REVIEW

Review of public health commodity distribution models in Nigeria

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Abstract

The distribution of public health commodities is a challenging activity directly responsible for the success of a public health program or intervention. Getting the distribution strategy right is a major concern of many health program implementers and stakeholders in Nigeria. This study intends to look at available models previously or currently used for the distribution of public health commodities in Nigeria. Literature search was carried out in PubMed and Google Scholar on articles related to the public health commodities distribution models in Nigeria. Websites of health organizations operating in Nigeria and publicly funded health institutions were also visited for gray literatures on public health commodities distribution strategies. The study shows the absent of scientific publication as source of information on the distribution model; instead, most of the research publications were review publications in addition to program reports from international nongovernmental organizations and health authorities in Nigeria. Direct delivery and information capture, pull and push, hub and spoke, 5 tier, vertical distribution, integrated distribution models were some of the models identified from the study. Analysis from the review suggests hub/spoke model and integrated model as a desirable model for the distribution of public health commodities.

Keywords Supply chain models, Public health commodities, Distribution models, Distribution strategy

Introduction

The success of any public health programs relies heavily on the reliability of the supply chain system necessary for the provision of uninterrupted program commodities required for the implementation of the health program [1–3]. As the saying goes no product, no program. Despite the general believe in the value of a reliable supply chain system for the success of a public health program, poor access to public health commodities is a visible feature in several countries across Africa and other developing countries outside the continent [4–6]. The resultant effect of the poor access to public health product is seen in the poor health indices in the affected countries [6–9].

Health programs aimed at addressing these poor indices are often implemented in most developing countries across several diseases' areas of public health importance [10]. These programs are commonly donor funded with some financial and non-financial resources contribution from the local authorities and usually cut across several public health interventions not limited to the prevention and controls of diseases using quality diagnostic and therapeutic tools which are required to be consistently available for use in the treatment and prevention of diseases and promoting health [11–15]. To achieve this, project implementers and local public health players will have to come up with strategies to ensure these diagnostic and therapeutic tools which are mostly medicines and laboratory commodities are always available for a successful project implementation.

A very important project output within these programs is to ensure an uninterrupted availability of commodities utilized within each program, which largely depends on the availability of the right strategy for the distribution of

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commodities and the effective execution of the strategy to ensure commodities get to beneficiaries. Consequently, to always achieve a desirable level of health commodities across service delivery point which serves the clients or beneficiaries, there is need for the availability of a buoyant and adaptable supply chain strategy for the management of the health commodities particularly a suitable commodity distribution model or models. Likewise, distribution model must be sustainable and acceptable to all key stakeholders complying with all ethical requirements while achieving the goals of ensuring an uninterrupted availability of health products. For instance, while making decision on how vitamin A supplements are made available to rural dwellers in the interior part of Northern Nigeria, vitamin A supplement will be imported from India and transported in a way that complies with good distribution practices to maintain its quality while also complying with regulatory requirements in Nigeria and then distributed on time to service delivery points where children will have access to them. For this purpose, the distribution strategy and model must be suitable to ensure timely access to the program commodities.

The last mile distribution of commodities represents as important and critical stage in ensuring the availability of program commodities at service delivery points [16]. Indeed, the presence of an efficient distribution model for health often ensured health commodity security and zero of stock outs of health products [17]. On the contrary, the supply chain systems in most developing countries like Nigeria are associated with inefficient distribution of health commodities which are due to several factor inherent in the health systems [18].

Thus, the purpose of this study is to provide a broad description of the public health distribution models used in the distribution of public health commodities in Nigeria to ensure the uninterrupted availability of health products to serve the population. The study will act as a guide for the selection of suitable and adaptable distribution models for the management of public health commodities in the challenging environment of most developing countries.

This study will critically review and analyze selected logistics and supply chain literature to understand the available distribution models utilized for the management of public health commodities in developing countries. The study will provide a descriptive report on the qualitative review of distribution models for public health commodities in Nigeria.

The study will classify the range of published distribution strategies used to get public health commodities to the point of care from 2005 to 2021 and recommend an effective and efficient distribution model for the distribution of public health commodities in developing. In addition, the report will capture a review of available literature on public health commodity management for the distribution of public health commodities in Nigeria.

