



(RESEARCH ARTICLE)



## Strengthening decentralized access: integrating supply chain, stakeholder engagement, and patient support in emerging health systems

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### Abstract

Emerging health systems in low- and middle-income countries (LMICs) face persistent challenges in extending equitable, consistent, and culturally responsive care across diverse geographies. Centralized health infrastructure often fails to meet the complex demands of remote or marginalized populations, leading to gaps in continuity of care, delayed access, and diminished health outcomes. This paper explores a holistic approach to strengthening decentralized healthcare access through the strategic integration of supply chain resilience, stakeholder engagement, and patient-centered support systems. We begin with a systemic overview of decentralization as a policy instrument and operational model in global health, focusing on its implementation in LMICs through primary healthcare networks, task-shifting, and regional service hubs. Particular emphasis is placed on how logistics systems especially last-mile distribution, cold chain management, and data synchronization enable or constrain service availability in under-resourced settings. Next, the paper examines stakeholder engagement as a critical enabler of decentralized care, highlighting the role of local governance structures, community health workers, and civil society actors in co-designing solutions, ensuring cultural alignment, and sustaining trust. In parallel, patient support structures such as digital follow-up tools, mobile health reminders, and decentralized chronic disease management are assessed for their ability to improve adherence, reduce attrition, and promote health literacy. The paper synthesizes these three domains into a unified operational framework, illustrated through comparative case studies from East Africa and Southeast Asia. Ultimately, we propose that successful decentralization requires not just physical redistribution of services, but a re-engineering of operational flows, incentive systems, and trust-building mechanisms tailored to local realities.

**Keywords:** Decentralized healthcare; LMIC supply chains; Stakeholder engagement; Patient support; Health system strengthening; Last-mile delivery

## 1. Introduction

### 1.1. The Case for Decentralized Health Access

Decentralized healthcare delivery has gained increasing attention as a viable solution to overcome persistent access challenges in low- and middle-income countries (LMICs). In many underserved settings, central hospitals and bureaucratic systems struggle to meet the distributed and often urgent needs of rural or peri-urban populations [1].

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Distance, travel time, under-resourced facilities, and workforce shortages continue to constrain care-seeking behavior and timely intervention, particularly in primary and preventive health domains.

Decentralized models offer the advantage of proximity, responsiveness, and contextual adaptation. These systems delegate both administrative and service-delivery responsibilities to local units district hospitals, community health posts, mobile clinics, or trained community health workers (CHWs) enabling flexible alignment with the population's needs [2]. In addition, decentralization supports task-shifting, wherein non-physician cadres are empowered to perform essential services under appropriate supervision, significantly broadening the reach of limited human resources [3].

Crucially, decentralization enhances data ownership and accountability at the point of care. Local teams are often more familiar with the dynamics of disease burden, sociocultural attitudes, and logistical constraints, making them well-positioned to co-design and adapt care pathways [4]. Figure 1 illustrates how decentralized systems differ structurally and operationally from centralized delivery models, particularly in how patient flows and decision-making are distributed.

When linked with digital tools and supply chain platforms, decentralized systems become even more agile allowing resource tracking, remote supervision, and inventory visibility. In sum, decentralization does not simply mean fragmentation; when well-structured, it represents a cohesive yet distributed ecosystem that brings healthcare closer to where people live, work, and grow.

### **1.2. Historical Failures of Centralized Models in LMICs**

Centralized healthcare models, while often designed with equity in mind, have frequently failed to deliver on that promise in LMICs. Central control over resources and decision-making has historically led to delayed service delivery, unequal distribution of personnel, and urban-centric infrastructure development [5]. Health facilities in remote or marginal areas have been chronically underfunded, with limited diagnostic capabilities and inconsistent medicine stocks, causing systemic service discontinuities [6].

Moreover, centralized budgeting and procurement processes are typically rigid, making it difficult to reallocate funds swiftly in response to local outbreaks or seasonal disease patterns [7]. Political centralization has further created governance bottlenecks, with local administrators unable to act without clearance from overburdened ministries leading to treatment delays, stock-outs, and preventable deaths.

The disconnect between central planning and local realities also extends to cultural misalignment. National campaigns may neglect the local language, customs, or gender dynamics, leading to poor uptake despite heavy investment [8]. This pattern of inefficiency and misalignment has been repeatedly documented in maternal health programs, HIV outreach, and immunization campaigns across sub-Saharan Africa and Southeast Asia.

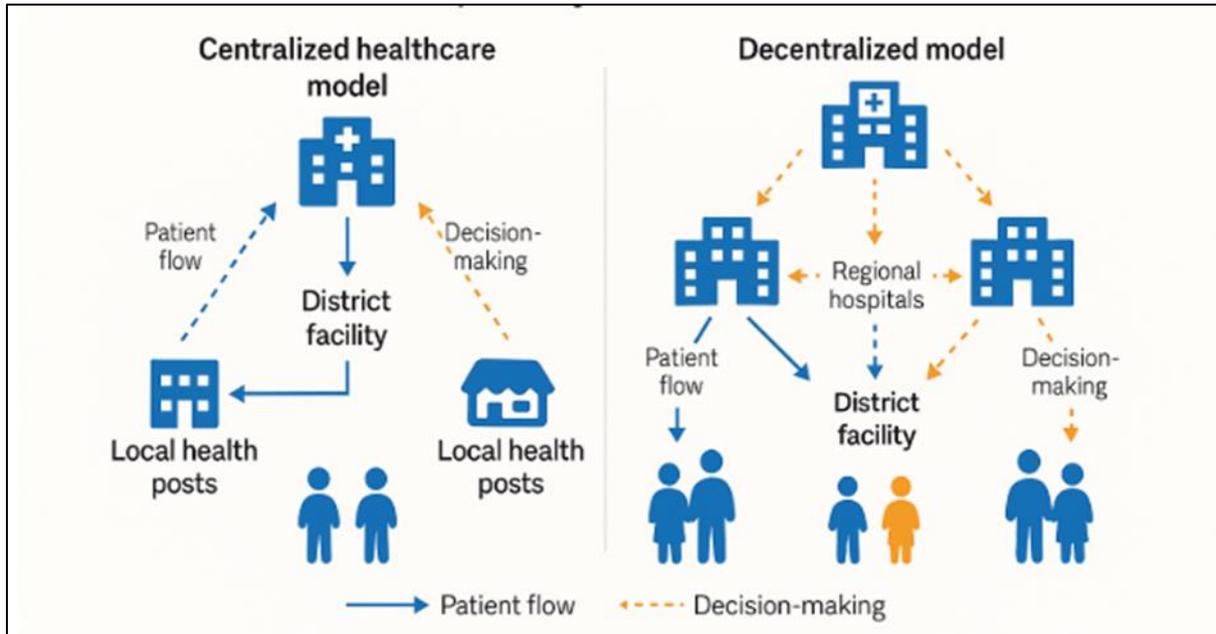
In contrast, decentralized systems when adequately funded and governed can respond with agility and contextual intelligence, closing the implementation gap that centralized models have struggled to bridge.

### **1.3. Objectives and Relevance of a Systems Integration Approach**

This article aims to explore how systems integration can enhance the performance and resilience of decentralized healthcare delivery in LMICs. Rather than replacing centralized mechanisms, the focus is on intelligently connecting decentralized units through shared information systems, interoperable logistics, and scalable governance frameworks [9].

By examining real-world examples of health integration at district and community levels, this analysis will unpack how decentralized delivery gains strength through data harmonization, infrastructure layering, and collaborative accountability loops. These approaches enable decentralized units to function not as isolated outposts but as synchronized nodes within a national health system.

