

Health Supply Chain Bottlenecks and Their Association with Medication Access and Prescribing Practices in Sub-Saharan Africa: A Narrative Review

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Abstract

Background: Health supply chain bottlenecks remain a major barrier to equitable access to essential medicines in low- and middle-income countries, particularly in Sub-Saharan Africa. Persistent stockouts, weak inventory systems, and last-mile distribution failures not only limit medication availability but are associated with altered prescribing practices, contributing to irrational medicine use and increased risk of antimicrobial resistance (AMR). This narrative review synthesizes available evidence on health supply chain bottlenecks and assesses their association with medication access and prescribing practices across Sub-Saharan Africa. **Methods:** A comprehensive literature search was conducted across Google Scholar, PubMed, and ScienceDirect, for studies published between January 2009 and May 2026. Studies were eligible if they addressed any one of the following domains: supply chain bottlenecks or inefficiencies; medication access outcomes (including prescription fill rates); or prescribing practices assessed using frameworks such as the World Health Organization (WHO) prescribing indicators. Studies were not required to address all three domains simultaneously. Following title and abstract screening of 218 unique records, 50 studies and reports were included in the final synthesis. Evidence was synthesized thematically across global, regional, and country-specific contexts. **Results:** Evidence consistently shows that supply chain bottlenecks, including procurement inefficiencies, poor demand forecasting, weak inventory management, and last-mile distribution failures are significantly associated with medication access and prescribing practices. Across Sub-Saharan

Africa, essential medicine availability in public facilities is often below 50%, with stockout rates ranging from 40% to 60%. Antibiotic prescribing rates frequently exceed recommended thresholds ($\leq 20\%$ - 26.8%), reaching over 70% in some settings. These patterns reflect a compounding relationship between medicine shortages and irrational prescribing. **Conclusion:** Evidence suggests that health supply chain bottlenecks are strongly associated with medication access and prescribing practices in Sub-Saharan Africa. Addressing these challenges requires integrated interventions, including strengthening procurement and forecasting systems, expanding electronic logistics management information systems, improving last-mile distribution, and implementing antimicrobial stewardship programs. Strengthening supply chain systems is essential for improving rational medicine use and mitigating AMR in the region.

Keywords

Health Supply Chain, Medicine Stockouts, Medication Access, Prescription Fill Rate, Prescribing Practices, Antimicrobial Resistance, Antimicrobial Stewardship, Essential Medicines, Sub-Saharan Africa, WHO Prescribing Indicators

1. Introduction

1.1. The Global Burden of Medicine Inaccessibility

The World Health Organization (WHO) defines access to medicines as a priority concern, indicating that essential medicines must be available and accessible at all times, in adequate quantities, in appropriate dosage forms and quality, and at affordable prices for all patients (Yadav, 2015). Medication access is the ability of patients to obtain prescribed medicines in a timely, affordable, and appropriate manner (World Health Organization, 2010). The prescription fill rate is the proportion of prescribed medicines actually dispensed to a patient, expressed as a percentage (Yimer, Addis and Alemu, 2022). When availability is compromised, some of the consequences include delayed treatment, adverse drug events, medication errors, increased healthcare costs, prolonged hospitalizations, and preventable deaths (Santhireswaran et al., 2025). The WHO promotes the rational use of medicines by ensuring that patients receive treatments appropriate to their clinical needs, in doses that meet individual requirements, for adequate periods, and at the lowest possible cost (Iqbal, Geer and Dar, 2016). In addition, supply chain inefficiencies frequently disrupt prescribing practices, resulting in irrational prescribing, therapeutic substitution, and incomplete treatment courses (Papalexi, Bamford and Breen, 2020; Kapobe et al., 2026; Makowane et al., 2026; Mbuzi et al., 2026). Significantly, it is estimated that more than half of all medicines globally are prescribed or dispensed irrationally, and that irrational prescribing itself reduces medicine availability by as much as 50%, creating a cycle of wastage and scarcity (Latifah et al., 2019).

Despite increased investments in procurement of essential medicines globally, their availability at health facilities remains critically low in many LMICs, a situation largely driven by supply chain bottlenecks (Vledder et al., 2019). A systematic scoping review of medicine availability across Africa, encompassing 198 availability studies, found that most measures classified public facility medicine availability as low (<50%) at the primary care level (Lane et al., 2024).

The WHO has developed five core prescribing indicators to measure the rationality of prescribing at the facility level (Yimer, Addis and Alemu, 2022). These indicators include: 1) the average number of medicines per patient encounter (WHO optimal: 1.6 - 1.8), 2) the percentage of medicines prescribed by generic name (WHO optimal: 100%), 3) the percentage of patient encounters with an antibiotic prescribed (WHO optimal: ≤20% - 26.8%), 4) the percentage of patient encounters with an injection prescribed (WHO optimal: 13.4% - 24.1%), and 5) the percentage of medicines prescribed from the Essential Medicines List (WHO optimal: 100%).

The economic consequences of inaccessibility are equally significant: when public facilities lack essential medicines, patients are compelled to purchase from private pharmacies at substantially higher out-of-pocket costs, further entrenching health inequity (Yenet, Nibret and Tegegne, 2023). Against this backdrop, improving medication access rates at the primary care level in SSA is not merely a logistical challenge but a matter of fundamental public health urgency.

1.2. Purpose and Scope of This Review

This review organizes evidence from global, regional, and local literature on health supply chain bottlenecks and their influence on medication access and prescribing practice, with a particular focus on public health facilities in SSA (Steele et al., 2019; Olutuase et al., 2022). Specifically, the narrative review seeks to: 1) assess evidence of the key supply chain bottlenecks that may affect essential medicine availability, 2) review evidence of the association between health supply chain bottlenecks and medication access, and 3) review evidence of the association between health supply chain bottlenecks and prescribing practices consistent with the WHO Drug Use Indicator framework.

1.3. Conceptual Framework

The conceptual framework is grounded in the WHO Health Systems Building Blocks framework, which identifies six interconnected components of a functional health system: service delivery, health workforce, health information systems, access to essential medicines, financing, and leadership and governance (Figure 1). This review draws on the “access to essential medicines” building block as its primary domain.

The framework proposes two associational pathways through which health supply chain bottlenecks may be linked to medication access and prescribing practices. In the first pathway, supply chain bottlenecks such as poor demand forecasting are associated with reduced availability of essential medicines and low prescription fill rates at the point of care.