Main text

Research approach and design

PubMed and Google Scholar databases were explored for articles and research publications on health commodities distribution strategies used for the implementation of public health interventions in Nigeria. Gray literatures which represent publication on the topic of interest by health organizations in Nigeria were also searched. The search strategy involved search through Google Scholar and PubMed to identify related articles on the topic on interest, after which the identified publications were scanned through for the selection of relevant articles. Selection criteria were initially based on the title of article relevant to supply chain management in Nigeria. Thereafter, screening was based on the assessment of abstract of the publication for relevance. The irrelevant articles from the screening of the title of the article and review of the abstract were excluded from the final screening for final selection for inclusion in the review.

At the end of the assessment process, only 5 related articles were considered for final inclusion into the review.
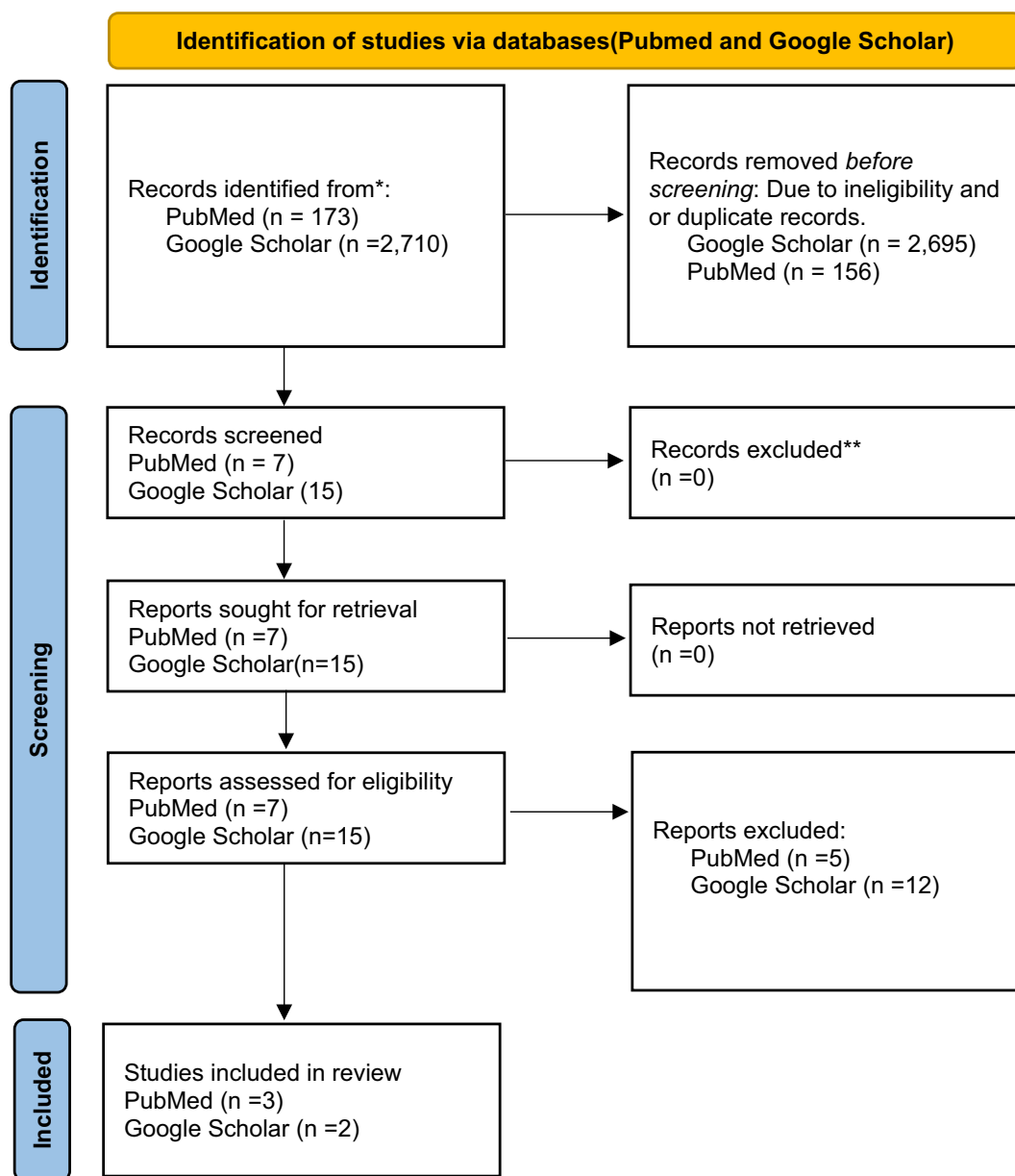
Search strategy

The following key words were used to carry out the literature search: "Public health commodities" OR "public health products" AND "distribution model" OR "logistic model" OR "supply chain model" OR "distribution network" AND "Nigeria."

