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Narrative Review on Pharmaceutical Logistics Challenges in Developing Countries

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ABSTRACT

Background: Pharmaceutical logistics is crucial for ensuring timely, affordable and safe access to essential medicines especially in developing countries. However various systemic and structural challenges such as poor infrastructure, fragmented supply chains, weak governance and limited resources undermine effective distribution. These constraints negatively affect healthcare delivery and public health outcomes. This review explored the existing literature on logistics challenges affecting pharmaceutical supply chains and proposed solutions.

Methods: A narrative review design was adopted following the PRISMA guidelines. Extensive searches were conducted across databases including PubMed, Scopus, Web of Science and Google Scholar using defined keywords and Boolean operators. The search targeted studies published between 2015 and 2025. Inclusion criteria focused on peer reviewed articles and reports related to pharmaceutical logistics in developing countries. A total of thirty-five articles meet all eligibility criteria and were subjected to thematic analysis.

Results: Two hundred and thirty-five articles were identified through the searches (n=235) and fourteen articles with duplicated titles were excluded (n=14). Two hundred and twenty-one articles with titles and abstracts were screened (n=221). One hundred and seventy articles had their titles and abstracts not related (n=170). Fifty-one full-text articles were assessed for eligibility (n=51). Sixteen full-text articles were excluded for irrelevance (n=16), while thirty-five articles were used for the analysis (n=35). Five major themes emerged from the included studies. Twenty-eight studies were on infrastructure and technological deficiencies (n=28). Thirty studies focused on supply chain, management and co-ordination issues (n=30). Twenty-two studies were on human resources and capacity gaps (n=22). Twenty-five studies focused on financial and economic constraints while twenty-four articles, (n=24) focused on policy governance and regulatory challenges such as weak policy enforcement and corruption.

Conclusion: Pharmaceutical transportation in developing counties is constrained by a complex interplay of infrastructural, managerial, financial and political factors. While various innovations such as digital transformation and AI based tools show promise, their scalability is limited by resource and capacity gaps.

Introduction

The health care sector, particularly the pharmaceutical industry plays a significant role in contributing to the economy. A healthy population is essential for a productive workforce, which makes the availability of affordable and acceptable medical supplies crucial[1]. Pharmaceuticals account for a significant percentage of health care spending, while inadequate medication management makes it difficult to obtain medication which leads to waste and health risk[2]. Pharmaceutical logistics also known as pharma-logistics is the process that involves procurement, storage, transportation and distribution of pharmaceutical products. It ensures that the pharmaceutical product reaches the appropriate location at the right time[3]. A "well-functioning" logistics system must satisfy the six right of logistics[4]. Pharmaceutical products require precise handling, storage and transportation due to their sensitive nature.

Moreso, delays or disruptions in the supply chain can lead to stockouts, compromised drug quality or treatment

failures which have direct consequences on both public health and economic performance[5]. It is impossible to discuss pharmaceutical logistics without discussing pharmaceutical supply chain. The network of people, processes, information and resources that transform raw materials and components into finished goods and services before delivering them to customers is known as pharmaceutical supply chain[6]. Consequently, supply chain management (SCM) can be defined as the integration of crucial business processes throughout the supply chain with the aim of generating value for customers and stakeholders[7]. The stages involved in pharmaceutical supply chain be broken down as follows:

- Drug discovery and development: This step includes clinical trials and regulatory approvals which is the first step in research and development (R & D) process.
- Manufacturing: To guarantee safety and effectiveness, approved medications are produced in accordance with strict good manufacturing practices (GMP).
- Storage and warehousing: Some facilities are used to store medications particularly those products that are sensitive to temperature.
- Distribution: To ensure prompt delivery and integrity, products are shipped from producers to distributors down to medical facilities.
- Hospital users and retail pharmacies: Clinics, hospitals and pharmacies are the places where end users obtain medications.

Effective logistics systems are essential for maintaining the integrity and efficacy of medicines, particularly those that require specialized handling, such as vaccines and other temperature sensitive drugs. In developing countries where health care systems are often strained, the importance of robust pharmaceutical logistics systems cannot be over-emphasized. The proper organization of logistic systems from producer to the end user is an essential step in improving the allocation of available resources while also increasing the quality of healthcare[8]. Pharma logistics aim to facilitate an efficient supply chain that ensures customers satisfaction. The effective customization of necessary medications and medical supplies is hampered by flaws and structural gaps in developing nations. These problems jeopardize the pricing, accessibility and quality of medication which have detrimental effects on public health as seen in countries such as South-Africa. Regardless of economic standing, inadequate pharmaceutical logistics results in shortage of medications[9].

