THE LANCET Global Health

COMMISSION ON MEDICAL OXYGEN SECURITY

COUNTRY CASE STUDY

Nigeria

From national policy to local implementation

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Case study focus

The Nigeria government was one of the first countries to publish a national strategy for oxygen. In 2016, the Federal Ministry of Health, collaborated with stakeholders to develop the National Policy on Medical Oxygen, and subsequently the National Strategy for the Scale-up of Medical Oxygen in Health Facilities 2017-2022. The National Policy on Medical Oxygen laid the foundation for the national strategy, emphasizing a comprehensive approach to managing patients and improving access to life-saving oxygen in Nigeria.

The comprehensive 5-year roadmap, aimed to address the high morbidity and mortality from hypoxaemia among children in Nigeria, and serves as a roadmap for engaging stakeholders across the medical oxygen ecosystem, including oxygen generation,

Key messages

- *Nigeria was one of the first countries to establish a national oxygen strategy. While the launch of this policy had started to mobilise action, the COVID-19 pandemic provided the stimulus needed for widespread awareness and resource mobilisation.*
- *Medical oxygen systems involve a wide range of actors. As a solution, Nigeria has established Oxygen Desks at the Federal and State levels to support coordination and monitoring of oxygen supply and need.*
- *Despite medical oxygen receiving political focus, wider health system issues limit their impact, with poor infrastructure, healthcare worker capacity and high out of pocket costs for patients, preventing equitable access.*

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distribution, administration, and maintenance, to guide increased access to medical oxygen supply systems in Nigeria. This case study focuses on understanding the political environment surrounding medical oxygen in Nigeria, assessing the extent to which national-level Federal Government policies have been adopted and implemented at State and local levels across Nigeria. We explore enabling factors contributing to effective policy enactment, and challenges that have limited uptake. This is particularly crucial when contextualized within the complex framework of the Nigeria Health System, a mixed system of public, private and donor-funded delivery through primary, secondary and tertiary health facilities.

Country Context

Demography, economy and epidemiology

Approximately 40% of Nigerians live below the national poverty line of US$382 per year, and 31% living below the international extreme poverty line of US$2.15 per person per day.(7) Economic inequalities exist in Nigeria, with poverty clustered in the Northern States and in rural areas of the country. Of those living below the international poverty line, 79% are living in Northern States and 87% live in rural areas (Table 1).(7)

The top causes of mortality across all ages in Nigeria are neonatal conditions, acute lower respiratory infections, diarrhoeal diseases, tuberculosis, and malaria.(8) The three leading causes of death in children under-five in Nigeria are malaria, diarrhoea, and pneumonia, (9) responsible for 64% of mortality in this group.(2) Nigeria is not on track to achieve SDG 3.2 by 2030 (Figure 1).(10)

Indicator	Value in 2022/2023	Data source
Total population	223.8 million	United Nations Population Fund, 2022[1] UNICEF, 2023[2]
Total under-five population	35.9 million	UNICEF, 2023[2]
Under-five mortality	102 per 1,000 live births 111 per 1,000 live births	National Bureau of Statistics, 2022[3] UNICEF, 2023[2]
Life expectancy (m:f)	68 years: 78 years	United Nations Population Fund, 2022[1]
GDP	$US 2280 per capita in Q1 2023 3	International Monetary Fund, 2023[4]
Healthcare expenditure	$US 70 per capita	The World Bank, 2023[5]
Income status	Lower-middle income	The World Bank 2023[6]
Neonatal mortality rate	34 per 1,000 live births	National Bureau of Statistics, 2022[3]

Table 1: Key metrics and indicators for Nigeria

Hypoxaemia contributes to over a million preventable deaths in low-income countries every year.(11) In Nigeria, an estimated 625,000 deaths occur annually from diseases associated with hypoxaemia,(12) however, reliable data about the hypoxaemia burden and oxygen need for different disease conditions is largely lacking. Notably, hypoxaemia is prevalent among hospitalized children in Nigeria, increasing the odds of death by six-fold in neonates and eight-fold in under-five children.(13)