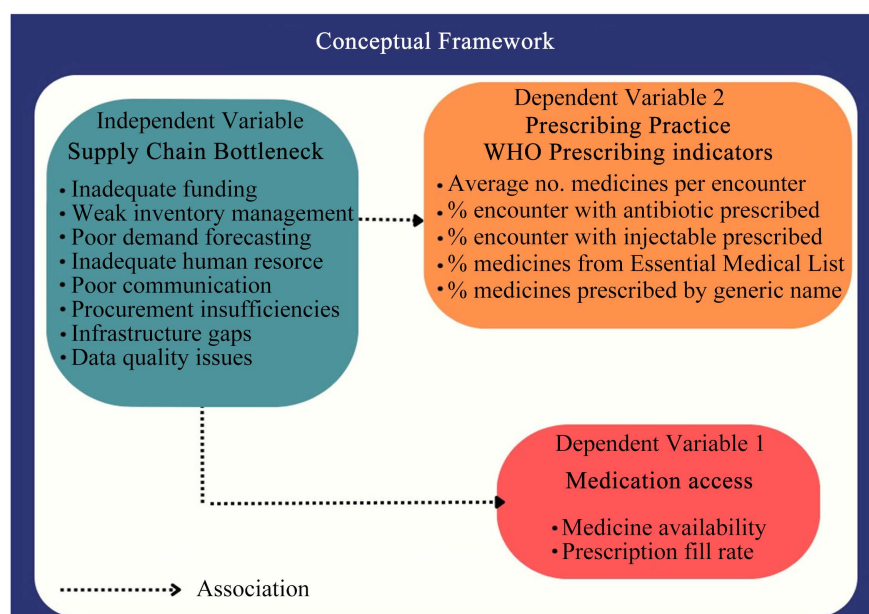


Figure 1. Conceptual Framework indicating factors that influence access to medication and prescribing practices of medicines in healthcare facilities.

In the second pathway, supply chain bottlenecks are associated with distortions in prescribing practices in that prescribers may deviate from standard prescribing guidelines to adapt to supply chain challenges by selecting alternative agents or substituting suboptimal medicines for unavailable preferred options. These patterns are associated with observable deviations across the WHO prescribing indicators.

Consistent with the scope of a narrative review, this framework does not assert a causal relationship; rather, it proposes that health supply chain bottlenecks are associated with medication access and prescribing practices, and this association is the primary focus of this review.

2. Materials and Methods

2.1. Study Design

This study employed a narrative review design to synthesize existing literature on health supply chain bottlenecks and their association with medication access and prescribing practices in Sub-Saharan Africa. A narrative review approach was considered most appropriate because the topic covers multiple disciplines, including pharmaceutical supply chain management, public health systems strengthening, antimicrobial stewardship, and rational medicine use. The available evidence is highly diverse in terms of study designs, outcome measures, health system levels assessed, and methodological approaches, making statistical pooling or meta-analysis inappropriate.

2.2. Search Process

A comprehensive literature search was conducted between March 2026 and May

2026 using academic databases including Google Scholar, PubMed, and ScienceDirect. The publication date limits for the included studies were set from January, 2009 to May, 2026 for all databases. The major search terms and combinations used included; health supply chain or pharmaceutical supply chain bottlenecks and stockout or medicine shortage; Sub Saharan Africa or low- and middle-income country and medication access or prescription fill rate; Sub Saharan Africa or low- and middle-income country and prescribing practices or WHO prescribing indicators or irrational prescribing. The sequential screening approach was used, firstly, the title and abstract were screened by the first author and a sample of excluded records was independently verified by the second author to confirm correct exclusion, with disagreements resolved by consensus. Secondly, full-text eligibility assessment and data extraction were likewise conducted by the first author and cross-checked by the second author for all included sources.

The screening and data extraction procedures were conducted using a structured review process and included consistency checks among the authors to improve transparency and rigor. No language restrictions were applied at the search stage, although only English-language records were subsequently retained. The study included peer-reviewed studies published in English between January 2009 and May 2026. The initial search yielded 245 records across all three databases (Google Scholar, PubMed, and ScienceDirect), with 18 additional records identified through reference lists and institutional reports. After removal of duplicates, 218 unique records were screened by title and abstract against the eligibility criteria. Of these, 70 full-text sources were assessed for eligibility, and a final set of 50 studies and reports was included in the narrative synthesis. The selection process is summarized in **Figure 2** below. A narrative review design was chosen over a systematic review because the topic spans multiple disciplines with highly heterogeneous study designs, diverse outcome measures, and varied methodological approaches, making statistical pooling inappropriate for this broad health systems question.

2.3. Eligibility Criteria

Studies were included if they addressed one or more of the following review objectives: 1) health supply chain bottlenecks or inefficiencies; 2) medication access outcomes; or 3) prescribing practices, including the WHO prescribing indicators. The review synthesized evidence across these interconnected domains to construct the broader narrative framework. Additionally, studies were included if they: 4) were published between January 2009 and May 2026; and 5) were written in English and published in peer-reviewed journals or credible institutional reports. Private sector supply chains, or high-income country contexts, were excluded unless they provided global-level benchmarks relevant to the review. The selection process followed a sequential screening approach: records were first screened by title and abstract, and those meeting the thematic criteria were retrieved in full text for final inclusion assessment. Studies that did not report on

supply chain performance, medication access, or prescribing practices in the LMIC context were excluded at the full-text stage. Although a formal PRISMA flow diagram is not required for narrative reviews, the overall selection process is summarized in **Figure 2** to support transparency and reproducibility.