Nigeria and other Sub-Saharan Africa countries deal with corruption, weak regulatory framework, poor infrastructure and other challenges[10]. The impact of improved logistics on practice promotes cost efficiency and ensure that the right therapeutic interventions is achieved[11]. Across all the reviewed literatures, there is a consensus that resolving pharma logistics challenges in developing countries requires a multi-faced and systems-based approach. These include strengthening infrastructure, improving governance and regulatory oversight. Others are investing in local pharmaceutical production, storage capacity and accelerating digital transformation of supply chain. While some pilots interventions such as those in Zambia and Uganda have shown promise, the broader evidence indicates that scaling up such models remains a challenge in the face of systemic limitations. This review explored the existing literatures on the challenges and barriers affecting pharmaceutical logistics in developing countries.

Methods

The review followed the PRISMA guidelines for narrative reviews. (Preferred Reporting Items for Systematic Reviews and Meta-Analysis)[12].

Search Strategy

A search of 4 electronic data bases (PubMed, Scopus, web of science and Google Scholar) was conducted to identify relevant studies between 2015 and 2025. MOA, RIO and ICI carried out the database search using the key words “Logistics”, “or”, “Transportation”, “challenges”, “And”, “Distribution”, “Medicines”.

Additional articles were also manually extracted from the reference list of selected articles to obtain relevant information on pharma logistics challenges in developing countries.

Inclusion and exclusion criteria

Studies that were expected to be considered for the review were expected to describe pharmaceutical logistics challenges in developing countries. The inclusion criteria for the study include peer reviewed articles between 2015 and 2025, studies published in English language, descriptive qualitative case study, cross sectional studies and reports related to pharmaceutical logistics and developing countries. Other included studies are research reports on developing countries, World Health Organisation (WHO) and United Nations (UN).

The exclusion criteria were research studies that focused only on developed countries. Also excluded were studies that focused on general supply chain management, opinion pieces, blog posts and non-peer reviewed articles.

Data synthesis

All the articles identified were screened independently by EJU, EEA and ICI. The selection process involved multiple steps by the three researchers. The collected articles are managed by using the Zotero reference manager after a prior review of the articles and abstracts. Two independent reviewers were involved in the data extraction process to minimize bias and improve accuracy. Any discrepancies in data extraction were resolved through discussion or consultation with a third reviewer. The extracted data were discussed under suitable themes and headings and subsequently entered into a Microsoft Excel Spread Sheet for easy analysis and organization.

Results:

The search process initially generated 235 results. After removing duplicates, 221 unique articles remained. These articles were then screened based on their title and abstracts which removed 170 articles. The resulting 51 articles were considered for further evaluation. Full-text access was obtained for the 51 articles and their eligibility was assessed. 16 articles were further excluded for not meeting the eligibility criteria. Consequently, 35 articles were selected and included for the reviews. Figure 1 provides a visual representation of the selection process.