Approximately 13 million persons in Nigeria, including children, adolescents and adults, have clinical asthma,(14) and evidence show a low rate of oxygen saturation monitoring at admission and during the course of treatment for patients with acute asthma in Nigeria. Specifically, only 5% of patients with acute asthma have an SpO2 measured upon admission, and while supplemental oxygen was administered to 31% of them, none of these decisions were informed by an oxygen saturation measurement.(15)

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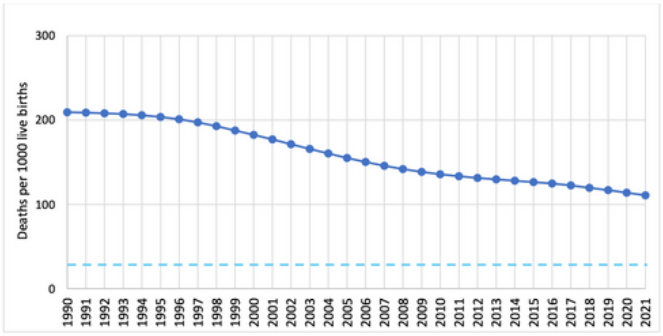

Figure 1: Trend in the under-five mortality rate in Nigeria. Source: UNICEF Data (2023): Monitoring the situation of children and women - Nigeria. https://data.unicef.org/country/nga/

A study in 2012 indicated that 57% of endoscopists in Nigeria monitor oxygen saturation during sedation, with half (51%) utilizing supplemental oxygen for diagnostic gastrointestinal endoscopy. (16) For chronic obstructive pulmonary diseases (COPD), a review by Ale et al. (2022) provided the first national estimates for the prevalence of COPD in Nigeria, reporting a median prevalence of 9.2% (interquartile range, IQR=7.6–10.0).(17) However, the contribution of COPD to burden of hypoxaemia in Nigeria has not been determined.

Health system

The Nigerian healthcare system is public sector driven, with a substantial private sector involvement in service provision.(18) The Nigerian healthcare system operates with tertiary, secondary and primary levels of care. Secondary- and tertiary-level health facilities are predominant in urban areas, while primary healthcare (PHC) facilities mostly serve rural areas. The Federal government has a responsibility to organize tertiary health services through the network of teaching hospitals and federal medical centres while, the State government is primarily responsible for secondary health services but may also provide tertiary services when financial capacity is available. The local government provides primary health services through health posts and clinics, primary health centres and comprehensive health centres – Figure 2. Patients are referred from the primary health care which is the first entry point of care to other higher levels of care.(18)

Private health facilities are classified based on their structure and the services they provide.19 There is no regulation that appropriately classifies which level of healthcare private facilities belong as structures and designs of private facilities vary across settings. The private healthcare providers in Nigeria are broadly clinics, maternity homes, and hospitals with ownership including individuals, faith-based and other civil society organisation.19 The Department of Hospital Services of the Federal Ministry of Health coordinates all interventions for medical oxygen and medical oxygen systems in the country, providing strategic guidance to government, partners, and stakeholders in the oxygen landscape.(20)

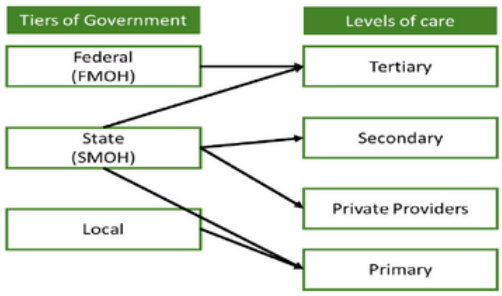

Figure 2: Health system structure in Nigeria. Source: National Strategy for the Scale-up of Medical Oxygen in Health Facilities 2023-2027.