The search for gray literature was less systematic. It entails a search through the websites of key organizations and health institutions and agencies in Nigeria. Once identified, the publication was downloaded and achieved for review for relevant details on the distribution model used for the management of health programs in Nigeria. Most of the identified publications were mostly inform of program reports, standard operating guidelines, and national strategy documents.

Result

Database searches from both PubMed and Google Scholar produced a total of 2,882 citations, out of which 5 articles were included in this review (Fig. 1). The initial search on Google Scholar yielded 2,710 related articles out of which 15 articles were selected based on the title. While on PubMed, the search yielded 172 related articles out of which 17 related articles were selected based on the titles (Fig. 1).

Identification of studies via databases(Pubmed and Google Scholar)

Identification

Records identified from*:
  PubMed (n = 173)
  Google Scholar (n =2,710)

Records removed *before screening*: Due to ineligibility and or duplicate records.
    Google Scholar (n = 2,695)
    PubMed (n = 156)

Screening

Records screened
PubMed (n = 7)
Google Scholar (15)

Records excluded**
(n =0)

Reports sought for retrieval
PubMed (n =7)
Google Scholar(n=15)

Reports not retrieved
(n =0)

Reports assessed for eligibility
PubMed (n =7)
Google Scholar (n=15)

Reports excluded:
    PubMed (n =5)
    Google Scholar (n =12)

Included

Studies included in review
PubMed (n =3)
Google Scholar (n =2)

Fig. 1 The various steps involved the search in PubMed and Google Scholar

Identified distribution models and features

In addition to the description above for the selection of articles from PubMed and Google Scholar databases, websites of international nongovernmental organizations and health agencies in Nigeria were visited for gray literatures. This search resulted in 10 relevant publicly available literatures which were included in this review.

Push and pull distribution model

These models are common models in Nigeria, and it simply involves the distribution levels making the decision on the quantity of health commodities to be distributed. Pull distribution model was identified as a common model used for the supply of Antivenom into the country [19]. The distribution of public health commodities in Nigeria is mostly pushed in which quantity

to be supplied is determined from higher levels to lower level of the supply chain [20].

Five tier distribution model
This is common within the public health sector in Nigeria, and it involves the movement of commodities across 5 different supply chain levels [21].

Some authors also describes the national strategic cold store as the national central hubs while the 6 zonal stores across the 6 geopolitical zones as the regional hubs [20, 22].

Hub and spoke
The hub and spoke model was recently initiated in Nigeria as a strategy for the distribution of HIV commodities as part of the differentiated service delivery model for improving the quality of HIV services provided to HIV clients in the country [23].

Direct distribution and information capture (DDIC)
This model was piloted in Nigeria by the USAID|DELIVER PROJECT in 2013 across 2 states (Ebonyi and Bauchi). The model was utilized to distribute health commodities to 378 health facilities in the states, thereby making malaria, family planning and maternal and child health commodities available to beneficiaries in the states [24]. The trucks arrive, carrying predetermined quantities of health commodities, based on the facilities past consumption data. By investing in reliable transportation, DDIC ensures that truck drivers and team leaders are available to deliver commodities to health facilities according to an established delivery schedule [25]. A team leader traveling with the truck inspects the facilities' storage space, counts stock-on-hand for the different health commodities, and enters this inventory data into a specifically designed inventory management database.

Facility lead commodity pick-up
The model was observed in Kano, Nigeria. Drugs and Medical Consumables Supply Agency (DMCA) operates a central warehouse in Kano Municipality. Health facilities (secondary and primary healthcare centers) registered under the drug revolving funds comes directly to the DMCA warehouse to place order for and receive commodities through their staffs [16]. Health facility workers managed the pick-up of commodities. This is an example of a 2-tier distribution system. This was also observed in the distribution of family planning commodities in Nigeria [26].