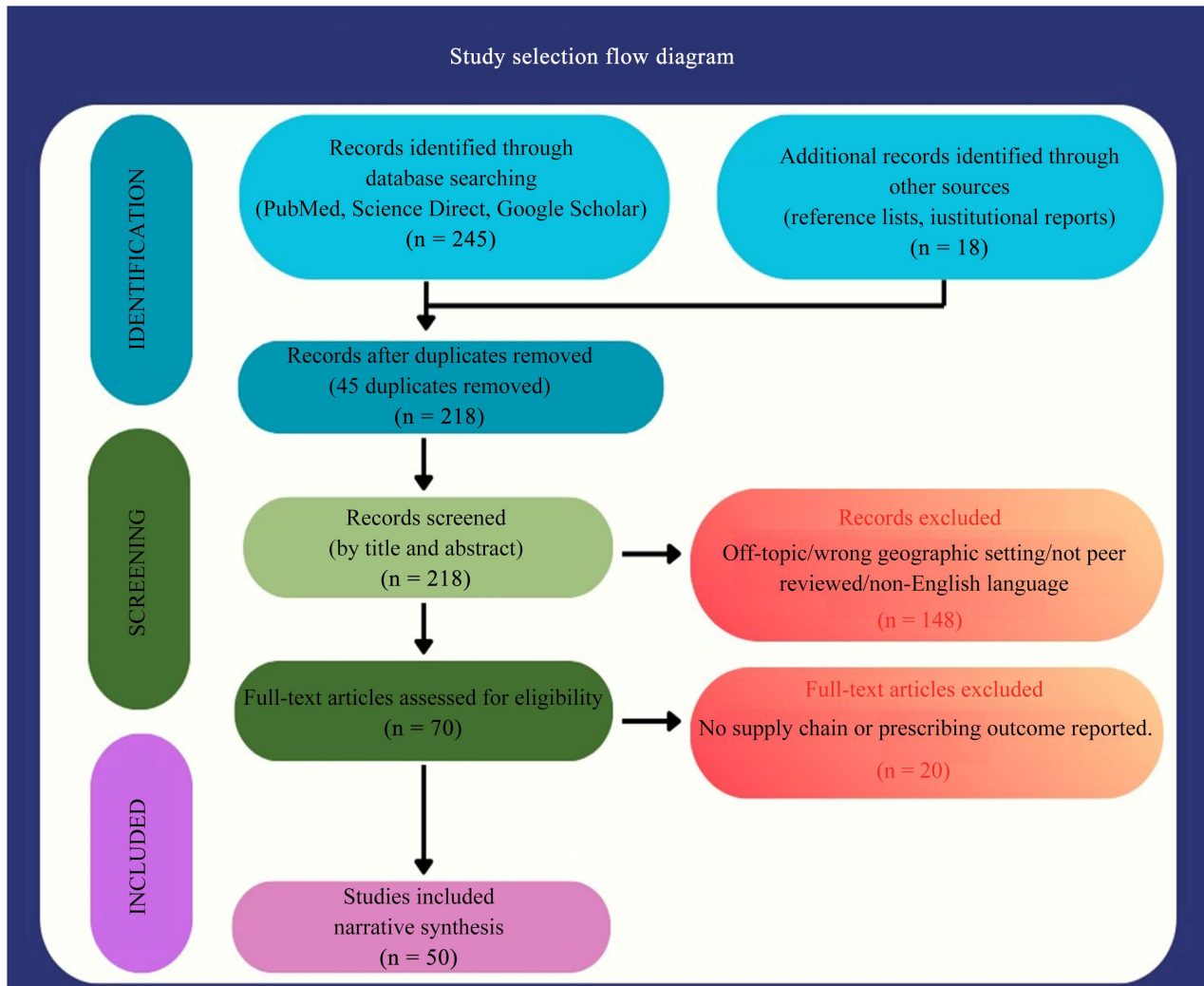


Figure 2. Literature selection flow diagram.

2.4. Data Extraction and Synthesis

Data extraction was conducted thematically. For each included study, the following information was extracted: country or region of study, level of the health system examined, supply chain bottlenecks identified where available, medication access outcomes where available (including prescription fill rates), prescribing practice outcomes where available (including WHO prescribing indicator values), and key recommendations. Evidence was then synthesized narratively under three geographic strata: global, Sub-Saharan Africa, and local (Zambia), consistent with the review objectives. Quantitative prescribing data were tabulated for comparative analysis against WHO reference values.

2.5. Quality Assurance

Given the narrative review design, formal risk-of-bias assessment tools such as CASP or Cochrane appraisal frameworks were not uniformly applied. This represents an inherent limitation of narrative reviews compared with systematic reviews, which typically employ standardized quality appraisal and reproducible evidence synthesis procedures. Consequently, the findings presented should be interpreted as a broad thematic synthesis of available evidence rather than a quantitatively weighted assessment of study quality.

However, several measures were undertaken to enhance rigor, transparency, and credibility. These included the use of predefined eligibility criteria, structured database searching across multiple sources, sequential title/abstract and full-text screening, and thematic extraction of key study variables. Priority was also given to peer-reviewed and indexed studies, while findings were triangulated across multiple countries, study settings, and methodological approaches to improve consistency of interpretation. Where conflicting findings existed, both perspectives were reported and critically discussed. Regarding the appraisal of evidence types: peer-reviewed and indexed literature were accorded the highest priority during interpretation and synthesis. Institutional or governmental reports and grey literature were included primarily to provide contextual and policy-relevant insights. The findings were triangulated across multiple study designs, countries and methodologies to improve consistency and credibility. The review did not apply formal quantitative weighting because of the narrative review design and heterogeneity of the evidence base.

Furthermore, limitations within the primary literature itself, including reliance on cross-sectional designs, inconsistent measurement of supply chain indicators, self-reported outcomes, and limited evidence from primary healthcare settings, were explicitly acknowledged throughout the review.

3. Results

3.1. Global Perspective: Supply Chain Bottlenecks and Medication Access

Globally, several key bottlenecks have been identified within pharmaceutical supply chains. These include unreliable data systems that hinder forecasting and decision-making, weak regulatory frameworks, corruption, inadequate funding, shortages of skilled personnel, and bureaucratic procurement processes (Muhia, Withera and Songole, 2017; Aigbavboa and Mbohwa, 2020). Poor infrastructure and weak information-sharing mechanisms among supply chain stakeholders further contribute to operational inefficiencies, resulting in delays, stockouts, and medicine wastage (Steele et al., 2019; Papalexi, Bamford and Breen, 2020). Inadequate inventory management also negatively impacts medication access and patient health outcomes (Bahadori, Ehsan and Bahariniya, 2024), as poor inventory controls can lead to drug expiry and the availability of substandard medicines.

Bottlenecks equally manifest through delayed delivery schedules, contributing to poor availability and wastage of essential medicines in public health facilities (Yadav, 2015). They are further observed at the point of care through ineffective implementation of Standard Operating Procedures (SOPs) and related policies, which contribute to irrational prescribing and inefficient medicine use (Alfaouri, Jaaron and Igudia, 2025). Furthermore, the availability of essential medicines is a prerequisite for their accessibility to patients (Laxminarayan et al., 2016). Medicine shortages result in patients being forced to seek care at other facilities or purchase medicines from private pharmacies at significantly higher personal cost, all of which adversely affect prescription fill rates and patient outcomes (Steele et al., 2019).

3.2. Supply Chain Bottlenecks and Prescribing Practices: Global Evidence

It is important to note at the outset that prescribing practice is multifactorial: while supply chain performance is a significant contributor, clinical training, diagnostic capacity, patient demand, antimicrobial stewardship programs, and governance frameworks all independently shape prescribing decisions. The evidence presented here does not establish causation but rather demonstrates a strong associational relationship between supply chain performance and prescribing outcomes. Where an individual study measured both supply chain performance and prescribing outcomes within the same setting and sample, this is noted as direct evidence. Where the association is inferred by comparing findings from separate studies conducted in different settings or time points, this is described as inferential evidence. The majority of evidence in this review is inferential in nature, reflecting the current state of the literature.