In a landscape where universal health coverage (UHC) remains an aspiration, the importance of locally-responsive yet systemically aligned healthcare models cannot be overstated [10]. This paper advocates for a design lens that merges autonomy with integration ensuring that while services reach deep into communities, they remain supported by a coherent framework of policy, logistics, and monitoring.



**Figure 1** Comparison of Centralized vs Decentralized healthcare delivery pathways in LMICs

## 2. Conceptual framework for decentralized access

### 2.1. Defining Decentralization in the Health Systems Context

Decentralization in health systems refers to the transfer of authority and resources from central institutions to local entities such as district health offices, community health facilities, or municipal governance structures [5]. This shift enables decision-making that is more responsive to local conditions, thereby improving operational flexibility, resource allocation, and community engagement in service delivery.

In practice, decentralization exists on a continuum from administrative delegation to full devolution of budgeting, procurement, and human resource management. In many LMICs, partial decentralization has taken root, where national ministries still set broad policy but allow regional units to handle implementation details [6]. This hybrid structure balances standardization with adaptability, ensuring baseline equity while making room for contextual tailoring.

Beyond formal health sector actors, decentralization also engages non-state and community-based stakeholders, including traditional leaders, religious institutions, and NGOs. These actors often play pivotal roles in mobilizing populations, shaping health-seeking behaviors, and extending service coverage to hard-to-reach areas [7].

One of the defining advantages of decentralization is that it localizes accountability. When facility heads or district managers have the power and visibility to make context-specific decisions, they are also more answerable to the populations they serve. This fosters community trust and improves care utilization, especially for primary and preventive services.

However, decentralization is not inherently beneficial unless accompanied by capacity building, information systems, and financial support. When implemented without these safeguards, it risks fragmenting services and exacerbating disparities between regions [8]. As shown later in Table 1, successful decentralized models align well with the WHO health systems building blocks, ensuring system coherence and resilience.

### 2.2. Three Core Pillars: Supply Chain, Stakeholder Engagement, Patient Support

A robust decentralized health system is underpinned by three core pillars: supply chain functionality, stakeholder coordination, and community-level patient support. Each component plays a critical role in transforming decentralization from a policy idea into a viable delivery mechanism.

First, supply chain decentralization ensures timely procurement, storage, and distribution of medicines, vaccines, and diagnostic tools. Local warehouses or last-mile delivery systems that are digitized and monitored enhance stock

visibility and reduce wastage [9]. Countries that empower district managers to place emergency orders or reallocate buffer stocks often experience fewer disruptions in care continuity, especially during outbreaks or seasonal surges [10].

Second, multi-stakeholder engagement at the district and sub-district levels strengthens coordination and sustainability. This includes civil society groups, local government units, healthcare workers’ unions, and private providers. Their involvement improves buy-in, reduces resistance to program changes, and encourages co-financing or resource pooling in underfunded areas [11]. In decentralized environments, health planning meetings often serve as critical governance tools for aligning local objectives with national health priorities.

Third, community-level patient support mechanisms such as home-based care teams, referral tracking systems, or peer navigators are vital in closing the gap between facility-based services and actual health outcomes. These systems help ensure that vulnerable populations follow through on referrals, adhere to treatment regimens, and receive ongoing psychosocial support [12].

Importantly, these pillars are interdependent. A well-stocked clinic is ineffective without community trust; similarly, high engagement is insufficient without service availability. Table 1 maps these components against the WHO’s six health system building blocks governance, workforce, information, medicines, financing, and service delivery highlighting their integrated role in reinforcing decentralized care structures.

**Table 1** Mapping Decentralized Health Delivery Components to WHO Health System Building Blocks

WHO Building Block	Decentralized Component	Integrated Role
Governance	Local health councils, CHW leadership	Enhances accountability and community-tailored decision-making
Health Workforce	Task-shifting, community-based cadres	Expands care reach and addresses human resource shortages
Health Information	Mobile reporting tools, local dashboards	Enables real-time data capture and decentralized program oversight
Medical Products	Localized supply hubs, last-mile cold chains	Reduces stock-outs and supports timely access in remote areas
Financing	Conditional grants, community-based insurance	Promotes equitable resource allocation and sustainability
Service Delivery	Health posts, outreach clinics, mobile care teams	Facilitates proximity-based, culturally sensitive care models

When decentralized units are equipped with these pillars and linked through feedback loops and shared dashboards, they not only respond to local needs but also contribute meaningfully to national health system performance and equity.

### 2.3. Health Equity and Systems Thinking

Health equity must remain the guiding principle of decentralized system design. While decentralization offers new pathways to inclusion, it can inadvertently exacerbate inequalities if poorly managed. Systems thinking a framework that sees health systems as dynamic, interconnected wholes is critical in ensuring that decentralized reforms remain equitable and sustainable [13].

Equity in this context refers to distributional justice: the fair allocation of resources, services, and opportunities across population groups, particularly those historically underserved due to geography, income, gender, ethnicity, or disability. Decentralization must prioritize equity-sensitive metrics, such as coverage in informal settlements, availability of disability-inclusive infrastructure, or linguistic diversity in health education [14].

Systems thinking encourages the mapping of feedback loops, understanding of cross-sectoral linkages (e.g., education, transportation), and identification of leverage points where small changes can produce outsized results. For example, decentralizing the budgetary authority for maternal health outreach programs while also improving road access can lead to better antenatal coverage and reduced maternal mortality outcomes unachievable by health reforms alone [15].

Furthermore, systems thinking advocates for adaptive design regularly revisiting data to tweak interventions and redistribute resources dynamically. This approach counters the risk of rigid decentralization, where local systems drift from national equity goals.

Ultimately, decentralization that is equity-driven and systems-informed becomes more than administrative reform it transforms into a responsive and inclusive delivery strategy capable of adjusting to local needs without losing sight of collective health system goals. This balance is foundational for advancing universal health coverage in practice, especially in diverse and resource-constrained environments.

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### **3. Supply chain systems in decentralized healthcare**

#### **3.1. Role of Last-Mile Logistics and Cold Chains**

Effective last-mile logistics form the cornerstone of functional health systems in remote and underserved regions. In decentralized health models, where primary care delivery hinges on localized availability, the final segment of the distribution chain often determines health outcomes. This is especially true for temperature-sensitive commodities like vaccines, insulin, oxytocin, and certain diagnostic reagents that rely on robust cold chain infrastructure [9].

The challenges of last-mile delivery are exacerbated by poor road networks, inconsistent electricity supply, and fragmented transportation capacity in rural and peri-urban zones. Many facilities must rely on manually coordinated supply drops that are vulnerable to disruptions during climate events or fuel shortages [10]. Solar-powered refrigeration units, portable cold boxes, and digitally tracked transport containers have become critical enablers of cold chain continuity in such settings.

Cold chain integrity is further threatened when product movement lacks synchronized temperature monitoring. Without passive or active tracking mechanisms, temperature excursions can go unnoticed, resulting in compromised product efficacy and costly wastage [11]. Integration of Bluetooth-enabled data loggers and IoT sensors has allowed health logistics teams to remotely monitor storage conditions and intervene preemptively.

In response, partnerships between governments, NGOs, and private logistics providers have created hybrid models that pool vehicle fleets and use centralized coordination platforms to dispatch supplies based on regional needs [12]. These models often prioritize maternal health kits, childhood vaccines, and chronic disease drugs categories with the highest impact potential in low-resource settings.

Figure 2 illustrates a digitized supply chain map showing cold chain flows to rural health posts, where alerts are triggered in real time when stock falls below minimum levels or temperatures breach safety thresholds. Embedding such visualizations into national dashboards enables higher accountability and proactive support from central procurement teams.