Highly centralized supply chain system
This model was mentioned in a review article as a model used in Nigeria for the distribution of public health commodities [27].

Decentralized drug distribution model
This is a drug distributed strategy utilized in settings where governments rapidly adjusted policies and service delivery mechanisms to provide ARVs to PLHIV in or near their homes usually referred to as home delivery of ARVs [28].

Public private partnership distribution model (PPP distribution model)
In this model, the public sector responsible for the management of public health commodities leveraged private sector capabilities to support the distribution of health commodities [20]. Some disease programs in Nigeria use a privately operated 3rd party logistics providers (3PL) to distribute commodities from the central warehouse to the various service delivery points in Nigeria, "while others use a combination of 3PL, facility vehicles, and local couriers, depending on the level of the supply chain system" [29]. "PPP models have been developed for stakeholder considerations" [30].

### Multiple program specific vertical distribution model
The distribution of public health commodities in Nigeria is characterized by multiple vertical distribution of health products focused around the movement of health commodities and information by specific health programs [29]. Each individual health program typically has an oversight role in the distribution of their respective health products.

Integrated commodity distribution model
In Nigeria, Chemonics is currently combining parallel donor-funded warehousing and distribution supply into a single streamlined supply chain, and the project facilitates the provision of critical life-saving HIV and malaria health commodities to the people of Nigeria [31]. This was also piloted in some states in Nigeria [32]. "Some preliminary integration for Malaria and HIV programmes exists as the same 3PL works on both" [30].

Analysis of the identified models
Most of the selected articles were gray literatures (Fig. 2). Gray literature represents 67% of the source of the articles used for the review while PubMed and Google Scholar represent 20% and 13%, respectively,
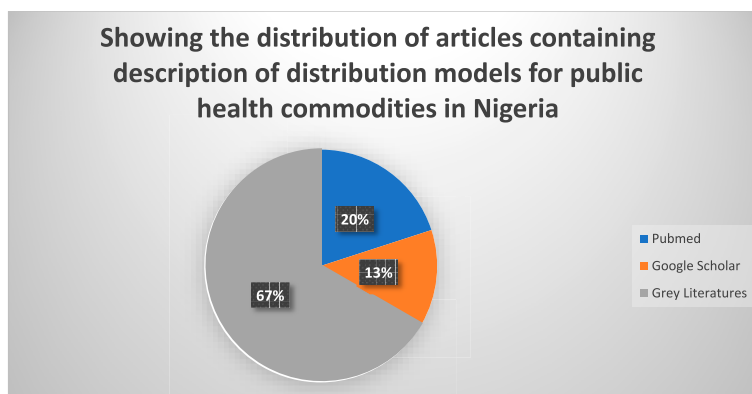
Fig. 2 The distribution of sources of articles selected for the study/review. *******Gray literature describes literatures from website of government institutions, international nongovernmental organization working within the public health space in Nigeria
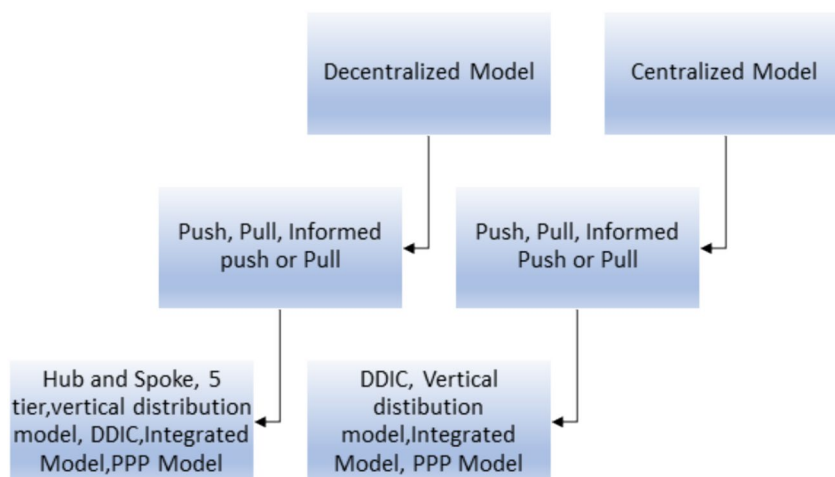
Fig. 3 The possible relationship between the various identified model

thus indicating that most of the research articles were from government and public health organization sites.