Supply chain inefficiencies globally have been associated with distorted prescribing practices. The WHO estimates that more than half of all medicines are prescribed or dispensed irrationally, with irrational prescribing reducing medicine availability by as much as 50% (Latifah et al., 2019). Evidence from Central India found that 47% of prescriptions were irrationally prescribed, with only 19% of prescriptions containing complete dosing information, further illustrating the pervasive nature of this problem (Lavtepatil and Ghosh, 2025). Similarly, a study conducted in Ethiopia found that irrational drug use was common among outpatients, with polypharmacy and antibiotic overprescribing identified as significant concerns: antibiotic prescribing in some Ethiopian facilities exceeded 66.5% of all encounters, far above the WHO optimal of $\leq 20\%$ - 26.8% (Melku, Wubetu and Dessie, 2021).

Additionally, supply chain managers frequently fail to share critical information such as current stock status with prescribers; this miscommunication not only increases wastage but also prolongs the time required to dispense correct medicines and adequately fulfil prescription orders (Bhakoo, Singh and Sohal, 2012; Papalexi, Bamford and Breen, 2020). Multiple interacting factors shape pre-

scribing decisions, including educational background, workplace conditions, and the pharmaceutical market environment (Davari, Khorasani and Tigabu, 2018), making it difficult to attribute irrational prescribing to supply chain factors alone. However, the evidence suggests these factors are not independent: supply shortages create conditions in which even well-trained prescribers are compelled to deviate from rational prescribing guidelines.

3.3. Supply Chain Bottlenecks: Sub-Saharan Africa

In Sub-Saharan Africa and other low-resource settings, pharmaceutical supply chains encounter systemic challenges that significantly affect medicine availability. Studies have identified weak regulatory systems, persistent medicine stock-outs, poor demand forecasting capacity, and inadequate human resources as major bottlenecks (Muiruri and Mugambi, 2017; Otuto, Chizuroke and Udo-chiamaka, 2018; Aigbavboa and Mbohwa, 2020). Corruption, political instability, and severe financial constraints further disrupt procurement and distribution systems throughout the region (Olutuase et al., 2022). Problems associated with medicine availability in public hospitals have been attributed to budget shortages, bureaucratic delays, distribution failures, lack of skilled personnel, inappropriate selection of medicines, and an inability to accurately estimate requirements (Muhia, Withera and Songole, 2017).

Country-level evidence from across the region demonstrates the breadth and consistency of supply chain failures. In Kenya, shortages of medical supplies in public health facilities prevented patients from accessing subsidized essential products (Fredrick and Muturi, 2016). In Uganda, despite commitments to improving accessibility and availability of essential drugs, actual realization remains poor and structural bottlenecks at each stage of the supply chain have not been systematically identified or documented (Okot-Chono et al., 2009). In South Africa, procurement inefficiencies caused medicine parcels to reach facilities without all prescribed medicines, substantially increasing pharmacy workloads and creating barriers to timely patient care (Magadzire et al., 2014). In Nigeria, systemic weaknesses in outbound pharmaceutical value chains, including distribution infrastructure, regulatory gaps, and procurement bureaucracy, were found to worsen stockout frequency and duration (Aigbavboa and Mbohwa, 2020; Olutuase et al., 2022).

Shortages of essential medicines in clinic settings have also been associated with poor stock control and management practices, particularly in nurse-managed pharmacies at primary health facilities (Zuma and Modiba, 2019). While these findings represent distinct national contexts, they share a common pattern: supply chain failures concentrated at the last mile, compounded by human resource constraints and weak information systems.

Association with Medication Access and Prescribing Practices across the Region

In South Africa, a survey of 231 facilities documented 609 stockout events over

three years, with antiretroviral medications alone accounting for 78% of all reported stockouts (Wolvaardt et al., 2020), illustrating how stockouts concentrate around the medicines most critical to survival. Similarly, another study in South Africa demonstrated that stockouts resulted in medicine parcels being dispatched to health facilities with incomplete supplies of prescribed medicines (Magadzire et al., 2014). In Zambia, a large-scale randomized experiment across 439 health facilities found stockout frequencies for first-line pediatric malaria medicines as high as 47.9% under standard supply chain arrangements (Vledder et al., 2019).

Global studies highlight that PFRs are closely associated with the overall performance of pharmaceutical supply chains; poor communication between logistics managers and prescribers often delays medication access and reduces prescription fulfilment rates (Papalexi, Bamford and Breen, 2020). In Eritrea, where supply chains were better coordinated, 87% of available drugs were adequately dispensed in referral hospitals (Siele et al., 2022), demonstrating direct evidence of how improved supply chain performance translates directly into better prescription fill rates.

The potential association between supply chain bottlenecks and prescribing practices has been partially documented across Africa, though the evidence base remains incomplete and largely associational. A narrative review of antibiotic use across Sub-Saharan African hospitals found prevalence rates ranging from 37.7% in South Africa to as high as 80.1% in Nigeria, with the majority of facilities exceeding 50%, all substantially above the WHO optimal of $\leq 20\%$ - 26.8% (Siachalinga et al., 2023). Considerable prescribing of broad-spectrum antibiotics was found across the region, often driven by the absence of microbiological diagnostic facilities and concerns about co-payments for laboratory tests, resulting in widespread empiric prescribing (Siachalinga et al., 2023). In Zambia, antibiotics were found to constitute 72.3% of all patient encounters in a post-COVID hospital study (Mudenda et al., 2024), substantially exceeding the WHO optimal. In Ethiopia, antibiotic encounter rates were reported between 44.5% and 85% across different facilities, consistently surpassing WHO benchmarks and reflecting the compounding effect of stockouts on irrational prescribing (Melku, Wubetu and Dessie, 2021). A qualitative study in Addis Ababa primary healthcare facilities assessed both supply chain constraints and prescribing practice at the same facilities and revealed that supply shortages, absent treatment guidelines and non-review of patient history pose a direct association on private sector prescribing (Altaye, Thupayagale-Tshweneagae and Mfidi, 2024).

The following tables provide structured syntheses of the evidence reviewed:

- 1) **Table 1:** Summarizes medicine access rates across selected countries and regional contexts.
- 2) **Table 2:** Document stockout prevalence and contributing supply chain bottlenecks.
- 3) **Table 3:** Presents observed prescribing practices in SSA against the WHO prescribing indicator reference values.

Table 1. Medicine access rates in Sub-Saharan Africa and global comparators.