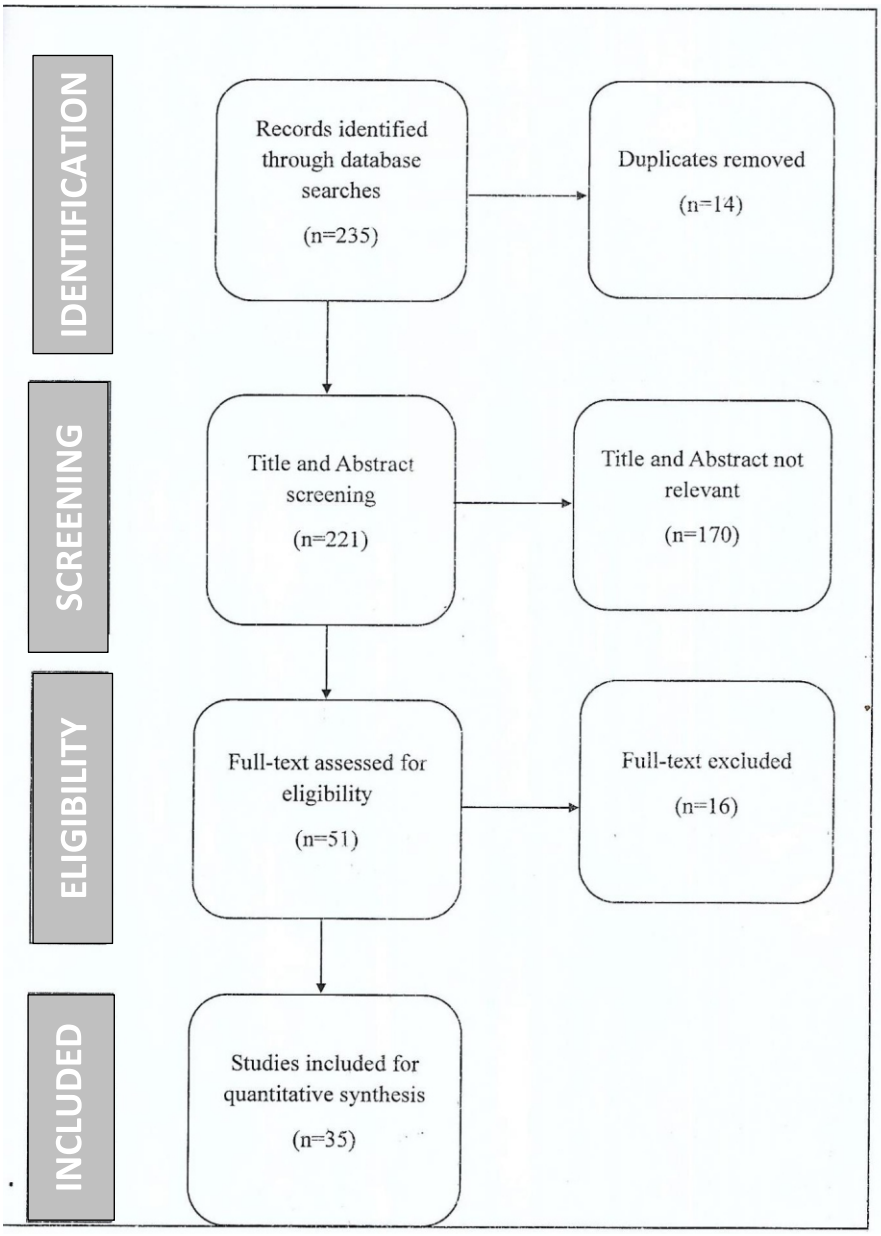

Figure 1: PRISMA Flowchart of study selection

The thematic analysis of the selected studies identified five and several sub-themes. These themes represent the core barriers affecting the efficiency, reliability and effectiveness of pharmaceutical logistics systems in low- and middle-income countries.

Theme 1: Infrastructural and Technological Deficiencies

Sub-Theme 1:1: Poor road and transportation networks

The findings reveal that inadequate infrastructure, particularly poor road networks and unreliable transportation systems have been widely reported as significant barriers to effective pharmaceutical distribution[13,14,15].

Sub-Theme 1:2: Lack of cold chain infrastructure

The findings revealed that challenges with cold chain logistics, especially with vaccines and other temperature-sensitive medicines were evident[16,17,18].

Sub-Theme 1:3: Limited digital infrastructure and traceability systems:

Digital tools such as drug traceability system and logistics management information systems are underutilized or poorly implemented in many settings[19,20,21].

Theme 2: Supply chain management and coordination challenges

Sub-Theme 2:1: Fragmented logistics systems and ineffective procurement processes.

The findings revealed an enormous lack of integration and coordination within national supply chain systems.

Sub-Theme 2:2: Stockouts, excess inventory and weak data sharing.

The findings revealed that stockouts, overstocking and weak data sharing were some of the challenges. More so, poor data visibility and fragmentation between facilities contribute to misaligned ordering and forecasting.

Theme 3: Human resources and capacity gaps:

Sub-Theme 3:1: Lack of skilled personnel and inadequate training

The findings revealed that many health systems are constrained by a shortage of personnel trained in pharmaceutical logistics and supply chain management[22]. In addition, in-service training opportunities are limited, while the existing workforce often lacked specialized skills[23].

Sub-Theme 3:2: Weak supervision structures and high staff turnover.

The findings revealed that high staff turnover and poor supervision impacted service delivery and institutional capacity negatively[24].

Theme 4: Financial and Economic Constraints

Theme 4:1: Inadequate logistics finding and high fuel/transport cost

In many low-income settings, logistics funding is insufficient and often not prioritized in health budgets[25].

In addition, high transport and fuel costs, coupled with inflation make routine delivery costly and unsustainable[26]

Sub-Theme 4:2: Dependence on donor support and budget mismanagement

Several studies highlighted the overdependence on donor program for essential medicines and vaccines, raising concerns about long-term sustainability. In addition, budget mismanagement was also a challenge[27,28].

Theme 5: Administration and regulatory challenges

Sub Theme 5:1: Weak policy improvement and regulatory fragmentation

The findings revealed that many countries have pharmaceutical logistics policies that are either outdated or poorly enforced[29,30,31].