Possible relationships between the identified models

Figure 3 shows the possible relationships between the identified models which can be broadly classified as either a decentralized model or a centralized model (Table 1).

Discussion

Several public health commodities distribution models were identified from the study. Most of which were from gray literatures published by government institutions and or nongovernmental international organizations with public health projects in Nigeria (Fig. 2). A total of 9 different models were identified from the study, and these include push, multiple program specific vertical distribution model and pull, integrated commodity distribution

models, public private partnership distribution model (PPP), facility lead commodity pick-up, highly centralized supply chain system, decentralized dug distribution model, hub and spoke and direct distribution and information capture (DDIC).

Analysis of the description of the identified models shows that distribution models used in Nigeria for the distribution of public health commodities can be broadly divided in two (Fig. 3). This classification depends on whether commodity distribution is handled centrally or decentralized to be managed at the various level within the supply chain. The centralized models can either be pull or push or DDIC or vertical distribution model or integrated model or PPP model.

A centralized model is often desirable when structures and systems at the lower levels are weak for the management of commodities. Although it may be time-consuming and expensive [33], it is still recognized as a

Table 1 Key findings in terms of the various identified models and commodities/programs managed under the models (Table 1)

Themes	Key findings	References
Types of distribution model	Push and pull model	Habib et al. [19], Shittu et al. [20], National AIDS & STIs Control Programme & Federal Ministry of Health Nigeria [23]
	Integrated commodity distribution model	Chemonics International [31], National Supply Chain Integration Project, Nigeria [32], Deloitte [30]
	Public private partnership distribution model	Shittu et al. [20], Ajulo et al. [29], Deloitte [30]
	Multiple program specific vertical distribution model	Ajulo et al. [29]
	5 tier commodity distribution model	Federal Ministry of Health, Nigeria [21], Shittu et al. [20]
	Facility lead commodity pick-up	USAID | DELIVER PROJECT, Task Order 4 [16], Usman et al. [26]
	Highly centralized supply chain system	Igharo [27]
	Decentralized drug distribution model	Hoke et al. [28]
	Hub and spoke	National AIDS & STIs Control Programme & Federal Ministry of Health Nigeria [23]
	Direct distribution and information capture	USAID | DELIVER PROJECT, Task Orders 4 and 7 [24]
Types of Public Health Commodities/Programme	HIV commodities	Hoke et al. [28], National AIDS & STIs Control Programme & Federal Ministry of Health Nigeria [23]
	Antivenom	Habib et al. [19]
	Vaccines	Shittu et al. [20]
	Malaria	USAID | DELIVER PROJECT, Task Orders 4 and 7 [24], Ajulo et al. [29]
	TB	Ajulo et al. [29]
	Essential commodities	Ajulo et al. [29]
	Family planning	USAID | DELIVER PROJECT, Task Orders 4 and 7 [24]
	Other essential commodities	USAID | DELIVER PROJECT, Task Order 4 [16], Usman et al. [26]

common model utilized in Nigeria for the distribution of public health commodities in Nigeria. The lead time for the distribution of commodities in a centralized model is often more prolonged compared with a decentralized distribution model [34]. This is more pronounced when there is need for an emergency response to supply issues. However, the centralized model has some benefits which includes low operating costs compared to the decentralized model. Nevertheless, a decentralized model seems to be a more preferred and ideal/effective model for most public health commodity distribution in Nigeria and should be the standard model for the distribution of public health commodities in Nigeria.