Country/Region	Source	Medicine Access Rate/Prescription Fill Rate	Measurement Method	Notes
Global (LMICs)	(Yadav, 2015; Vledder et al., 2019)	Average essential medicine accessibility in public facilities was as low as 29.4% across WHO regions; prescription fill rates were 30% - 60% at the primary care level	(WHO-HAI) survey methodology; supply chain field experiment	Chronic underperformance driven by procurement failures and last-mile distribution gaps
Sub-Saharan Africa (SSA)	(Yenet, Nibret and Tegegne, 2023; Lane et al., 2024)	Medicine accessibility in public facilities is substantially lower than in private facilities across Africa; availability is categorized as low (<50%) in most primary care contexts	Systematic scoping review of 198 availability studies using the WHO/HAI methodology	Urban-rural divide compounds access inequity; the poorest populations are most affected
Eritrea	(Siele et al., 2022)	87% of available medicines were adequately dispensed in referral hospitals, with the highest performance reported in the reviewed SSA literature	(WHO/INRUD) core drug use indicators evaluation	Better supply chain coordination was associated with improved dispensing and access rates.
Ethiopia	(Tessema et al., 2022; Yenets, Nibret and Tegegne, 2023)	Essential medicine accessibility ranged from very low (<30%) to fairly high (>50%), depending on facility level and medicine category; COVID-19 worsened stockout rates.	Comparative cross-sectional study using the WHO drug availability index	NCD and chronic disease medicines are most severely affected during supply disruptions
South Africa	(Fredrick and Muturi, 2016; Wolvaardt, Nemuntandani and Kamungoma-Dada, 2020)	231 facilities reported 609 stockout events; ARV medicines accounted for 78% of all stockouts; medicine parcels reached facilities with incomplete supplies	Stop Stock Outs Project (SSP) case management database; cross-sectional study	Stockouts are described as “normal” despite severe treatment interruption consequences
Malawi	(Chiumia et al., 2024)	Accessibility of essential pediatric medicines varied substantially between public and private facilities; private sector rates were consistently higher.	WHO/HAI methodology; facility survey	Foreign exchange shortages compounded medicine procurement challenges
Zambia	(Vledder et al., 2019; Musamba and Mwanza, 2025)	Stockout frequency for first-line pediatric malaria medicines was 47.9% under standard supply chain arrangements; approximately 40% of Ndola District facilities experienced regular stockouts.	Randomized experiment across 439 facilities; cross-sectional survey	Shift to direct distribution model reduced stockout frequency from 47.9% to 13.3%
Kenya	(Fredrick and Muturi, 2016; Lane et al., 2024)	Patients were unable to access subsidized essential medicines at public facilities due to frequent shortages; private sector prices are unaffordable for the majority of patients	Facility survey; scoping review	Human resource shortages and inadequate procurement capacity are the primary drivers.

Table 2. Stockout rates and key supply chain bottlenecks by country/region.

Country/Region	Source	Stockout Rate/Frequency	Medicines Most Affected	Primary Supply Chain Bottleneck(s)
Global	(Yadav, 2015; Josh, David and Jenny, 2025)	Drug shortages affect over 50% of countries across all income levels; the burden is disproportionate in LMICs	Essential medicines broadly: antibiotics, ARVs, and chronic disease medicines	Procurement bureaucracy, poor forecasting, and inadequate regulatory frameworks
Sub-Saharan Africa	(Vledder et al., 2019; Alfaouri, Jaaron and Igudia, 2025)	40% - 60% of primary health facilities experience regular stockouts; some country surveys exceed 60%	First-line antibiotics; ARVs; malaria medicines; vaccines	Weak inventory management; last-mile distribution failures; inadequate human resources
South Africa	(Wolvaardt, Nemuntandani and Kamungoma-Dada, 2020)	609 stockouts reported across 231 facilities over three years (2013-2015); ARVs were most affected (78% of events)	Antiretroviral therapy (78%); anti-infectives (17.1%); TB medicines (4.9%)	Procurement inefficiencies, urban-rural facility disparities, and nurse-managed pharmacies with poor stock control
Ethiopia	(Tessema et al., 2022; Melku, Wubetu and Dessie, 2021)	COVID-19 increased stockouts of cardiovascular and diabetes medicines; availability < 50% in many facilities	Chronic disease (NCD) medicines, antibiotics, and antimalarials	Central Medical Store distribution failures, inadequate transport, and weak demand forecasting
Zambia	(Vledder et al., 2019; Kamere et al., 2023; Musamba and Mwanza, 2025)	47.9% stockout frequency for first-line pediatric malaria medicines; 40% of Ndola District facilities with regular stockouts; average 27 days of stockout per quarter	Pediatric malaria medicines, antibiotics, and family planning supplies	Last-mile distribution to remote facilities; poor eLMIS utilization; weak DHMT coordination; inadequate stock monitoring
Kenya	(Fredrick and Muturi, 2016)	Frequent shortages of medical supplies prevented patient access to subsidized essential products across public facilities.	Essential medicines broadly include diagnostic supplies.	Weak procurement and storage; inadequate human resources; budget shortfalls
Uganda	(Okot-Chono et al., 2009)	Structural bottlenecks at each stage of the supply chain are documented; poor realization of drug availability commitments.	ARVs; TB medicines; essential primary care medicines	Bureaucratic procurement; corruption; documentation gaps; systemic last-mile failures
Nigeria	(Aigbavboa and Mbohwa, 2020; Oluatase et al., 2022)	Worsened stockout frequency and duration across outbound pharmaceutical value chains	Vaccines, antibiotics, and essential medicines broadly	Distribution infrastructure gaps, regulatory weaknesses, procurement bureaucracy, and corruption

Table 3. Prescribing practices against WHO prescribing indicator reference values.

Country/Region	Source	Key Prescribing Practice Finding(s)	The WHO Indicator Values Observed	Interpretation
Global (LMICs)	(Latifah et al., 2019)	Over 50% of all medicines globally are prescribed or dispensed irrationally; irrational prescribing reduces medicine availability by up to 50%	Antibiotic prescribing frequently exceeds $\leq 20\%$ - 26.8% optimal; generic prescribing often falls below 100% target	Irrational prescribing and stockouts form a self-reinforcing cycle of scarcity and waste