#### **3.2. Data-Driven Procurement and Forecasting**

Procurement efficiency in decentralized health systems is tightly linked to the accuracy of demand forecasting and the reliability of data inputs. In many LMICs, the absence of real-time data from health posts results in either chronic understocking or wasteful overstocking of medical commodities. Data-driven procurement seeks to rectify this by introducing predictive analytics, consumption-based ordering, and population-adjusted forecasting methods [13].

Unlike traditional calendar-based procurement cycles that rely on static allocations, data-enabled approaches tap into service utilization records, stock movement logs, and disease surveillance signals to dynamically adjust procurement volumes. For instance, real-time increases in malaria diagnoses can trigger higher orders of antimalarial medications in the following month [14].

Additionally, mobile-based inventory management systems have allowed lower-tier facilities to participate in procurement planning. When health workers log dispensed items through USSD codes or mobile apps, district teams can visualize actual consumption rates without relying solely on manual monthly reports [15]. This granular insight enables responsive reordering and redistribution among facilities with similar profiles.

Procurement automation platforms often integrated with national logistics management information systems (LMIS) can also flag anomalies such as unexpected stock depletion or procurement delays. These systems are particularly

valuable during emergency response campaigns or seasonal fluctuations when stock pressures intensify and response windows are narrow [16].

Furthermore, bundling forecasting with supplier engagement has improved procurement reliability. By sharing digital dashboards with prequalified suppliers, governments enable manufacturers to plan better and reduce lead times. In some cases, supplier-managed inventory models have been introduced where vendors directly replenish stocks based on agreed consumption thresholds [17].

The shift to evidence-based procurement is essential for decentralized systems where resource constraints demand precise, anticipatory allocation of medical supplies. This approach reduces cost, curtails waste, and increases patient access to essential services.

### 3.3. Inventory Management in Remote Facilities

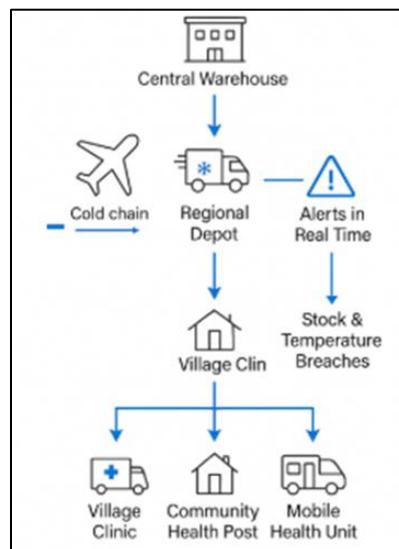
Remote facilities often operate with minimal storage capacity, intermittent supervision, and staff shortages factors that complicate inventory management and threaten service continuity. Traditional paper-based bin cards and monthly tally sheets are ill-suited to reflect real-time inventory positions or inform dynamic resupply decisions [18]. Digital tools that can function offline and sync periodically have emerged as critical alternatives.

Health posts equipped with basic tablets or mobile phones can use lightweight inventory apps to record receipts, stock balances, and expiries. When linked with barcoding or QR systems, these tools reduce manual errors and improve tracking of item movement across departments or satellite clinics [19]. Stock visibility improves significantly, and stock-out patterns such as those related to delivery misalignments or expired batches can be identified quickly.

Automated reorder alerts, configurable minimum/maximum stock levels, and real-time reporting dashboards have further improved the efficiency of these systems. Some platforms also integrate supervisory checklists and digital forms for external audits, reducing the lag time between incident detection and action [20].

Facility staff often cite training and battery life as top challenges in sustaining these digital systems. Consequently, many implementation programs include solar charging stations and mentorship networks that pair new users with experienced digital inventory managers. Where internet is limited, data packets can be stored locally and uploaded when connectivity resumes, ensuring continuity in data flow without operational disruption [21].

Central dashboards that consolidate stock data from remote facilities allow district health offices to plan outreach, initiate emergency transfers, and avoid duplication during donor-led replenishment campaigns. These dashboards, when publicly accessible, also foster transparency and cross-agency coordination.



**Figure 2** Displays an integrated real-time inventory map including alerts, buffer levels, and routing information for sample health posts in remote districts an essential tool for managing scarce resources

### **3.4. Interoperability Across National and Regional Systems**

The effectiveness of decentralized supply chains is ultimately tied to the interoperability of data systems that govern procurement, distribution, and stock monitoring. Many countries maintain parallel platforms for HIV, TB, reproductive health, and immunization programs each with its own codes, reporting formats, and analytics standards. This fragmentation hinders strategic decision-making and leads to duplication or resource misallocation [22].

Interoperability refers to the ability of diverse information systems and devices to exchange, interpret, and use data in a coordinated way. In the health supply context, this means enabling district-level LMIS, warehouse stock databases, and central procurement tools to “talk” to each other. When well-integrated, systems can auto-populate order forms, reconcile physical counts with shipment records, and align disease burden data with stock needs [23].

Middleware solutions, like OpenHIE and DHIS2 Tracker, have provided templates for cross-platform integration. These systems use health-level 7 (HL7) protocols and standard data dictionaries to ensure consistency and scalability across geographies. In Rwanda and Tanzania, such integrations have enabled smoother vaccine stock transitions between donor-funded and government-managed supply chains [24].

Moreover, interoperability extends to customs and finance systems, especially where imported medical commodities require clearance, foreign exchange tracking, and tax exemption documentation. Digital linkages with port authorities and treasury platforms reduce delays and improve traceability for essential goods [25].

Without interoperability, decentralized health systems risk becoming isolated silos. Facilities may have the tools but lack consolidated views, resulting in inefficient procurement and weak accountability. A shared data architecture that links national, regional, and facility-level actors ensures that every node in the supply chain can operate with situational awareness and act on real-time insights.

As shown in Figure 2, the effectiveness of rural logistics hinges not only on the tools but also on their interoperability linking last-mile data with national health system intelligence.

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## **4. Stakeholder engagement in localized health delivery**

### **4.1. Community Health Workers and Indigenous Leadership**

Community Health Workers (CHWs) serve as the bridge between health systems and underserved populations, particularly in rural or hard-to-reach areas. Their embeddedness in communities allows them to deliver contextually appropriate care, often rooted in trust and cultural alignment [14]. Many LMICs have expanded CHW networks to address primary healthcare gaps, maternal health, and immunization campaigns, all while supporting disease surveillance at the grassroots level.

In parallel, indigenous leadership structures including tribal councils, village elders, and spiritual leaders play an influential role in healthcare access. These leaders are not merely symbolic figures; they frequently arbitrate health decisions, coordinate local response efforts, and mobilize participation in outreach campaigns [15]. Recognizing and integrating their authority enhances local buy-in, reduces resistance to external programs, and supports smoother implementation of decentralized health initiatives.

To be effective, CHWs must be supported through proper training, supervision, and compensation. Historically, many have worked on a voluntary basis, which has led to issues of attrition and burnout. New models advocate for formal integration of CHWs into health workforces, backed by regulatory frameworks and performance-based incentives [16].

A synergistic model emerges when CHWs and indigenous leaders collaborate. For instance, in parts of Kenya and Nepal, elder councils actively supervise community drug distribution, while CHWs provide technical support and recordkeeping [17]. This dual-leadership model ensures both scientific and cultural legitimacy.

As summarized in Table 2, CHWs and indigenous actors represent different categories of decentralized stakeholders, yet their combined influence significantly improves health system responsiveness and equity. Investing in their collaboration strengthens localized governance and facilitates context-sensitive service delivery.