Additionally, pull and push models are both common in Nigeria according to reports from studies captured in this review. These models based their principles on how commodities are issued or ordered to service delivery point in terms of the decision-making levels within the supply chain pipeline. While in the case of the pull models the health facilities staffs at the lowest level of the supply chain pipeline decide the quantity of commodities to be resupplied through a process known as requisition, the push model on the other hand has the higher level of the pipeline deciding commodities to be issued to the health facilities in the process also known as commodity allocation. The drawbacks from the push distribution model are mostly related to its reliance on already existing data

like demographic, morbidity, mortality, registered birth numbers among others. Estimates from these data may omit latent demand that may arise from nonregistered births or unknown populations in areas that are hard to reach [20]. Also, studies have shown better performance in terms of commodity stock out rate with the pull distribution model compared with the push distribution model in Nigeria [35]. Even though the pull model is highly desirable, it may not be suitable in an environment like Nigeria due to the skill level of health facility workers at the lower level of the supply chain who are often given the responsibility of making requisition for health commodities. For this reason, a push system may still be suitable in Nigeria especially for health facilities with less skilled workers. Thus, a mixed push and pull distribution model may be operated in the management of public health commodities in Nigeria depending on the prevailing circumstances related to the capacity of the workers at the lower level of the supply chain in the country.

Again, informed push was mentioned in the study which is a modified pushed model. This is a general model used by the HIV program in Nigeria, where lower level health personnel calculate and placed orders for commodities to be supplied to the health facilities [23]. To ensure the accuracy of order placed by health facilities, logistics management coordination unit (LMCUs) and implementing partners (IPs) usually provide technical

support in generating quality information, review and validate bimonthly reports to ensure all health facilities commodity needs are accurately captured. This model is also accurately integrated within the hub and spoke models described above (Fig. 3).

The decentralized model is becoming a desired model due to the challenges encountered during the COVID 19 pandemic where restriction of movement was a common strategy use to curtail the spread of the virus. It involves decentralizing the distribution functions or points to other geographical locations [33] usually closer to the point of final location within the supply chain pipeline. A decentralized network tends to ensure closeness to treatment centers [36]. Similarly, information is closer to the point of distribution, since localized authorities tends to have more required information for distribution [37]. This model is also highly common in developed countries health systems and in private sector with success and is implemented in several forms and variations.

Hub and spoke distribution models are a common decentralized strategy utilized by companies across the world in the supply chain management of products and were also found in this study within the HIV sector in Nigeria. This model is visible in the food and consumer goods industry and in airline industry for the transportation of people and goods across the world. Similarly, this strategy has been used with success in healthcare industry where service delivery points are organized in a way where we have a more comprehensive anchor service delivery points complemented by secondary delivery points which offers limited patients services. Hub and spoke model has been shown to promote efficiency within the system and has numerous benefits which include reduced length of haul, consistent timely delivery of commodities, reduced cost, improved productivity, reduction in carbon footprint, stable pricing, and others [38, 39].

Companies within the private sector understand that a central distribution model may not always work in all cases. For instance, Coca Cola's had to adopt a hub and spoke distribution model to get access to rural market. Coca Cola stock was transported from the bottling plants to hubs and then from hubs to spokes which are usually smaller towns and from spokes to retailers who catered to the demands in rural areas [40]. This is also similar in Nigeria where Coca Cola uses the strategy to ensure availability of its products even in the remotest places in Nigeria. This may also be adopted within the public health sector in Nigeria.

The use of hub and spoke model has also shown impact in other healthcare areas as documented by several research reports. This includes acting as a lifeline for improved access to quality health services among rural population and serving patients better, improving access to quality medications for opioid use disorders [41] and more recently as a proposed distribution strategy of choice for COVID-19 distribution [42]. These reports are mostly from advanced climate where there is access to adequate financial and human resources which if inadequate may limit the success of the strategy. Nevertheless, similar application of the strategy with comparable positive impact can be found within the Uganda National Health System. These studies, however, fail to capture detailed analysis of the financial implication of the implementation of the strategy which makes the studies lacking in clear demonstration of efficiency and cost-effectiveness. Thus, while these reports may not be a clear reflection of possible positive impacts of the application of the strategy in Nigeria due to a different environmental factors like financial and human resources, it may be a pointer to the possible positive impact in the country if replicated appropriately.

Cost saving can be achieved by improving the efficiency of a logistics system [43]. The need for cost saving and coordination within the supply chain system informed another models called the integrated distribution model which has had application within the private sector for several years. This model can be in the form of either a decentralized model or a centralized model (Fig. 3) and may also be applied as a pull or push system. The unique feature of this model is the integrated distribution of commodities instead of a more costly parallel distribution of commodities. Thus, the model is less costly and more cost effective and may be a more sustainable model in a challenging environment like Nigeria where funding is an issue in the health system.

