Ikunaiye NY. Community Pharmacists: On the frontline of health service against COVID-19 in LMICs. Res Social Adm Pharm. 2021;17(1):1964-6.
202. Erku DA, Belachew SA, Abrha S et al. When fear and misinformation go viral: Pharmacists' role in deterring medication misinformation during the 'infodemic' surrounding COVID-19. Res Social Adm Pharm. 2021;17(1):1954-63.
203. Lambert M, Smit CCH, De Vos S et al. A systematic literature review and meta-analysis of community pharmacist-led interventions to optimise the use of antibiotics. Br J Clin Pharmacol. 2022;88(6):2617-41
* Good review of community phamacist initiatives to improve antimicrbial dispensing
204. Finnis A. Can pharmacists prescribe antibiotics? The new plans for prescriptions in England, explained. 2023. Available at URL: https://inews.co.uk/news/health/pharmacists-can-prescribe-antibiotics-new-plans-pharmacy-prescriptions-england-explained-2330773 (Accessed 20 July 2023)
205. Sarwar MR, Saqib A, Iftikhar S, Sadiq T. Knowledge of community pharmacists about antibiotics, and their perceptions and practices regarding antimicrobial stewardship: a cross-sectional study in Punjab, Pakistan. Infect Drug Resist. 2018;11:133-45.
206. Cox JA, Vlieghe E, Mendelson M et al. Antibiotic stewardship in low- and middle-income countries: the same but different? Clin Microbiol Infect. 2017;23(11):812-8.
207. Kimathi G, Kiarie J, Njarambah L et al. A cross-sectional study of antimicrobial use among self-medicating COVID-19 cases in Nyeri County, Kenya. Antimicrob Resist Infect Control. 2022;11(1):111.
208. Chowdhury F, Sturm-Ramirez K, Mamun AA et al. Effectiveness of an educational intervention to improve antibiotic dispensing practices for acute respiratory illness among drug sellers in pharmacies, a pilot study in Bangladesh. BMC Health Serv Res. 2018;18(1):676.
209. Chang J, Xu S, Zhu S et al. Assessment of non-prescription antibiotic dispensing at community pharmacies in China with simulated clients: a mixed cross-sectional and longitudinal study. Lancet Infect Dis. 2019;19(12):1345-54.
210. WHO. Kenya national action plan on antimicrobial resistance: review of progress in the human health sector. 2022 Available at URL: https://www.who.int/publications/i/item/9789240062689 (Accessed 20 March 2023)
211. Santa-Ana-Tellez Y, Mantel-Teeuwisse AK, Leufkens HGM et al. Seasonal Variation in Penicillin Use in Mexico and Brazil: Analysis of the Impact of Over-the-Counter Restrictions. Antimicrobial Agents and Chemotherapy. 2015;59(1):105-10.
212. Onwunduba A, Ekwunife O, Onyilogwu E. Impact of point-of-care C-reactive protein testing intervention on non-prescription dispensing of antibiotics for respiratory tract infections in private community pharmacies in Nigeria: a cluster randomized controlled trial. Int J Infect Dis. 2023;127:137-43.
213. Markovic-Pekovic V, Grubisa N. Self-medication with antibiotics in the Republic of Srpska community pharmacies: pharmacy staff behavior. Pharmacoepidemiol Drug Saf. 2012;21(10):1130-3.

214. Arparsrithongsagul S, Kulsomboon V, Zuckerman IH. Multidisciplinary perspective intervention with community involvement to decrease antibiotic sales in village groceries in Thailand. Asia Pac J Public Health. 2015;27(2):Np2480-8.
215. Nabadda S, Kakooza F, Kiggundu R et al. Implementation of the World Health Organization Global Antimicrobial Resistance Surveillance System in Uganda, 2015-2020: Mixed-Methods Study Using National Surveillance Data. JMIR Public Health Surveill. 2021;7(10):e29954.
216. Schäfermann S, Hauk C, Wemakor E et al. Substandard and Falsified Antibiotics and Medicines against Noncommunicable Diseases in Western Cameroon and Northeastern Democratic Republic of Congo. Am J Trop Med Hyg. 2020;103(2):894-908.
217. Zabala GA, Bellingham K, Vidhamaly V et al. Substandard and falsified antibiotics: neglected drivers of antimicrobial resistance? BMJ Glob Health. 2022;7(8).