**Table 2** Stakeholder Typology and Roles in Decentralized Health Initiatives Across Africa and Asia

Stakeholder Type	Representative Actors	Primary Roles
Community-Level Service Providers	Community Health Workers (CHWs)	Deliver frontline care, promote adherence, collect patient-level data
Indigenous or Local Leaders	Tribal Chiefs, Faith-Based Health Advocates	Bridge cultural gaps, support trust-building and care acceptability
Program Implementers	Local NGOs, Civil Society Organizations	Coordinate outreach, provide training, manage logistics
System Enablers	Regional Health Managers, Supervisors	Ensure data flow, enforce quality standards, resolve operational gaps
Policy Intermediaries	Traditional Councils, Local Health Committees	Mediate between community and national health agencies

#### 4.2. Public-Private Collaborations in Distribution

Public-private partnerships (PPPs) are crucial in extending the logistical reach and efficiency of decentralized health systems. In many LMICs, national distribution mechanisms often fall short in servicing remote zones due to resource constraints, poor infrastructure, or seasonal access issues. In such cases, partnerships with logistics companies, private pharmacies, and health startups fill vital operational gaps [18].

One widely adopted model involves outsourcing last-mile transportation to private courier services equipped with GPS tracking and mobile routing platforms. This allows ministries of health to monitor delivery progress in real-time and ensure cold chain compliance for temperature-sensitive vaccines [19]. For instance, several West African countries have collaborated with third-party logistics providers to distribute COVID-19 supplies through drone networks, reaching mountainous or flood-prone regions previously inaccessible by road.

Pharmaceutical companies have also partnered with national programs to support bundled procurement and supply chain financing, lowering per-unit costs and reducing stock-outs. These arrangements often include performance clauses tied to on-time delivery, wastage rates, and cold chain integrity [20]. In rural India, local pharmacies enrolled in digital health networks serve as last-mile distribution nodes, tracking inventory via SMS-based platforms.

Moreover, digital health innovators are developing real-time inventory dashboards and predictive restocking algorithms powered by private sector tools but used in public health programs [21]. These integrations enable dynamic supply planning and reduce over-reliance on static delivery schedules.

As illustrated in Table 2, PPPs constitute a stakeholder category with high operational leverage in decentralized models. Their engagement, when governed transparently and aligned with public goals, can transform health distribution into a more adaptive and cost-efficient system while maintaining accountability and oversight.

#### 4.3. Participatory Program Design and Feedback Loops

Effective decentralization goes beyond delegation; it requires active participation from the intended beneficiaries in both design and evaluation phases. Participatory program design ensures that services are not only accessible but also relevant and acceptable to target populations [22].

One key mechanism is the inclusion of community advisory boards (CABs) in program planning. These boards, typically composed of local residents, faith leaders, CHWs, and youth representatives, provide grounded insights into behavioral barriers, cultural sensitivities, and implementation bottlenecks. They also help define success metrics from a user perspective rather than solely relying on clinical indicators [23].

Feedback loops must be embedded into operational workflows, not treated as afterthoughts. SMS-based surveys, townhall meetings, mobile kiosks, and exit interviews can all serve as data collection methods for real-time community feedback. When such data is analyzed and acted upon at the local level, it builds trust and accountability, signaling that citizen voices matter in shaping their own health outcomes [24].

Participatory design also enhances innovation. In Indonesia, co-creation workshops between health officials and indigenous midwives led to new maternal referral pathways, decreasing delays during obstetric emergencies. In Uganda, adolescent girls helped co-design SRH (sexual and reproductive health) campaigns, increasing uptake among their peers.

Table 2 highlights that stakeholder typologies in decentralized health must include community co-designers and evaluators, not just implementers or recipients. Programs with participatory DNA tend to show higher retention rates, better adherence to protocols, and more durable behavior change. Ultimately, decentralization achieves legitimacy and longevity when communities transition from passive recipients to co-owners of healthcare transformation.

#### **4.4. Trust-Building and Cultural Responsiveness**

Trust remains the cornerstone of effective decentralized health systems. Without trust, even well-funded and technically sound interventions struggle to gain traction. Decentralization presents a unique opportunity to embed trust-building into the fabric of health delivery, especially through culturally responsive design and relational continuity [25].

Cultural responsiveness involves tailoring services to the values, languages, norms, and expectations of the target community. This may include training health workers in local dialects, adapting patient education materials to indigenous belief systems, or aligning service hours with market schedules and harvest seasons [26]. When services feel familiar and respectful, utilization rises.

Continuity of care is also critical. Frequent staff turnover at remote clinics disrupts the relational bonds that many patients rely on for disclosure and adherence. Decentralized models that promote locally recruited and retained staff, supported by upskilling initiatives, foster long-term trust and consistent care-seeking behavior [27].

Misinformation and historical marginalization must also be addressed. In post-conflict areas or regions with histories of medical neglect, rebuilding trust requires truth-telling, restitution, and community engagement over time. Health campaigns should openly acknowledge past failures and outline concrete safeguards for future programs.

One effective tool is the establishment of health ombudsman mechanisms local forums where grievances can be aired and resolutions tracked transparently. When coupled with public data dashboards, these systems demonstrate a commitment to fairness and accountability.

As described in Table 2, cultural brokers, language interpreters, and community educators are essential roles in a trust-based stakeholder framework. Decentralization done well is not just a shift in logistics it is a human-centered transformation rooted in empathy, transparency, and cultural fluency.

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## **5. Patient-centered support in distributed models**

### **5.1. Differentiated Service Delivery Models (DSDMs)**

Differentiated Service Delivery Models (DSDMs) represent a paradigm shift in chronic care particularly for HIV, tuberculosis, and increasingly noncommunicable diseases (NCDs). Rather than standardizing care through centralized protocols, DSDMs tailor services based on individual clinical stability, geography, and social need [19]. This approach is particularly relevant in decentralized systems, where proximity to care facilities is not uniform.

Models include facility-based fast-track refills, community adherence groups (CAGs), home-based care, and multithrough dispensing (MMD) for stable patients. Each is matched to a client's profile, thus avoiding unnecessary clinic visits and decongesting overburdened facilities [20]. CAGs, for example, rotate medication pickup responsibilities while creating informal support groups that reinforce adherence.

Clinical triaging tools and digital registries enable health workers to classify patients into the appropriate DSDM. This allows for dynamic allocation of human and pharmaceutical resources, ensuring that high-risk patients receive more intensive monitoring while stable individuals enjoy autonomy and convenience [21].

DSDMs have shown positive impacts on retention, viral suppression, and patient satisfaction. In Malawi and Zimbabwe, implementation of MMD and CAGs improved viral load monitoring compliance and reduced transport costs for patients

[22]. These models also enhance staff efficiency, allowing providers to prioritize complex cases without overwhelming workflows.

As shown in Figure 3, the patient journey under decentralized care benefits from layered support structures, with DSDMs acting as a key customization node. By integrating DSDMs into decentralization strategies, health systems can maintain quality of care while expanding reach an essential duality in the face of resource limitations and diverse care-seeking behaviors.

## 5.2. Integration of Mental Health and NCD Care

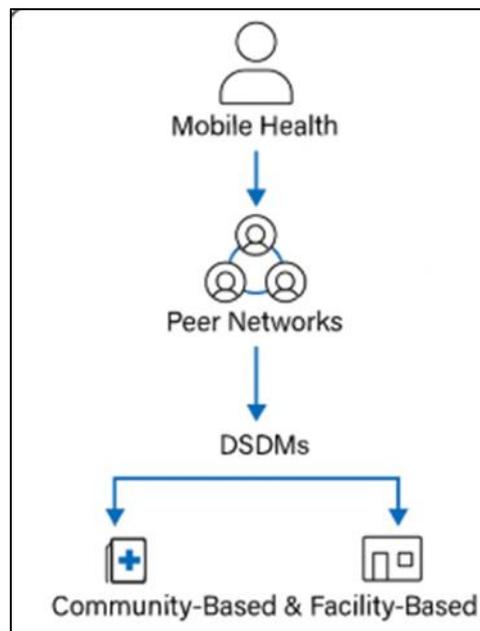
Decentralized healthcare delivery must evolve to address not only infectious diseases but also the growing burden of mental health and NCDs in LMICs. Historically sidelined due to stigma and lack of funding, these conditions now constitute a significant portion of the disease burden in remote and underserved populations [23].