Continued

India	(Lavtepatil and Ghosh, 2025)	47% of prescriptions were irrationally prescribed; only 19% of prescriptions contained complete dosing information; branded medicines were overused	Generic prescribing: 61% (optimal: 100%); incomplete prescriptions: 81%	Brand-name promotion and weak SOPs drive irrational prescribing; it is costly for patients
Ethiopia	(Melku, Wubetu and Dessie, 2021; Altaye, Thupayagale-Tshweneagae and Mfidi, 2024)	Polypharmacy and antibiotic overprescribing are common across public facilities; stock shortages due to absent guidelines, and the private sector's influence on prescribing.	Antibiotic encounters: 44.5% - 85% (optimal: $\leq 20\%$ - 26.8%); medicines per encounter: up to 4.8 (optimal: 1.6 - 1.8)	Supply stockouts compel even trained prescribers to deviate from rational prescribing guidelines; private sector prescribing cascades into public facilities.
South Africa	(Magadzire et al., 2014; Siachalinga et al., 2023)	Antibiotic prescribing prevalence ranged from 37.7% (lowest in SSA) to 68.7% at the primary care level; guideline adherence was as low as 4%	Antibiotic encounters: 37.7% - 68.7% (optimal: $\leq 20\%$ - 26.8%); guideline adherence: 4% - 45.1%	Prescribing remains significantly above WHO benchmarks; stockouts of first-line medicines drive empiric and suboptimal substitution
Zambia	(Kamere et al., 2023; Mudenda et al., 2024)	Antibiotics constituted 72.3% of all patient encounters post-COVID, far exceeding the WHO optimal range; AMS was compromised by supply constraints.	Antibiotic encounters: 72.3% (optimal: $\leq 20\%$ - 26.8%)	The highest antibiotic prescribing rate was documented in the reviewed literature; supply chain failures may amplify AMR risk.
Ghana	(Hailesilase et al., 2024)	AMS intervention reduced antibiotic encounters from 36% to 18%; generic prescribing improved from 76% to 80% post-intervention	Antibiotic encounters: 36% $\rightarrow$ 18% post-AMS; generic prescribing: 76% $\rightarrow$ 80%	Structured stewardship programs can halve irrational antibiotic prescribing at the facility level when implemented consistently
Eritrea	(Siele et al., 2022)	Improved supply chain coordination associated with better prescribing quality; 87% dispensing rate at referral hospitals	Dispensing rate: 87% (highest in reviewed SSA literature)	Suggests that supply chain performance may be an important contributor to prescribing quality and medication access
Nigeria	(Aigbavboa and Mbohwa, 2020; Siachalinga et al., 2023)	Antibiotic use prevalence as high as 80.1% in hospitals; guideline adherence is low; empiric prescribing is driven by the absence of diagnostics	Antibiotic encounters: 80.1% (optimal: $\leq 20\%$ - 26.8%); guideline adherence: low	Highest antibiotic prescribing prevalence documented in SSA; absence of diagnostics may drive empiric overprescribing

Continued

Rwanda	(Icyishatse et al., 2026)	Among 655 inpatients, 44.76% received at least one antibiotic; 1.95 antibiotics were prescribed per patient; deviation from national STGs	Antibiotics per patient: 1.95; antibiotic encounters: 44.76% (optimal: ≤20% - 26.8%)	Availability of antibiotics and prescription guidelines is limited in the facility; the AMS program is recommended.
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4) **Table 4:** Presents documented interventions in SSA.**Table 4.** Documented interventions to address supply chain bottlenecks and prescribing irrationality in Sub-Saharan Africa.

Intervention	Country/Region	Evidence of Effectiveness	Limitations/Gaps
Electronic Logistics Management Information Systems (eLMIS)	Sub-Saharan Africa (Mkumbwa et al., 2023; Milulu, Mwita and Basinda, 2024)	Reduced reporting turnaround time; improved inventory visibility	Connectivity challenges in remote areas, poor data entry quality, and inadequate training limit uptake
Push-to-Pull Supply Model Reform	Zambia (Tayob, 2012; Vledder et al., 2019)	Improved supply chain responsiveness; reduced national-level overstocking	Facility-level demand forecasting capacity remains weak; limited evidence at the primary care level
District-Level Supply Chain Support Supervision	South Africa (Tayob, 2012)	The impact of supervisory visits shows Improved ordering compliance and better stock monitoring	District pharmacists usually do not manage to visit all the facilities for technical supervision
Capacity Building for Facility-Level Pharmacy Staff	Tanzania (Mkumbwa et al., 2023)	Improved inventory management practices; reduced wastage in trained facilities	High staff turnover; limited qualified pharmacy personnel in rural PHCs; evaluation data sparse
Antimicrobial Stewardship Programs (ASPs)	Ghana, Zambia (Mudenda et al., 2024; Abruquah et al., 2025)	Antibiotic encounters reduced from 36% to 18% post-AMS intervention (Ghana); improved AWARe adherence	Primarily implemented at secondary/tertiary level; limited evidence for primary care; resource-intensive

Table 1 reveals a consistent disparity in medicine access between high-income settings and public health facilities across Sub-Saharan Africa. Globally, essential medicine accessibility in public facilities averages as low as 29.4% across WHO regions, with prescription fill rates falling to 30% - 60% at the primary care level in LMICs, far below the near-universal access observed in well-resourced settings. Within the SSA region, availability is consistently classified as low (below 50%) in most public primary care contexts, driven by last-mile distribution failures, procurement shortfalls, and weak inventory management.

Table 2 maps the depth of supply chain failures across SSA and demonstrates that medicine stockouts are not random or isolated events but reflect structural bottlenecks embedded at multiple levels of the pharmaceutical supply chain. Globally, drug shortages affect more than 50% of countries, with the burden disproportionately concentrated in LMICs. At the regional level, 40% - 60% of pri-

mary health facilities in SSA experience regular stockouts, a figure that exceeds 60% in some country surveys driven by weak inventory management, last-mile distribution failures, and inadequate human resources.

Table 3 presents evidence that prescribing practices across SSA deviate substantially from WHO optimal benchmarks. These deviations appear to be associated with supply chain failures, though multiple factors, including prescriber training, diagnostics availability, and patient demand, are also likely contributors. The most striking pattern is the overuse of antibiotics: antibiotic encounter rates range from 37.7% in South Africa to as high as 85% in Ethiopia and 80.1% in Nigeria, all substantially exceeding the WHO optimal threshold of 20% - 26.8%. Polypharmacy is equally concerning, with medicines per patient encounter reaching up to 4.8 in some Ethiopian facilities against a WHO optimal of 1.6 - 1.8.

Table 4 presents the key interventions documented across SSA to address supply chain bottlenecks and prescribing irrationality, revealing a landscape of promising but unevenly implemented and underexplored strategies. Electronic Logistics Management Information Systems (eLMIS) have demonstrated clear benefits in reducing reporting turnaround times and improving inventory visibility; however, their impact remains constrained by connectivity challenges in remote areas, poor data entry quality, and inadequate staff training barriers that are especially pronounced at the primary care level, where they are needed most.