218. Waffo Tchounga CA, Sacré PY, Ciza Hamuli P et al. Prevalence of Poor Quality Ciprofloxacin and Metronidazole Tablets in Three Cities in Cameroon. Am J Trop Med Hyg. 2023;108(2):403-11.
219. Sami SA, Marma KKS, Chakraborty A et al. A comprehensive review on global contributions and recognition of pharmacy professionals amidst COVID-19 pandemic: moving from present to future. Futur J Pharm Sci. 2021;7(1):119.
220. Kampamba - Mutati R, Mwila C, Mudenda S et al. Continuing professional development needs of pharmacy professionals in Zambia: Findings and future directions. Pharmacy Education. 2022;22:301-11.
221. Enz C. NEW DIRECTIONS FOR CROSS- CULTURAL STUDIES: LINKING ORGANIZATIONAL AND SOCIETAL CULTURES. Available at URL: https://ecommons.cornell.edu/bitstream/handle/1813/72141/Enz101_Linking_Organizational_And_Societal_Cultures.pdf?sequence=1 (Accesed 20 March 2023)
222. Fischer M. Available at URL: https://www.washingtonpost.com/news/worldviews/wp/2013/05/16/a-revealing-map-of-the-worlds-most-and-least-ethnically-diverse-countries/ (Accessed 20 July 2023)
223. Obebi Cliff-Eribo K, Sammons H, Star K et al. Adverse drug reactions in Nigerian children: a retrospective review of reports submitted to the Nigerian Pharmacovigilance Centre from 2005 to 2012. Paediatr Int Child Health. 2016;36(4):300-4.
224. Joseph AM, Fernandez V, Kritzman S et al. COVID-19 Misinformation on Social Media: A Scoping Review. Cureus. 2022;14(4):e24601.
225. Muric G, Wu Y, Ferrara E. COVID-19 Vaccine Hesitancy on Social Media: Building a Public Twitter Data Set of Antivaccine Content, Vaccine Misinformation, and Conspiracies. JMIR Public Health Surveill. 2021;7(11):e30642-e.
226. Hernandez RG, Hagen L, Walker K et al. The COVID-19 vaccine social media infodemic: healthcare providers' missed dose in addressing misinformation and vaccine hesitancy. Hum Vaccin Immunother. 2021;17(9):2962-4.
227. Schellack N, Strydom M, Pepper MS et al. Social Media and COVID-19;Perceptions and Public Deceptions of Ivermectin, Colchicine and Hydroxychloroquine: Lessons for Future Pandemics. Antibiotics. 2022;11(4):445.
228. Wang Q, Huang R. The impact of COVID-19 pandemic on sustainable development goals - A survey. Environ Res. 2021;202:111637-.
229. Morton S, Pencheon D, Squires N. Sustainable Development Goals (SDGs), and their implementation: A national global framework for health, development and equity needs a systems approach at every level. Br Med Bull. 2017;124(1):81-90.
230. Odey GO, Alawad AGA, Atieno OS et al. COVID-19 pandemic: impacts on the achievements of Sustainable Development Goals in Africa. Pan Afr Med J. 2021;38:251.
231. Ogunnigbo O, Nabiryo M, Atteh M et al. Exploring the Antimicrobial Stewardship Educational Needs of Healthcare Students and the Potential of an Antimicrobial Prescribing App as an Educational Tool in Selected African Countries. Antibiotics. 2022;11(5):691.
232. Olaoye O, Tuck C, Khor WP et al. Improving Access to Antimicrobial Prescribing Guidelines in 4 African Countries: Development and Pilot Implementation of an App and Cross-Sectional Assessment of Attitudes and Behaviour Survey of Healthcare Workers and Patients. Antibiotics. 2020;9(9).
233. Appiah B, Asamoah-Akuoko L, Samman E et al. The impact of antimicrobial resistance awareness interventions involving schoolchildren, development of an animation and parents engagements: a pilot study. Antimicrob Resist Infect Control. 2022;11(1):26.
234. Wonodi C, Obi-Jeff C, Adewumi F et al. Conspiracy theories and misinformation about COVID-19 in Nigeria: Implications for vaccine demand generation communications. Vaccine. 2022;40(13):2114-21.