Integrating mental health into primary care involves training frontline workers in psychosocial assessment, brief interventions, and medication management. WHO's mhGAP Intervention Guide has been widely used to support this integration, offering modular tools that are context-adaptable and scalable across decentralized systems [24]. Coupling these protocols with culturally tailored counseling methods has shown promise in addressing depression, anxiety, and substance use disorders in community settings.

Similarly, hypertension, diabetes, and asthma require long-term monitoring, lifestyle interventions, and patient empowerment. Decentralization enables care at local clinics or community hubs, often with task-shifting to nurses or CHWs supported by decision aids and point-of-care diagnostics [25].

Co-location of services where patients can receive both mental and physical health care at a single touchpoint improves service uptake and adherence. In Ethiopia and South Africa, pilot programs linking diabetes care with depression screening revealed improved clinical outcomes and reduced dropout rates [26]. Integrated care also reduces logistical burdens on patients, especially those living far from referral hospitals.

The effectiveness of these integrations relies on structured workflows, community sensitization, and supportive supervision. While resource gaps remain, decentralized platforms offer a viable foundation for integrated care models, breaking the traditional silos that have long impeded holistic health.



**Figure 3** How layered support can include mental and chronic care, expanding the utility of decentralized service flows beyond communicable diseases

### 5.3. Mobile Health Interventions for Remote Adherence

Mobile health (mHealth) interventions have gained traction as a linchpin of decentralized healthcare strategies. These tools provide real-time engagement, remote monitoring, and patient education particularly valuable in contexts where facility access is inconsistent or geographically limited [27].

One widely used intervention is two-way SMS adherence support, where patients receive automated medication reminders and can text back for help or updates. This bidirectional communication fosters not only accountability but also a sense of connection to the health system, even when the nearest clinic may be hours away [28].

Mobile applications have been developed for treatment diaries, appointment scheduling, and pill refills. In Uganda, mTrac enabled CHWs to report real-time data on service availability and adverse events, contributing to faster responses from district health offices [29]. Some programs have adopted Interactive Voice Response (IVR) for areas with low literacy, ensuring inclusivity.

Importantly, many mHealth interventions are integrated with electronic medical records (EMRs) and logistics management information systems (LMIS), creating a digital loop that supports clinical decision-making and inventory tracking. In Bangladesh and Kenya, mobile-enabled platforms have been used to optimize antiretroviral therapy distribution and forecast demand based on consumption trends [30].

Privacy concerns and digital access gaps remain challenges. However, decentralization allows for community-level customization of digital interventions, ensuring they align with literacy, language, and connectivity conditions. Some countries have started using solar-powered mobile kiosks and health info hotlines to bridge access divides.

As shown in Figure 3, mHealth is a vital layer in the patient support infrastructure of decentralized systems. It enhances resilience, provides continuity during disruptions, and offers a scalable, low-cost means of improving adherence in remote populations.

### 5.4. Empowering Patients Through Peer Networks and Counseling

In decentralized health systems, patient empowerment is a central pillar for sustainability and effectiveness. Peer networks and lay counseling platforms have emerged as powerful enablers of this empowerment, fostering knowledge sharing, emotional support, and collective action [31].

Peer educators often individuals with lived experience play a unique role in reinforcing adherence and reducing stigma. Their relatability encourages openness, especially in areas where hierarchical health systems or sociocultural taboos inhibit disclosure. Peer groups have been instrumental in managing HIV, mental illness, and maternal health complications across community settings [32].

Counseling services, when localized and destigmatized, help patients build confidence in self-care. In Malawi and Cambodia, peer navigators have supported patients transitioning from hospital to home-based care, ensuring follow-up and linking them to essential services [33].

Importantly, these structures also decentralize knowledge, ensuring that health literacy is not confined to professionals. This participatory model strengthens collective resilience and boosts the credibility of health systems.

Figure 3 shows how peer interactions fit into the broader architecture of decentralized patient support. Together with professional care, mHealth, and DSDMs, these relational networks form a holistic ecosystem that nurtures long-term health engagement.

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## 6. Case studies: decentralized models in action

### 6.1. Uganda: Hub-and-Spoke Model for HIV and TB

Uganda's decentralized healthcare strategy has been anchored by a hub-and-spoke model that improves accessibility and continuity of care for HIV and tuberculosis (TB) patients. Under this model, high-capacity regional hospitals serve as hubs, offering advanced diagnostics, antiretroviral therapy (ART) initiation, and second-line treatments, while peripheral spokes health centers at lower administrative levels handle refills, monitoring, and community outreach [23].

The system gained prominence through the PEPFAR-supported Strengthening TB and HIV & AIDS Responses in Uganda (STAR) initiative. This program emphasized differentiated service delivery, including community drug distribution points and mobile clinics. These approaches enabled same-day ART initiation and decentralized sample collection for viral load testing, drastically reducing patient wait times and health system burden [24].

Community Health Workers (CHWs) and expert clients played critical roles in tracking lost-to-follow-up cases and offering psychosocial support. The Ministry of Health implemented electronic medical records (EMRs) integrated across hub and spoke facilities, improving data harmonization [25]. These innovations contributed to improved retention in care and viral suppression rates, particularly in rural districts such as Mbarara and Lira.

Supply chain reliability was improved by establishing regional warehouses closer to rural spokes, reducing stock-outs of ART and GeneXpert cartridges. Additionally, sputum transport networks were optimized through partnerships with local courier services [26].

Figure 4 highlights Uganda's model as emblematic of a successful regional tiered referral system, balancing centralized resource intensity with community-level reach. The hub-and-spoke architecture has provided critical lessons on scalability, continuity, and real-time responsiveness key ingredients in HIV and TB control within decentralized contexts.

## **6.2. India: Decentralized Primary Care via Health and Wellness Centers**

India's flagship reform in primary healthcare Health and Wellness Centers (HWCs) has restructured service delivery in decentralized settings. Launched under the Ayushman Bharat program, HWCs aimed to provide comprehensive primary care, including chronic disease management, mental health, maternal and child services, and palliative care [27].

Each HWC is linked to a Primary Health Centre (PHC) and is manned by mid-level health providers, Accredited Social Health Activists (ASHAs), and multipurpose workers. Services have expanded beyond immunization and family planning to include hypertension and diabetes screening, with patient health records stored digitally and shared across tiers [28].

Decentralized capacity was strengthened through regular training of frontline workers using case-based modules and state-supported telemedicine platforms. Urban HWCs also implemented eSanjeevani, a video-based consultation system linking patients to district and subdistrict hospitals for specialized services [29].

Essential medicines and diagnostics are procured through state logistics corporations, with inventory monitored using electronic procurement systems such as e-Aushadhi. This has minimized leakages and ensured availability of medicines at last-mile facilities, particularly in states like Tamil Nadu and Himachal Pradesh [30].

Community engagement is fostered through wellness activities such as yoga sessions, school health campaigns, and outreach camps, reinforcing preventive care. Regular social audits and participatory feedback channels have enabled localized adjustments and fostered public trust.

As illustrated in Figure 4, India's decentralized HWC model emphasizes service expansion, digital integration, and health promotion, tailoring delivery to the needs of underserved rural and urban populations. The initiative represents one of the largest investments in people-centered, community-oriented primary care on a decentralized framework globally.