3.4. Supply Chain Bottlenecks, Medication Access and Prescribing Practice: Local Perspective (Zambia)

In Zambia, the primary distribution of essential medicines is managed by the Zambia Medicines and Medical Supplies Agency (ZAMMSA), while secondary distribution falls under the responsibility of District Health Management Teams (DHMTs) (Kamere et al., 2023). At the district level, supply chain performance depends heavily on coordination between facility staff and district health offices. Despite district officers providing technical support and monitoring ordering patterns, inefficiencies in reporting and demand forecasting are still linked to medicine shortages and delayed deliveries (Vledder et al., 2019). A study in Ndola District found that approximately 40% of health facilities experienced regular stockouts of essential medicines, reflecting systemic supply chain failures despite substantial national investments (Musamba and Mwanza, 2025).

Consistent with findings in Sub-Saharan Africa, facilities in remote areas face particularly acute challenges arising from inadequate transportation infrastructure, while urban facilities encounter inefficiencies in inventory management (Musonda and Mutono-Mwanza, 2025). These challenges are worsened by poor data quality, weak inventory management systems, and limited technical capacity among health workers responsible for supply chain management (Omole et al., 2019).

Health supply chain bottlenecks in Zambia limit access to essential medicines, reduce prescription fill rates, and compel patients to seek treatment from private pharmacies or alternative facilities (Steele et al., 2019). Additionally, supply chain

constraints were associated with antibiotics constituting 72.3% of all patient encounters post-COVID, far exceeding the WHO optimal range, which compromised AMS efforts (Mudenda et al., 2024).

4. Discussion

The findings consistently reveal that supply chain bottlenecks spanning procurement inefficiencies, poor demand forecasting, weak inventory management, and last-mile distribution failures are strongly associated with reduced medication access and deviations from rational prescribing practice. Where supply chains fail, prescription fill rates fall, and prescribing practice shifts toward irrational patterns. Within SSA, access to essential medicines is classified as low (below 50%) in most public primary care contexts across the continent (Lane et al., 2024).

The contrast offered by Eritrea, where better supply chain coordination was associated with 87% of available medicines being adequately dispensed, underscores a critical point: improved supply chain performance can meaningfully raise prescription fill rates even in resource-limited settings in SSA (Siele et al., 2022). In Uganda, structural bottlenecks at each stage of the supply chain have prevented the realization of drug availability commitments, with procurement bureaucracy, corruption, and documentation gaps as primary drivers (Okot-Chono et al., 2009); in Nigeria, distribution infrastructure gaps and regulatory weaknesses worsen both the frequency and duration of stockouts (Aigbavboa and Mbohwa, 2020; Olutuase et al., 2022); and in Zambia, facilities in Ndola District experienced an average of 27 days of stockout per quarter, with poor eLMIS utilization and weak DHMT coordination identified as proximate causes (Vledder et al., 2019; Kamere et al., 2023; Musamba and Mwanza, 2025).

Prescribing practices are shaped by complex interactions among medicine availability, clinical guidelines, diagnostic capacity, healthcare worker training, patient expectations, antimicrobial stewardship programs, and broader health system governance. It is important to emphasize that prescribing practice is multifactorial: supply chain performance is one significant contributing factor among several, and the evidence reviewed does not establish a causal pathway but rather suggests a strong association. Consequently, supply chain bottlenecks may contribute to irrational prescribing practices through reduced therapeutic options, increased empirical prescribing, and therapeutic substitution. Across all levels of evidence, global, regional, and local, a consistent pattern emerges: supply chain bottlenecks, particularly stockouts, last-mile distribution failures, and inventory management weaknesses, are consistently associated with reduced medicine accessibility and suboptimal prescribing practices (Yadav, 2015; Papalexi, Bamford and Breen, 2020; Musamba and Mwanza, 2025).

Three themes recur across all geographic contexts reviewed. Firstly, the gap between national-level medicine procurement and facility-level availability is a common characteristic of health systems in LMICs that has persisted despite increased health funding. This is evident in SSA, for instance, in Zambia, 40% of primary

health facilities report regular stockouts despite substantial national investments in ZAMMSA (Musamba and Mwanza, 2025). Secondly, irrational prescribing is consistently linked not only to prescriber knowledge gaps but to the availability of medicines at the point of care. Thirdly, primary health care facilities consistently emerge as the weakest link in the supply chain, yet are the least studied and the most consequential for population health outcomes.

The relative effectiveness of push versus Pull supply models and the role of eLMIS in improving supply chain coordination are key factors that can influence supply chain performance. While technology-enabled systems have shown promise in some contexts (Vledder et al., 2019), their implementation has been constrained by infrastructure limitations, inadequate training, and poor data entry practices at the facility level. The evidence does not yet support a strong conclusion on optimal supply system design for primary care settings in SSA, underscoring the need for more evaluation research. Additionally, capacity building for pharmacy staff in Tanzania improved inventory management and reduced waste in trained facilities, yet the benefits are frequently eroded by high staff turnover and the persistent shortage of qualified pharmacy personnel in rural primary health centers (Mkumbwa et al., 2023).

Antimicrobial stewardship programs, as demonstrated in Ghana and Zambia, hold significant promise in cutting antibiotic encounter rates in half in some settings but have primarily been implemented at secondary and tertiary facility levels, leaving primary care largely unaddressed (Mudenda et al., 2024; Abruquah et al., 2025). Similarly, many other studies in the SSA region have shown that ASPs are very critical in promoting the rational use of antibiotics and improving patient outcomes. At least 20 ASPs have been successfully implemented across Africa in recent years to improve antimicrobial prescribing, with checklists and guidance now being developed for SSA and beyond to help with their development and implementation (Saleem et al., 2022). ASPs are instrumental in curbing inappropriate antibiotic use and AMR and should be implemented in healthcare settings in LMICs. However, effective ASPs must be integrated with other components required for health systems strengthening, i.e. IPC, WASH facilities, adequate diagnostic microbiology services and efficient governance frameworks (Otaigbe and Elikwu, 2023).

The findings of this review carry several important implications for policymakers, health managers, and supply chain practitioners across Africa. Firstly, interventions must be multi-level, addressing procurement, distribution, facility-level inventory management, and prescribing practice simultaneously, since the supply chain system is an interconnected system requiring multi-sectoral coordination. Secondly, primary-level health facilities require dedicated attention in national supply chain strategies. These facilities serve the majority of the population yet face the most severe human resource and infrastructure constraints. Thirdly, strengthening the bond between supply chain managers and clinical care, particularly communication between pharmacy personnel and prescribers regarding

stock status, is a low-cost, high-impact intervention that the evidence consistently supports (Bhakoo, Singh and Sohal, 2012; Papalexi, Bamford and Breen, 2020).