In addition, regulatory fragmentation and lack of harmonization across tiers of government lead to conflicting practices[32,33,34].

Sub-Theme 5:2: Bureaucratic bottlenecks were also reported to delay procurement, licensing and distribution processes[35]

DISCUSSION

Infrastructural and technological deficiencies:

Poor road and transportation networks

A prevalent challenge across developing countries is the lack of robust infrastructure to support efficient pharmaceutical logistics. Poor road networks, unreliable electricity and insufficient storage facilities, particularly for cold chain products pose significant obstacles to last-mile delivery of essential medicines[10,13,14].

In Nigeria, bad road conditions and fuel scarcity lead to delays in deliveries and increase medicine wastage due to expiration or spoilage[10,18].

Lack of cold chain infrastructure:

Lack of cold chain infrastructure is worsened by

technological deficiencies in developing countries. Although the global trend tilts towards digitalized logistics systems, the lack of integrated pharmaceutical logistics systems results in discrepancies between stock levels and actual demand, ultimately leading to mismanagement. For instance, in Ethiopia, there is a notable gap in the technological systems used for inventory management[2].

Limited digital infrastructure and traceability system

Many developing countries have yet to fully adapt or integrate digital infrastructure for pharmaceutical traceability, inventory control or data sharing[19,20]. In Ghana and other sub-saharan African countries, the adoption of digital drug traceability systems has been slow, preventing real-time tracking of pharmaceutical products and exposing the supply chain to inefficiencies, efforts to implement drug traceability systems often fail due to limited internet connectivity, lack of technical expertise and insufficient funding[36].

Supply chain management and coordination challenges

Fragmented logistics systems and ineffective procurement processes

In many developing countries, supply chain management structures are fragmented and often characterized by parallel systems that do not communicate or share data effectively[36,37]. Nigeria, faces a lack of coordination between various stakeholders such as suppliers, hospital and government agencies which leads to mismatched supply and demand, causing shortage or overstock of medicines[36]. The fragmentation leads to challenges such as overstocking in one region while another faces critical shortages[37].

Stockouts and excess inventory.

Stockouts and over stocking were significant challenges. In addition, poor data visibility and fragmentation between facilities contribute to inappropriate ordering and forecasting[37]. Frequent medicine shortages disrupt treatment regimens, particularly for patients with chronic conditions. Inconsistent supply and procurement delays raise operational costs. The inefficiency of the supply chain in developing nations requires that government and non-governmental organizations should allocate more resources to remedy stockouts and procurement challenges[31].

Human resources and capacity gaps

Lack of skilled personnel and inadequate training.

Health facilities in developing countries operate with limited or no staff dedicated specifically to supply chain activities[22]. Often the available staff are assigned logistics duties without proper training which ultimately affects the accuracy and reliability of inventory and distribution function[38]. In many developing countries such as Nigeria and Ethiopia, there is a shortage of inadequately trained personnel to manage supply chain operations. This results in poor inventory management and inefficiencies in the handling of pharmaceutical products[24].

High and low staff turnover and weak supervisory structures

High staff turnover and poor supervision impacted service delivery and institutional capacity negatively[24]. In addition, many health care facilities in developing countries such as Zambia and Uganda are understaffed, which impedes efficient supply chain operations. This often leads to overwhelmed staff and increased error rates in pharmaceutical distribution[23]. Moreso, high staff turnover, especially in rural or underserved areas, disrupts the continuity of processes and institutional learning[16,26]. These human resource issues are exacerbated by weak supervisory and mentorship systems[37]. The inefficiency caused by understaffing leads to increased operational costs and higher rates of wastage. This diverts essential funds that could be better appropriated in its health care system23.

Financial and economic constraints

Inadequate logistics funding and high fuel transport costs:

Transportation of pharmaceuticals in many developing countries are not adequately funded[10,24]. For instance, due to the low prioritization of supply chain infrastructure in national health budgets in Malawi and Zambia, the allocation to medicines is insufficient to meet population needs[24]. In addition, high transportation costs, which are caused by fluctuating fuel prices, poor road infrastructure and vehicle maintenance are also challenges[11,26]. More so, in many developing countries, health facilities are forced to rely on "adhoc" transport methods or informal channels often leading to delays or losses[25].