## **6.3. Brazil: Family Health Strategy in Urban Favelas**

Brazil's Family Health Strategy (FHS) stands as a globally recognized example of a decentralized public health system, especially notable in the context of urban favelas. FHS deploys Family Health Teams (FHTs) comprising doctors, nurses, CHWs, and dentists who are assigned to geographically defined catchment areas, ensuring localized accountability and continuity of care [31].

Each FHT is responsible for approximately 1,000 households and conducts routine home visits, health promotion activities, and early detection screenings. This proximity-based model has been crucial in improving maternal and child health, reducing hospitalization rates, and enhancing immunization coverage in complex urban settings [32].

Electronic data tools support CHWs in updating household health profiles, monitoring chronic illnesses, and initiating referrals. Rio de Janeiro and São Paulo pioneered digital dashboards to track progress at municipal levels, enhancing governance and resource allocation [33].

Financing for the FHS comes from a pooled system shared between federal, state, and municipal governments, with performance-based incentives driving coverage improvements. Community health councils and participatory budgeting mechanisms ensure bottom-up governance and adapt services to local socio-cultural dynamics [34].

Challenges such as gang-controlled territories and limited physical infrastructure have been partially mitigated through partnerships with local NGOs and faith-based organizations. These groups have offered safe access points for immunization drives and facilitated maternal follow-up in restricted areas.

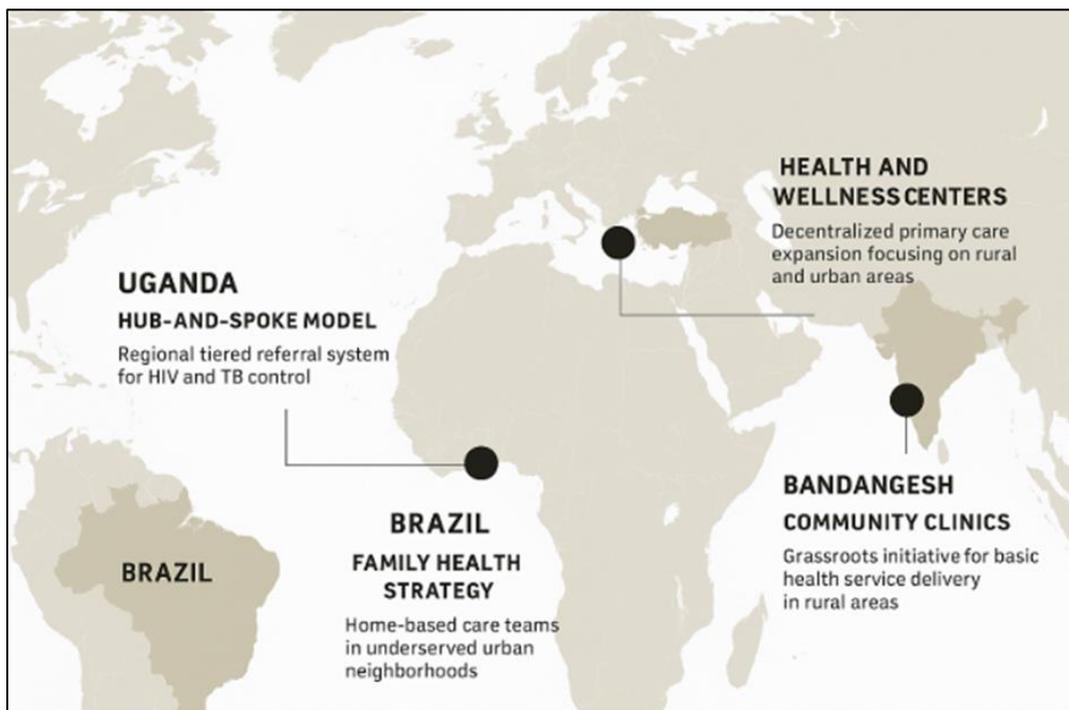
Figure 4 marks Brazil’s FHS as a highly localized, home-centric approach within a broader national health framework (SUS). Its ability to deliver equitable services in fragile and underserved urban zones demonstrates the value of hyperlocal, team-based decentralization in complex sociopolitical contexts.

#### 6.4. Bangladesh: Community Clinics for Maternal and Child Health

Bangladesh’s Community Clinic (CC) initiative is a cornerstone of its decentralized primary health care reform. More than 13,000 CCs have been established across the country, each serving approximately 6,000 people and providing preventive, promotive, and limited curative services with an emphasis on maternal and child health [35].

CCs are typically staffed by Community Health Care Providers (CHCPs) and supported by Family Welfare Assistants and Health Assistants who deliver immunizations, antenatal care, growth monitoring, and family planning services. Health workers reside in or near the served communities, improving trust and follow-up consistency [36].

Integration with national programs such as EPI (Expanded Program on Immunization) and the Integrated Management of Childhood Illness (IMCI) has enabled CCs to reduce under-five mortality and improve nutritional outcomes in rural and hard-to-reach areas [37]. These achievements have been bolstered by regular community engagement forums and health education sessions held at the clinic level.



**Figure 4** Showcases Bangladesh’s CC approach as a grassroots, participatory mechanism that has embedded basic health services within rural settlements, laying a sustainable foundation for universal health coverage [8]

A unique feature of the model is the involvement of Community Groups (CGs) and Community Support Groups (CSGs), which monitor service delivery, mobilize local resources, and act as liaisons between the government and local users.

This participatory structure has enhanced accountability and cultural responsiveness, ensuring that health messaging is adapted to local norms [38].

Supply chain and health information systems have been strengthened through tablet-based reporting tools and solar-powered cold chain equipment, particularly for vaccine storage.

## 7. Technology and infrastructure enablers

### 7.1. Digital Logistics Management Information Systems (LMIS)

The deployment of Digital Logistics Management Information Systems (LMIS) has become foundational in strengthening decentralized health systems, particularly in low-resource settings. These tools enhance transparency, reduce stock-outs, and support demand forecasting by integrating inventory, consumption, and distribution data across multiple tiers of the health supply chain [27]. Unlike paper-based systems, digital LMIS platforms enable real-time visibility from central warehouses to community-level facilities.

Notably, implementations in East Africa have demonstrated significant efficiency gains. In Tanzania, the eLMIS platform allowed zonal medical stores to synchronize replenishment cycles with health center requests, reducing delays in essential commodity distribution [28]. Integration with mobile SMS alerts for stock-level thresholds helped frontline workers signal impending shortages before disruptions occurred. Additionally, periodic reports auto-generated through LMIS dashboards informed procurement and donor alignment.

Data interoperability with existing health management information systems (HMIS) has also evolved. For instance, in Rwanda, LMIS modules are increasingly being integrated into the national DHIS2 platform to facilitate unified reporting [29]. This alignment has reduced duplication and minimized data silos while supporting automated analytics for decision-makers.

Challenges remain, including hardware reliability, internet connectivity, and the need for sustained training and technical support. However, successful models have addressed these gaps through solar-powered devices and capacity building at district levels.

Table 3 highlights LMIS as one of the most mature digital enablers in decentralized healthcare delivery, alongside electronic medical records and teleconsultation platforms. When deployed effectively, LMIS enhances not just supply chain transparency but also ensures that last-mile facilities receive commodities in sync with their service delivery trends, reinforcing availability and preparedness at all levels [30].