235. Stewart R, Madonsela A, Tshabalala N, Etale L et al. The importance of social media users' responses in tackling digital COVID-19 misinformation in Africa. Digit Health. 2022;8:20552076221085070.
236. Interagency Coordination Group on Antimicrobial Resistance. NO TIME TO WAIT: SECURING THE FUTURE FROM DRUG-RESISTANT INFECTIONS - REPORT TO THE SECRETARY-GENERAL OF THE UNITED NATIONS. APRIL 2019. Available at URL: https://www.who.int/antimicrobial-resistance/interagency-coordination-group/IACG_final_report_EN.pdf?ua=1. (Accessed 19 March 2023)
237. Akpan MR, Isemin NU, Udoh AE, Ashiru-Oredope D. Implementation of antimicrobial stewardship programmes in African countries: a systematic literature review. J Glob Antimicrob Resist. 2020;22:317-24.
238. Siachalinga L, Mufwambi W, Lee IH. Impact of antimicrobial stewardship interventions to improve antibiotic prescribing for hospital inpatients in Africa: a systematic review and meta-analysis. J Hosp Infect. 2022;129:124-43.
239. Siachalinga L, Godman B, Mwita JC et al. Current Antibiotic Use Among Hospitals in the sub-Saharan Africa Region; Findings and Implications. Infect Drug Resist. 2023;16:2179-90.
240. Otieno PA, Campbell S, Maley S et al. A Systematic Review of Pharmacist-Led Antimicrobial Stewardship Programs in Sub-Saharan Africa. Int J Clin Pract. 2022;2022:3639943.
241. Kamere N, Garwe ST, Akinwotu OO et al. Scoping Review of National Antimicrobial Stewardship Activities in Eight African Countries and Adaptable Recommendations. Antibiotics. 2022;11(9):1149.
242. Abena PM, Decloedt EH, Bottieau E et al. Chloroquine and Hydroxychloroquine for the Prevention or Treatment of COVID-19 in Africa: Caution for Inappropriate Off-label Use in Healthcare Settings. Am J Trop Med Hyg. 2020;102(6):1184-8.
243. Sariola S, Butcher A, Cañada JA et al. Closing the GAP in Antimicrobial Resistance Policy in Benin and Burkina Faso. mSystems. 2022;7(4):e0015022.
244. Assouma FF, Sina H, Dossou AD et al. Antibiotic Resistance Profiling of Pathogenic Staphylococcus Species from Urinary Tract Infection Patients in Benin. Biomed Res Int. 2023;2023:6364128.
245. BOMRA. MRSA 2019 Regulations Available at URL: https://bomra.co.bw/bomra-downloads/#132-154-wpfd-regulations (Accessed 20 March 2023)
246. Bahta M, Tesfamariam S, Weldemariam DG et al. Dispensing of antibiotics without prescription and associated factors in drug retail outlets of Eritrea: A simulated client method. PLoS One. 2020;15(1):e0228013.
247. Garoy EY, Gebreab YB, Achila OO et al. Methicillin-Resistant Staphylococcus aureus (MRSA): Prevalence and Antimicrobial Sensitivity Pattern among Patients-A Multicenter Study in Asmara, Eritrea. Can J Infect Dis Med Microbiol. 2019;2019:8321834.
248. Garoy EY, Gebreab YB, Achila OO et al. Magnitude of Multidrug Resistance among Bacterial Isolates from Surgical Site Infections in Two National Referral Hospitals in Asmara, Eritrea. Int J Microbiol. 2021;2021:6690222.