However, the literature reviewed has several important limitations. Firstly, there is significant variation in how supply chain bottlenecks, medication access, and prescribing practices are measured, making direct comparisons difficult. A substantial proportion of the included studies rely on cross-sectional designs, which capture supply chain performance and prescribing outcomes at a single point in time and therefore cannot establish temporal precedence. Cross-sectional studies are particularly limited in contexts characterized by seasonal variation in medicine demand and episodic procurement cycles, such as those observed in many SSA health systems, where a single measurement may not reflect typical facility-level conditions. Secondly, the majority of studies focus on secondary or tertiary level facilities, or on national supply systems, with comparatively little evidence from primary care settings.

Thirdly, most studies examine supply chain performance or prescribing practices in isolation, rather than assessing both outcomes simultaneously. A related methodological concern is the widespread use of self-reported outcomes in both supply chain and prescribing studies. Many studies relied on facility staff reports or prescription records that were subject to social desirability bias, recall error, or incomplete documentation. Self-reported medicine availability data, for instance, may overestimate actual stock because facility managers may under-report stock-outs for fear of administrative scrutiny. Similarly, prescribing data derived from self-completed registers or patient-reported dispensing may not accurately capture the true frequency of polypharmacy or antibiotic overprescribing, particularly in settings with weak facility-based record systems. These measurement biases may lead to underestimation of both supply chain failures and irrational prescribing, potentially attenuating the observed associations reported in this review. Additionally, there is inconsistency in how supply chain performance was measured across the reviewed literature. This heterogeneity in supply chain measurement makes it extremely difficult to benchmark performance across countries and health system levels. The absence of a consensus measurement framework for supply chain bottlenecks in LMIC primary care settings represents a critical methodological gap that future research must address if the field is to move from descriptive synthesis toward evidence-based supply chain optimization.

Finally, unlike systematic reviews, narrative reviews are more susceptible to selection bias and may lack full reproducibility because study inclusion and synthesis are inherently more interpretive. Although this review employed structured search procedures and explicit eligibility criteria to improve transparency, some relevant studies may still have been missed, particularly unpublished reports and non-English literature. Therefore, the conclusions should be interpreted as a comprehensive thematic overview rather than definitive causal evidence, making the findings sufficient to suggest a relationship between health supply chain bottlenecks, medication access and prescribing practices in SSA.

Future research priorities emerging from this review include: mixed-method studies that simultaneously assess supply chain bottlenecks, medication access, and prescribing practices using the WHO indicators at primary health care level; longitudinal designs that track PFRs and prescribing quality before and after supply chain interventions; evaluation of eLMIS implementation at the facility level with attention to data quality and user capacity; and intervention studies testing the impact of improved communication between pharmacy staff and prescribers on prescribing practices.

Policy Implications and Strategic Recommendations

Table 5 translates the cumulative evidence from this review into six clearly defined and evidence-grounded policy priority areas, providing a practical roadmap for governments, health ministries, and international partners. Each recommendation is directly anchored to a documented supply chain failure identified in the reviewed literature, making **Table 5** both a diagnostic and prescriptive tool. Together, the six priority areas represent a multi-level, interconnected policy response that mirrors the complexity of the supply chain system itself, and underscore that gradual interventions targeting only one level of the supply chain will be insufficient to achieve sustained improvement in medicine access and prescribing quality across SSA.

Table 5. Policy implications and strategic recommendations arising from the review.

Priority Area	Recommended Action	Rationale/Evidence Base
Procurement and Manufacturing Reforms	Streamline procurement bureaucracy; strengthen quantification and forecasting capacity. Sub regional collaborations among countries for bulk procurement or manufacturing (e.g. SADC, ECOWAS)	Procurement failures are identified as a leading cause of stockouts across SSA (Muhia, Withera and Songole, 2017; Alfaouri, Jaaron and Igudia, 2025)
Human Resource Development	Recruit and deploy qualified Pharmacy personnel at the primary care level; provide targeted supply chain training.	Human resource shortages critically undermine supply chain performance in primary facilities (Muiruri and Mugambi, 2017; Yenet, Nibret and Tegegne, 2023)
Last-Mile Distribution	Invest in road infrastructure; introduce mobile distribution units for remote facilities; ring-fence distribution budgets.	Last-mile failures are the most consistent bottleneck identified across all geographic contexts reviewed (Yadav, 2015; Steele et al., 2019)
Information Systems	Expand eLMIS with offline functionality; conduct regular data quality audits; train all facility staff on data entry.	Poor data quality and connectivity challenges undermine eLMIS effectiveness across rural SSA settings (Vledder et al., 2019)
Prescribing Practice Improvement	Mandate adherence to Standard Treatment Guidelines (STGs); implement antimicrobial stewardship programs at the primary care level; promote real-time stock communication between pharmacy and prescribers	Supply chain failures are associated with irrational prescribing practices; AMR risk may be amplified by stockouts (Papalexi, Bamford and Breen, 2020; Kamere et al., 2023; Mudenda et al., 2024)
Anti-Corruption and Governance	Strengthen accountability mechanisms; enforce penalties for procurement fraud; publish procurement data publicly.	Corruption and political interference are consistently identified as amplifying (Otuto, Chizuroke and Udochiamaka, 2018; Olutuase et al., 2022)

Therefore, beyond facility and district-level interventions, this review underscores the value of sub-regional collaboration across Africa in procurement and manufacturing, which has the potential to transform the structural determinants of medicine accessibility across SSA. Additionally, investment in road infrastructure would help mitigate or cushion the occurrence of last mile distribution failures. These recommendations are broader strategic proposals extrapolated from the identified structural bottlenecks, rather than interventions directly evaluated within the reviewed studies.

5. Conclusion

This narrative review presents organized evidence from global, regional, and local perspectives on the association of health supply chain bottlenecks with medication access and prescribing practices across SSA. The evidence consistently suggests that supply chain bottlenecks, particularly medicine stockouts, last-mile distribution failures, and inadequate inventory management are strongly associated with reduced medication access and deviations from recommended prescribing practices. However, it is important to acknowledge that prescribing practice is multifactorial, and supply chain performance represents one of several contributing influences alongside clinical training, diagnostic capacity, patient demand, and governance.

Primary-level health facilities, which constitute the frontline of healthcare delivery for the majority of the African population, are disproportionately affected and yet remain the least studied. Beyond the need for future research, the evidence synthesized here points to concrete actions that health systems can pursue now, such as streamlining procurement bureaucracy and strengthening quantification capacity to reduce forecasting errors. Additionally, expanding eLMIS with offline functionality and regular data quality audits to improve inventory visibility and deploying qualified pharmacy personnel at the primary care level to address the human resource gap that perpetuates poor stock management. Implementing ASPs at the primary care level alongside STGs to address prescribing irrationality driven by stockouts and investing in last-mile distribution infrastructure, including mobile distribution units for remote healthcare facilities are similarly grounded in the reviewed evidence.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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