**Table 3** Comparison of Digital Enablers Used in Decentralized Care Platforms

Digital Enabler	Primary Function	Decentralized Impact	Maturity Level
Logistics Management Information Systems (LMIS)	Real-time inventory monitoring and commodity tracking	Ensures stock availability at last-mile; improves supply chain planning	High
Electronic Medical Records (EMR)	Patient record keeping and clinical data integration	Supports continuity of care across facilities	Moderate to High
Teleconsultation Platforms (Telehealth)	Remote diagnosis, follow-up, and specialist support	Expands access to care in underserved areas	Moderate
GIS Mapping Systems	Spatial analysis of service gaps and resource distribution	Enables targeted allocation of mobile teams and supplies	Emerging to Moderate
Interoperable Dashboards	Unified data visualization from multiple systems	Facilitates informed decision-making and cross-program alignment	Moderate

## 7.2. GIS Mapping for Resource Allocation and Service Gaps

Geographic Information System (GIS) tools have emerged as indispensable in addressing disparities in healthcare access by visualizing service availability, geographic barriers, and population health needs. In decentralized models, GIS supports microplanning, infrastructure investment, and real-time routing of outreach activities, particularly in remote or underserved zones [31].

Kenya's use of GIS in its Universal Health Coverage pilot offered one such example. By overlaying facility data with population density, maternal mortality rates, and road networks, health authorities optimized site selection for new Health and Wellness Centers and maternity referral systems [32]. This approach allowed targeted expansion into low-access zones with the highest need for intervention.

In Sierra Leone, GIS-supported mapping of community health worker (CHW) coverage helped eliminate overlap in catchment areas and revealed underserved clusters. The Ministry of Health used this data to redeploy CHWs and tailor training programs by geographic risk profiles, significantly improving service equity [33].

Further applications include cold chain optimization, as seen in Nepal, where GIS was used to model ideal vaccine delivery routes to reduce spoilage and improve immunization coverage [34]. This geo-intelligence enables real-time adaptations during disruptions such as floods or political unrest, ensuring consistent service delivery.

While technical barriers such as licensing costs and skills gaps persist, open-source platforms like QGIS and collaborative networks with local universities have reduced entry barriers. Integration with DHIS2 and LMIS further streamlines decision-making.

As outlined in Table 3, GIS represents a cross-cutting digital tool that not only aids planning but also drives data equity. Its inclusion in decentralized health planning frameworks ensures that resource distribution aligns with community-specific realities rather than generic national estimates [35].

## 7.3. Telemedicine and e-Consult Platforms

Telemedicine and e-consultation platforms have extended healthcare reach in decentralized models by bridging geographic and specialist workforce gaps. These tools are especially vital in areas where primary providers operate without continuous access to secondary or tertiary-level expertise [36].

India's eSanjeevani platform stands as a notable example of scalability in this domain. Built as a two-mode teleconsultation system provider-to-provider and provider-to-patient it enabled over 20 million consultations within its first phase of roll-out. Primary health centers could consult district hospitals for dermatology, cardiology, and mental health, while patients engaged via local health workers and digital kiosks [37].

In Ethiopia, the Telehealth for Ethiopia initiative utilized mobile-enabled tablets in health posts to connect rural communities to midwives, pediatricians, and laboratory technologists stationed in regional hospitals. This closed the diagnosis and referral feedback loop and supported continuous professional development for frontline workers [38].

These platforms also serve to ease the burden on overstretched facilities. In Bangladesh, government-licensed telehealth centers reduced patient inflow into urban tertiary hospitals by triaging minor ailments remotely and offering prescription services validated by registered physicians [39].

Privacy and data protection regulations remain a challenge, particularly in systems with limited legal infrastructure. However, many countries have developed tiered access models where only credentialed personnel can retrieve sensitive health data.

According to Table 3, telemedicine, along with EMRs and LMIS, forms a triad of transformative digital tools that can drastically improve service delivery in decentralized environments. Teleconsult platforms increase access to specialist care, reduce indirect healthcare costs, and enable continuity of care especially during emergencies, public health crises, or remote isolation [40].

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## 8. Governance and policy for system integration

### 8.1. National Policy Reforms and Decentralization Mandates

National-level policy reforms have played a decisive role in catalyzing decentralized healthcare delivery in many low- and middle-income countries (LMICs). Driven by the need to enhance responsiveness and equity, decentralization mandates have often emerged as part of broader health sector reforms frequently linked to structural adjustment programs or public sector modernization efforts [32]. These mandates typically involve devolving administrative, financial, and decision-making authority from central ministries to regional or district health authorities.

Kenya's 2010 constitutional reform marked a watershed in health governance. It created 47 semi-autonomous county governments, each responsible for the planning and management of local health services. While the transition posed challenges such as disparities in human resource deployment it eventually enabled tailored responses to community-specific needs [33]. Similarly, Indonesia's post-decentralization framework empowered district governments to budget and deliver services independently, although with varying degrees of effectiveness across provinces [34].

Crucially, decentralization policies have also embedded community health systems within formal national frameworks. Ghana's Community-based Health Planning and Services (CHPS) initiative illustrates this alignment. Policy allowed community committees and local government actors to participate in health planning, improving both legitimacy and uptake [35].

However, decentralization alone does not guarantee improved service quality. Without strong central stewardship, disparities in service delivery can widen, particularly when local units lack the technical or financial capacity to execute new responsibilities. Coordination mechanisms such as intergovernmental fiscal transfers, national health accounts, and shared data platforms are essential to bridge these capacity gaps and avoid fragmentation [36].

As reflected in Figure 1, decentralization efforts must be carefully designed to preserve service equity while fostering local innovation. When properly supported, national reforms can act as enablers for inclusive, responsive, and resilient health systems grounded in local realities.

### 8.2. Financing Models: Conditional Grants and Results-Based Funding

Innovative financing models have emerged to support decentralized health delivery, especially in contexts where traditional input-based budgeting has failed to address service inefficiencies. Among the most impactful are conditional grants and results-based financing (RBF) mechanisms, which align financial incentives with performance metrics and service equity [37].

Conditional grants, often earmarked for specific functions like immunization or maternal health, have empowered subnational units to meet defined targets while maintaining some autonomy over implementation strategies. In Nigeria, the Basic Health Care Provision Fund (BHCPF) channels direct facility financing through conditional grants. Facilities receive allocations based on compliance with national standards for service availability, quality, and record-keeping [38].

Results-based funding further shifts the paradigm by linking disbursements to outputs or outcomes. Rwanda pioneered this approach through its Performance-Based Financing (PBF) model. Facilities earned incentives by meeting specific indicators such as antenatal visits or skilled deliveries verified through independent audits. This not only improved accountability but also drove internal investments in staff training and infrastructure [39].

Hybrid financing schemes have also evolved. In Cambodia, the Health Equity Fund combined capitation, fee exemption reimbursements, and performance-linked bonuses to ensure that remote populations received subsidized services while holding providers accountable for quality [40].

Despite their promise, such models require robust verification systems, financial management capabilities, and risk mitigation frameworks to guard against data manipulation or gaming. Integration with digital financial platforms and dashboard tools has improved transparency in disbursement flows and outcome reporting.

Table 3 illustrates how financing models differ in terms of incentive structure, monitoring complexity, and adaptability to scale. As LMICs deepen decentralization, sustained and equitable health financing will depend on aligning fiscal transfers with real-world service burdens and performance, not just population size or historical budgets [41].

## **9. Monitoring, evaluation, and adaptive learning**

### **9.1. Key Metrics for Access, Quality, and Continuity**

For decentralized health systems to remain accountable and improve over time, it is essential to identify and track specific metrics that capture the multidimensional nature of service delivery. Three key domains access, quality, and continuity of care form the backbone of monitoring frameworks that enable informed redesign and adaptation [37].

Access metrics go beyond simple facility counts. Geographic accessibility is captured through GIS-enabled catchment analysis, while real-time availability of essential commodities, such as antimalarials or contraceptives, is tracked through integrated Logistics Management Information Systems (LMIS) [38]. Equity indicators, such as utilization disaggregated by gender, age, and income quintile, ensure that marginalized populations are not left behind [39].