249. Ministry of Health Eswatini. NOTICE TO REGISTER ALL RETAIL PHARMACIES OPERATING IN ESWATINI. 2022. Available at URL: https://www.gov.sz/index.php/ministries-departments/ministry-of-health (Accessed 20 March 2023)
250. Ministry of Health Eswatini. MEDICINES AND RELATED SUBSTANCES CONTROL ACT, 2016 (Act 9 of 2016). Available at URL: https://faolex.fao.org/docs/pdf/swa196361.pdf (Accessed 21 March 2023)
251. FDA. G. FOOD AND DRUGS BOARD REVIEWED DRUG CLASSIFICATION LIST. Ghana. Available at URL: https://fdaghana.gov.gh/wp-content/uploads/2017/06/NEW-DRUG-CLASSIFICATION-LIST.pdf (Accessed 20 March 2023)
252. NHIS. NATIONAL HEALTH INSURANCESCHEME - MEDICINES LIST. March 2021. Available at URL: https://www.nhis.gov.gh/files/MedicinesList(2021).pdf (Accessed 21 March 2012))
253. Republic of Kenya. Kenya Gazette Supplement. The Pharmacy and Poisons (Ammendment) Bill, 2021. Available at URL: http://www.parliament.go.ke/sites/default/files/2021-02/Pharmacy%20and%20Poisons%20%28Amendment%29%20Bill%2C%202021.pdf (Accessed 20 March 2023)
254. Aywak D, Jaguga CDP, Nkonge NG et al. Pharmacy Practice in Kenya. Can J Hosp Pharm. 2017;70(6):456-62.
255. Lord J, Gikonyo A, Miwa A, Odoi A. Antimicrobial resistance among Enterobacteriaceae, Staphylococcus aureus, and Pseudomonas spp. isolates from clinical specimens from a hospital in Nairobi, Kenya. PeerJ. 2021;9:e11958.

256. Kariuki S, Wairimu C, Mbae C. Antimicrobial Resistance in Endemic Enteric Infections in Kenya and the Region, and Efforts Toward Addressing the Challenges. J Infect Dis. 2021;224(12 Suppl 2):S883-s9.
257. Caudell MA, Ayodo C, Ita T et al. Risk Factors for Colonization With Multidrug-Resistant Bacteria in Urban and Rural Communities in Kenya: An Antimicrobial Resistance in Communities and Hospitals (ARCH) Study. Clin Infect Dis. 2023;77(Suppl 1):S104-s10.
258. Chikowe I, Bliese SL, Lucas S, Lieberman M. Amoxicillin Quality and Selling Practices in Urban Pharmacies and Drug Stores of Blantyre, Malawi. Am J Trop Med Hyg. 2018;99(1):233-8.
259. PMRA. Pharmacy and Medicines Regulatory Authority Malawi Available at URL: https://pmra.mw/ (Accessed 21 March 2023)
260. Rodrigues CF. Self-medication with antibiotics in Maputo, Mozambique: practices, rationales and relationships. Palgrave Communications. 2020;6(1):6.
261. Pereko DD, Lubbe MS, Essack SY. Public knowledge, attitudes and behaviour towards antibiotic usage in Windhoek, Namibia. Southern African Journal of Infectious Diseases. 2015;30(4):134-7.
262. Akpan RM, Udoh EI, Akpan SE, Ozuluoha CC. Community pharmacists' management of self-limiting infections: a simulation study in Akwa Ibom State, South-South Nigeria. Afr Health Sci. 2021;21(2):576-84.
263. Government of South Africa. MEDICINES AND RELATED SUBSTANCES ACT, 1965 (ACT 101 OF 1965) Available at URL: https://sahpra.org.za/wp-content/uploads/2020/01/b335d1c0Act_101_of_1965_published_2003.pdf (Accessed 20 July 2023)
264. Moglad EH. Antibiotics Profile, Prevalence of Extended-Spectrum Beta-Lactamase (ESBL), and Multidrug-Resistant Enterobacteriaceae from Different Clinical Samples in Khartoum State, Sudan. Int J Microbiol. 2020;2020:8898430.
265. 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. 2018;13(11):e0207465.
266. Ministry of Health, Tanzania. Tanzania Food, Drugs and Cosmetics (Scheduling of Medicines). GOVERNMENT NOTICE No. 63 published on 27/02/2015 THE TANZANIA FOOD, DRUGS AND COSMETICS ACT, (CAP. 219). REGULATIONS Made under Section 122 (1) (y))and 77(2).
267. Mwita S, Jande M, Marwa K et al. Medicines dispensers' knowledge on the implementation of an artemisinin-based combination therapy policy for the treatment of uncomplicated malaria in Tanzania. Journal of Pharmaceutical Health Services Research. 2017;8(4):227-33.
268. Ndaki PM, Mushi MF, Mwanga JR et al. Dispensing Antibiotics without Prescription at Community Pharmacies and Accredited Drug Dispensing Outlets in Tanzania: A Cross-Sectional Study. Antibiotics. 2021;10(8).
