Supplementary Material and Tables

Tables

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

Country and Reference	Comment
Benin (1)	• 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 (2)
Botswana (3-5)	• 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 (6, 7)	• 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 (8, 9) • 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 (10, 11)	• 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 (12-15)	• 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 (16-18)	• 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 (19-21)

Malawi (22, 23)	• 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 alongside one-year imprisonment term • However, despite these regulations, there is still considerable purchasing of antibiotics without a prescription in Malawi enhanced by weak enforcement of the regulations
Mozambique (24-26)	• 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 (27-29)	• 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 (30, 31)	• 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 (32, 33)	• South African regulations currently prohibit the dispensing of antibiotics in pharmacies without a prescription, with potentially Community Pharmacists losing their licence for abuse
Sudan (34, 35)	• 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 (36)
Tanzania (37-40)	• 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 (41-45)	• There were low sales of antibiotics without a prescription in Zimbabwe in the early 2000s, again confirmed in the study of Nyazema et al. (2007) 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 (1)	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 (46)	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 (6)	• 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 (7)	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., (47)	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 (48)	• 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 (49)	• Qualitative interviews among personnel in 5 community pharmacies in Adia Ababa • One pharmacy professional was interviewed in each	• 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

		pharmacy using a semi-structured questionnaire	• Key reasons for dispensing antibiotics without a prescription including economics, pressure from patients and weak regulations
	Gelayee, 2017 (50)	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 (51)	• 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 (52)	• 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 (53)	• 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 (54)	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 (55)	• 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 (56)	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 (22)	• 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 pharmacist was out so no sale • Overall, where possible, 95% of the sellers that were approached sold amoxicillin without a prescription
	Sambakunsi et al., 2019 (57)	• 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 (58, 59)	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 (60)	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 (24)	• 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 (25)	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 (26)]	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 (61)	Quantitative and qualitative assessments of antibiotic access and use involving customer mapping, exit	• 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

		interviews and household surveys (650 in Mozambique)	• Low rates facilitated by limited access to community pharmacies and provision of free healthcare in public 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 (62)	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 (63)	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 (64)	• 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 (37)	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 (65)	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 (66)	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 (40)	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 (67)	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 (68)	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 (69)	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 (70)	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 (71)	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 (72)	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 (73)	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 (74)	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 (75)	Cross-sectional and prospective study involving using a closed-ended	• Self-medication was the initial most widely used option among 74.2% of children before being admitted to hospital in Cameroon

		questionnaire among 295 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 (76)	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 (77)	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 (78)	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 (79)	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 (80)	• 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 (81)	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 (61)	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 (82)	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 (83)	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 (84)	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 (13)	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 (85)	• 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 (18)	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 (86)	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 (87)	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) (88)	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 (89)	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 (90)	• 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 (91)	• 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 (30)	• 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 (92)	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 (93)	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 (31)	• 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 (94)	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., (35)	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 (95)	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 (34)	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 (96)	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 (97)	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 (98)	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 (28)	• 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 (27)	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 (99)	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 (61)	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 (32)	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 (100)

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 (1)	• 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 (3, 4, 101-104)	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 (1) and Valia et al., 2022 (105)	• 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 (41); 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 increasinly 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,

(42); Nyazema et al. (2007) (43); Belachew et al., 2021 (44); Dixon et al., 2021 (45)	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 (106)]

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” (107). 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 (107).

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 (108-111). 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.

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