Dependence on donor support and budget mismanagement:

Several studies highlighted the over-relevance on donor funding particularly for critical medicines such as vaccines and anti-retro-viral[21,27-28]. While donor programmes provide critical support, they are often not aligned with national logistics systems, leading to sustainability and ownership issues[27]. It was evident that once donor funding ends, many countries struggle to maintain their supply chain systems

established through external support[32]. Insufficient financial resources limit access to life-saving medicines, Impacting the health outcomes, particularly for chronic diseases. As a result, the disease become harder to manage and patients experience worsened health conditions[24]. Financial constraints lead to insufficient procurement which increases costs and reduces funds available for other essential health care[24]. Financial constraints lead to insufficient procurement which increases costs and reduces funds available for other essential healthcare[24].

Administration and regulation challenges

Weak policy implementation and regulatory fragmentation:

Many developing countries have national supply chain or pharmaceutical policies that are poorly enforced[30, 31]. In Ethiopia, there are significant gaps in the enforcement of pharmaceutical distribution policies especially in rural areas where access to essential medicines is limited due to poorly implemented regulations[22]. In addition, there is notable fragmentation of regulatory frameworks across national, regional and local levels[33,34,35].

This lack of harmonization results in contradictory guidelines, duplication of roles and operational confusion among health workers. In Nigeria and Ghana, poor enforcement of policies has led to the circulation of substandard medicines[32].

Poor intergovernmental co-ordination:

Bureaucratic inefficiencies exist as a barrier to timely medicine procurement and distribution[4]. Similarly, despite technological advancements, policy and regularly bottlenecks can undermine innovative approaches such as artificial intelligence driven logistics[39].

Strengths and limitations of the study

This study provided useful insights and evidence-based understanding of pharmaceutical logistics challenges in developing countries. The use of thematic analysis enabled the identification of key patterns and themes across diverse contexts, improving its charity and depth of interpretation. The review objectives were achieved such as identifying major challenges, assessing their impact on health care and the economy, and highlighting viable solutions.

However, the study has some limitations. Only English language publications were considered, potentially excluding relevant studies in other languages.

Access to some potentially relevant search sites such as AJOL and relevant articles was restricted due to paywalls limiting the comprehensiveness of the data pool. In addition, some geographic regions were under represented in the article which affected the generalizability of the findings.

Conclusions

The major challenges affecting pharmaceutical transportation in developing countries were identified as poor infrastructure, weak supply chain coordination, technological gaps, financial constraints and inadequate policies. These challenges negatively impact health care delivery by causing medicines shortages, delays and the circulation of substandard medicines while also increasing health care costs and weakening national economies. The review also explored evidence-based solutions such as infrastructural development, improved supply chain management, technological adoption, workforce training, sustainable funding and regulatory reforms. All identified challenges and their impacts were addressed alongside recommendations, offering a comprehensive roadmap for strengthening pharmaceutical logistics and improving health outcomes in developing countries.

Proposed solutions to the challenges:

Infrastructure and Technological deficiencies: Governments should invest in building reliable infrastructure (roads, warehouses) and integrated digital systems for tracking and managing inventories to improve efficiency and reduce stockouts. Investment in resilient transportation networks and cold chain infrastructure should be encouraged. Deployment of digital tools such as barcoding and systems for enhancing traceability is proposed. In addition, fostering public-private partnership for technology transfer, capacity building and expanding solar-powered solutions in off-grid areas area recommended.

Supply chain management and coordination challenges.

A centralized procurement system could streamline processes and reduce delays while adopting digital supply chain management platforms would support conducting the flow of goods between stakeholders. Demand forecasting tools to minimize mismatches in supply and integrating community health workers into last mile delivery using mobile tracking apps are proposed. In addition, stakeholders' alignment through supply chain governance committees should be encouraged.

Human Resources and Capacity Gaps

Implement training and development programs for logistics and supply chain staff to improve skills and reduce human error while performing targeted recruitment. Use of e-

learning platforms for in -service training and mentorship to enhance accountability and learning are recommended.

Financial and Economic Constraints.
Government should prioritize health-care funding and explore innovative financing model such as public-private partnerships or donors financing and improve affordability of medicines.

Administration and Regulatory Challenges,
Governments must strengthen regulation on pharmaceutical products, ensure robust enforcement and adopt modern technology such as track and trace systems to prevent the entry of counterfeit medicines. Harmonizing logistics regulations across health sector and government levels, building regulatory capacity using digital tools for drug verification and tracking are also proposed. Lastly, developing emergency policy frameworks to expedite medicine access during crisis and also instituting regular policy reviews while also engaging civil society in policy enforcement are also proposed.

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Authors' contributions:
RIO synthesized the literature from the data sources: MOA and ICI conducted the searches in the data bases to identify the relevant studies. EEA and EJU reviewed the manuscript. ICI, supervised, searched the data bases and reviewed the manuscript. All the authors read and approved of the final manuscript.

Conflict of Interest
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