269. Erku DA, Mekuria AB, Surur AS, Gebresillassie BM. Extent of dispensing prescription-only medications without a prescription in community drug retail outlets in Addis Ababa, Ethiopia: a simulated-patient study. Drug Healthc Patient Saf. 2016;8:65-70.
270. Gelayee DA. Self-Medication Pattern among Social Science University Students in Northwest Ethiopia. Journal of Pharmaceutics. 2017;2017:8680714.
271. Koji EM, Gebretekle GB, Tekle TA. Practice of over-the-counter dispensary of antibiotics for childhood illnesses in Addis Ababa, Ethiopia: a simulated patient encounter study. Antimicrob Resist Infect Control. 2019;8:119.
272. Embrey M, Vialle-Valentin C, Dillip A et al. Understanding the Role of Accredited Drug Dispensing Outlets in Tanzania's Health System. PLoS One. 2016;11(11):e0164332.
273. Ndaki PM, Mushi MF, Mwanga JR et al. Non-prescribed antibiotic dispensing practices for symptoms of urinary tract infection in community pharmacies and accredited drug dispensing outlets in Tanzania: a simulated clients approach. BMC Prim Care. 2022;23(1):287.
274. Ocan M, Aono M, Bukirwa C et al. Medicine use practices in management of symptoms of acute upper respiratory tract infections in children (≤12 years) in Kampala city, Uganda. BMC Public Health. 2017;17(1):732.
275. Ngu RC, Feteh VF, Kika BT et al. Prevalence and Determinants of Antibiotic Self-Medication among Adult Patients with Respiratory Tract Infections in the Mboppi Baptist Hospital, Douala, Cameroon: A Cross-Sectional Study. Diseases. 2018;6(2).
276. Penda CI, Moukoko ECE, Youmba JFN, Mpondo EM. Characterization of pharmaceutical medication without a medical prescription in children before hospitalization in a resource-limited setting, Cameroon. Pan Afr Med J. 2018;30:302.

277. Owusu-Ofori AK, Darko E, Danquah CA et al. Self-Medication and Antimicrobial Resistance: A Survey of Students Studying Healthcare Programmes at a Tertiary Institution in Ghana. Front Public Health. 2021;9:706290.
278. Sado K, Keenan K, Manataki A et al. Treatment seeking behaviours, antibiotic use and relationships to multi-drug resistance: A study of urinary tract infection patients in Kenya, Tanzania and Uganda. medRxiv. 2023:2023.03.04.23286801.
279. Aika I, Efe A, Joshua O. ACCESSIBILITY AND USE OF ANTIBIOTICS AMONG PATIENTS VISITING COMMUNITY PHARMACIES IN BENIN CITY, NIGERIA. African Journal of Health, Safety and Environment. 2021;2:154-64.
280. 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. 2022;17(1):e0263067.
281. Ministry of Health Botswana. Medicines and related substances act 2013 Available at URL: https://bomra.co.bw/bomra-downloads/#132-155-wpfd-mrs-act (Accessed 20 March 2023)
282. Mashalla Y, Setlhare V, Massele A 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. 2017;71(12).
283. Tiroyakgosi C, Matome M, Summers E et al. Ongoing initiatives to improve the use of antibiotics in Botswana: University of Botswana symposium meeting report. Expert Rev Anti Infect Ther. 2018;16(5):381-4.
284. NBFIRA. Medical Aid Funds Available at URL: https://www.nbfira.org.bw/medical-aid-funds (Accessed 20 July 2023)
285. Valia D, Ingelbeen B, Kaboré B et al. Use of WATCH antibiotics prior to presentation to the hospital in rural Burkina Faso. Antimicrob Resist Infect Control. 2022;11(1):59.
286. WHO/World Bank/OECD. Delivering quality health services: A global imperative for universal health coverage. 2018 Available at URL: https://documents1.worldbank.org/curated/en/482771530290792652/pdf/127816-REVISED-quality-joint-publication-July2018-Complete-vignettes-ebook-L.pdf (Accessed 20 March 2023)
287. Campbell SM, Braspenning J, Hutchinson A, Marshall MN. Research methods used in developing and applying quality indicators in primary care. Bmj. 2003;326(7393):816-9.

Key: * of interest; ** of considerable interest