Quality indicators include adherence to national treatment guidelines, correct case management, and user-reported experience scores. Facility audits often assess whether frontline staff have access to continuing education, supervision, and functioning equipment [40]. Many countries have incorporated supportive supervision checklists that are digitally submitted and linked to performance assessments.

Continuity of care remains a challenge in settings where patient records are fragmented or not portable. Metrics such as referral loop closure, follow-up adherence, and retention rates for chronic conditions like HIV or hypertension are critical. In Kenya, for example, efforts to improve ART retention led to innovative peer tracing systems to locate patients lost to follow-up [41].

These metrics are not isolated; their true utility emerges when triangulated across data sources and linked to decision-making cycles. As Figure 5 illustrates, metrics function as the foundation of a responsive loop, connecting observed gaps to iterative system redesigns. The ability to monitor all three domains in a harmonized manner allows local health systems to evolve continuously while maintaining a commitment to equity and impact.

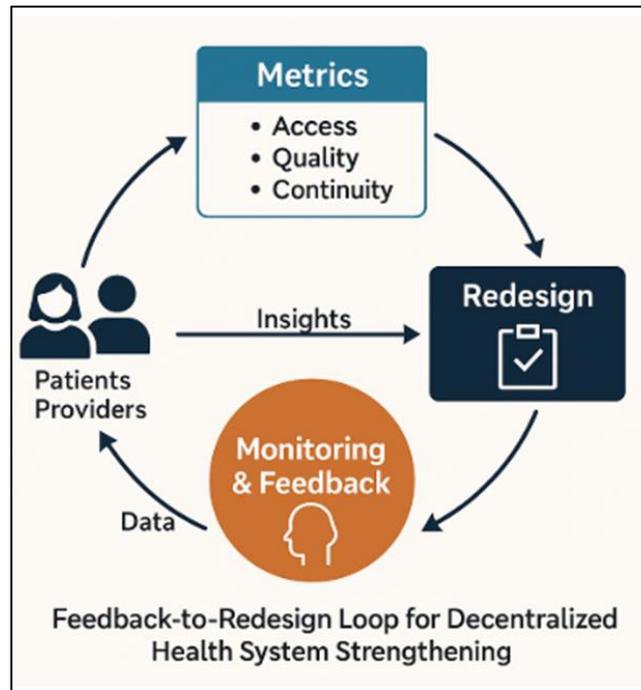
### **9.2. Feedback-Driven Model Iteration and Scale**

Decentralized health systems thrive when there is an embedded mechanism for adaptive learning the ability to absorb feedback and refine implementation in real time. This requires structured feedback loops that connect frontline experience with policy-level adjustments, supported by both digital and participatory mechanisms [42].

Routine community dialogues, health worker review meetings, and district health planning sessions are important entry points for qualitative feedback. In Uganda, community scorecards were used to capture beneficiary perspectives on service timeliness and respectfulness, prompting facility-level process improvements [43]. Such participatory feedback has proven more sustainable when tied to actionable budgets and incentives.

On the digital front, dashboards that visualize disaggregated access and quality metrics allow health managers to identify underperforming areas rapidly. Rwanda's HMIS dashboard, for example, enables monthly flagging of districts that fall below national norms on immunization or maternal health, with automated alerts triggering supervisory visits [44].

Scaling effective models from pilot to national level depends on retaining core design principles while tailoring for new contexts. India's expansion of Health and Wellness Centers built on iterative feedback from early adopters, such as adjusting health worker training content and adapting workflows for urban versus rural clinics [45]. Countries that succeeded in scaling have often created "learning laboratories" districts given greater autonomy to experiment, with results informing broader rollouts.



**Figure 5** Flowchart showing the importance of rapid feedback for model refinement

The redesign loop captures how data, both qualitative and quantitative, travels from patients and providers back to program design. This cyclical process ensures that decentralization is not a static structural shift but a dynamic strategy that evolves with user needs, enabling health systems to deliver more relevant and resilient care over time [46].

## 10. Conclusion and future outlook

### 10.1. Summary of Key Integration Insights

Decentralized health systems have emerged as a pragmatic response to persistent challenges in service equity, responsiveness, and resource allocation across low- and middle-income countries (LMICs). Throughout this article, multiple integration insights have been identified, illustrating how decentralization can be both scalable and sustainable when implemented with contextual intelligence.

First, decentralization requires deliberate system design that aligns facility readiness, supply chains, health information systems, and financing mechanisms under a shared vision of accessibility. Fragmented approaches often fail to deliver lasting improvements unless components are integrated with accountability loops.

Second, a consistent theme across case studies and models is the value of community participation. Whether through embedded community health workers, patient scorecards, or participatory budgeting, proximity and trust become operational assets that centralized models often overlook.

Third, the use of digital enablers such as telemedicine, logistics dashboards, and GIS tools has allowed decentralized models to function with real-time visibility and better coordination, even in remote settings. However, digital tools must be complemented by policies that promote interoperability and local ownership.

Fourth, workforce dynamics are crucial. Empowering local teams with autonomy, clinical decision-making support, and career pathways not only improves service delivery but also builds resilience into the system.

Lastly, integration requires adaptive governance. As conditions change epidemiologically, politically, or demographically systems must be able to evolve. Feedback loops, continuous performance monitoring, and the ability to reallocate resources are non-negotiables in sustaining impact.

These insights offer a foundational understanding of what it takes to move beyond pilots and toward resilient, decentralized models. Integration is not a one-time event but a continuous process that aligns people, data, and infrastructure toward the shared goal of health for all.

## 10.2. Roadmap for LMICs to Sustain Decentralized Access

To sustain decentralized access in LMICs, a structured roadmap must consider five core pillars: governance, infrastructure, financing, community alignment, and continuous adaptation. While each country's path is unique, the following steps offer a general framework for durable decentralization.

- **Institutionalization of Decentralization Mandates:** Governments must embed decentralization within legal and regulatory frameworks, supported by clear mandates for subnational entities. This includes redefining roles for national, district, and facility-level actors while ensuring accountability structures are in place. Policy harmonization must cover procurement, data reporting, and human resource management.
- **Infrastructure and Human Capital Investment:** Without baseline infrastructure power, connectivity, cold chain logistics decentralized systems remain aspirational. Prioritizing investment in digital and physical infrastructure at the periphery is key. Equally critical is a pipeline of trained health workers and managers with the competencies to operate in autonomous settings. Continuous professional development and mentorship models should be embedded at district levels.
- **Financing for Flexibility and Sustainability:** Rigid, input-based funding models hinder local innovation. Countries should transition toward results-based financing or conditional grants that allow districts and facilities discretion to address emergent needs. Sustainability also hinges on exploring blended financing from government budgets, donor pools, and community-based schemes.
- **Community Anchoring of Delivery Models:** Decentralized systems must reflect the lived realities of those they serve. Engaging local leaders, civil society groups, and patient networks ensures delivery models are culturally appropriate and responsive. This approach builds trust and drives utilization, even where physical access remains challenging.
- **Feedback-Driven Iteration and National Learning Systems:** Finally, decentralization cannot succeed without learning mechanisms. Routine monitoring, real-time data visualization, and embedded research teams can ensure that evidence informs evolution. Countries should foster "learning districts" that serve as incubators for innovations that can be adapted and scaled.

In conclusion, sustaining decentralized access requires an ecosystem-wide strategy that embeds flexibility, prioritizes the periphery, and centers equity. With deliberate planning and institutional learning, LMICs can build resilient systems that are locally led, contextually relevant, and capable of adapting to future shocks.

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## Compliance with ethical standards

### *Disclosure of conflict of interest*

No conflict of interest to be disclosed.

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