Nigeria currently has infrastructural, financial, and human resource gaps across several areas [44–48]. This includes poor road networks for the transportation of medicines, insufficient number of storage facilities of highest standards, inadequate number of skilled health supply chain workers, and poor investment within the health systems [46, 49]. Additionally, the health system is often plagued by repeated industrial actions by health workers and security challenges which often hamper public health supply chain activities [46, 50–52]. Overall, a resilient health systems and structure capable of responding to health commodity needs in a way that ensures an interrupted availability of life-saving health products is currently lacking in Nigeria. Therefore, a more agile and flexible supply chain model will be required to drive the public health supply chain system in the country. This is because the deficiencies and capacity gaps within the systems will subject it to a high level of uncertainties which will require a highly flexible supply chain system to ensure optimal performance

of commodity availability. For example, security threat caused by activities of terrorist may prevent the transportation of public health commodities by road across areas controlled by armed terrorist, thereby necessitating an alternative means of transportation or creating a system that ensure commodities are stored in bulk close to service delivery points across the country. Admittedly, with limited financial resources, poor transportation infrastructures and security challenges, a more cost saving integrated and decentralized model for the distribution of public health commodities with a mixed push and pull model may be suitable and adaptable for the Nigeria situation.

Conclusion

The Nigeria public health supply chain system is currently characterized by frequent stock out of health products across service delivery points which sometimes necessitate emergency order and delivery of these commodities. As a result, the desired distribution model should be one that can respond to commodity needs in a timely manner. For the most part, the lead time for the delivery must be as short as possible to ensure uninterrupted availability of live saving commodities. Consequently, a more decentralized distribution model may be the most appropriate model for the Nigeria challenging situation.

The review shows that most of the publications on public health commodities distribution models in Nigeria are more visible in gray literatures of public health organizations program reports. Scientific publications in peer review journals are mostly review articles with no original research publications describing the models used in the distribution of health products for public health interventions in Nigeria. Thus, the research method and strategy produce desired results in identifying distribution models used for the distribution of public health commodities in Nigeria even though these secondary data are not in form of primary research.

Some of the identified models were only piloted for specific health products while others are currently being utilized for the distribution of health products. The direct delivery and information capture model is an example of the piloted model in Nigeria, utilized for the distribution of HIV, malaria and family planning commodities to several health facilities in the country, whereas the 5-tier distribution model, hub and spoke models and a broader classification, the push and pull model are currently in operation across health programs in the country. While these models have been able to achieve short-term goals in a less qualitative way, they may not have a long-term benefit for the country. Thus, there will be need for coordination of all these models in the country to provide a better well-structured model for the distribution of public health commodities in Nigeria. This review provides valuable information on the various distribution strategies for the management of public health commodities and may act as a guide or template for the selection of suitable and adaptable distribution models for the management of public health commodities in the challenging environment of most developing countries and other similar environment. It may also give readers valuable information for further research on the suitability of distribution models for the management of public health commodities across the world.

Limitation and implication for future research

This study is limited by the limited number of articles utilized for the study. The exclusion of other databases like Embase and Web Science suggests the possibility of exclusion of other relevant articles which may provide additional information on the models used in the distribution of public health commodities. Also, some local and smaller nongovernmental organization with current or previous implementation of public health programs in Nigeria may not have their program reports publicly or easily available, thus indicating the exclusion of vital resources which may offer additional perspectives on the distribution models used in the management of public health commodities in Nigeria.

Additionally, the study shows the absence of research publications detailing the analysis of distribution models used for the distribution of public health commodities in Nigeria. Most research publications identified from the review are review articles. This gap shows the need for research studies focusing on the field assessment and identification of the distribution models used for the management of public health commodities in Nigeria.

Abbreviations

3PL	3rd party logistics providers
ARVs	Antiretrovirals
DDIC	Direct distribution and information capture
DMCA	Drugs and Medical Consumables Supply Agency
HIV	Human immunodeficiency virus
IP	Implementing partners
LMCU	Logistics management coordinating unit
PLWHIV	People living with HIV
PPP	Public private partnership
TB	Tuberculosis

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