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There are around 38,500 operational health facilities in Nigeria, including hospitals and clinics enumerated by the Federal Ministry of Health. Of these health facilities 0.4% are tertiary hospitals, 14% are secondary facilities, and 85% are primary facilities. The majority of the health facilities (74%) are publicly owned.(21)

Despite having the highest proportion of health workers in Africa, accounting for 26% (0.94 million) of the continents workforce, Nigeria's health workforce density of 1.95 per 1000 population is still below the WHO threshold of 4.45 health workers per population.(22,23) There are 39 doctors to 100,000 population (0.4 doctors per 1000 population) and 148 nurse/midwife to 100,000 population in Nigeria (1.5 nurses and midwives per 1000 population). (24) However, the human resource for health in Nigeria has seen significant reduction recently with migration of healthcare workers to high income countries.

Health financing comes from several sources including, but not limited to, tax revenue, out-of-pocket payments, donor funding, and health insurance (social and community).(25) However, out-of-pocket expenditure accounts for 78% of total health expenditure in the country, with high risk of catastrophic and impoverishing health expenditure for many households – especially for the large number in the population with no insurance packages. (24,26) Health insurance covers less than 5% of the population,(26) with these individuals primarily covered through health insurance from their employers; privately purchased insurance is uncommon.(27)

The low budget for health by the Nigerian government has been a major challenge in achieving universal health coverage. This is reflected in the failure to achieve the 2001 Abuja Declaration where African leaders pledged a commitment to increase budgetary allocation to 15%.(28,29) Competing programmes or activities have been given as a reason for not meeting this target. The situation is worse at the State and local government levels, where even less is allocated to health. Since the COVID-19 pandemic, the 36 State governments responded by increasing investment towards health. Between 2020 and 2022, only Kaduna and Sokoto states consistently achieved the target of 15% health expenditure, and 23 states failed to reach the target even once during this period, despite increasing their nominal spending on health.(30)

In the fiscal years 2021 and 2022, 13 States (Akwa Ibom, Anambra, Benue, Edo, Enugu, Jigawa, Kano, Katsina, Kebbi, Lagos, Niger, Rivers, and Yobe) consistently increased their budgetary allocation for health; Yobe, Imo, and Bayelsa States more than doubled their 2020 budgetary levels in 2022.(30) Nevertheless, despite documented poor health outcomes thirteen State governments, notably Ebonyi and Plateau State, decreased fiscal allocations to the healthcare sector in 2022.(30)

During the COVID-19 pandemic, the Nigerian government officially enacted the new National Health Insurance Act (NHIA) 2022 on May 19, 2022 which expands coverage to over 83 million poor and vulnerable people.(31,32) The NHIA Act was signed into bill to ensure universal health coverage with health insurance now mandatory for all Nigerians by the government. (31) On 1 August 2022, the WHO Country

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Representative announced their pledge to aid Nigeria in accelerating the operationalization of the NHIA Act including the Vulnerable Group Fund (VGF) through provision of sustainable health financing support for universal health coverage and health security.(32) They reiterated that the support to be provided is in line with WHO's goal of making sure that all individuals and communities receive the quality health services they need without suffering financial hardship.(32)

Under the past administration of President Muhammed Buhari's government, budgetary allocation for health in Nigeria surpassed a trillion naira for the first time in 2023, constituting 5.8% of the 2023 total budget.(28) In the subsequent term under the leadership of President Bola Tinubu, the 2024 health budget was set to N1.5 trillion (approximately US$2 billion), representing 5.5% of the total budget. Despite the increase in total amount from 2023, the value of the 2024 budget is lower in real-terms due to changes in the official Naira exchange rate, a 28% year-on-year inflation rate, and population growth.(33)

Furthermore, the 2024 budget continues to fall short of the Abuja declaration, representing only a third of the recommended 15% of the total budget which would have amounted to N4.1 trillion.(28,33) On January 11, 2024, the Federal Government revised the foreign exchange benchmark to N800 per dollar in the 2024 budget, considering the Naira's average performance and global dynamics.(34) Consequently, the 2024 health budget was revised down to represent US$1.9 billion. The incumbent President Bola Tinubu-led administration has expressed its commitment to increasing the annual budgetary allocation to the health sector to 10% of the country's total budget. However, this commitment is yet to be reflected in the first national budget set by the administration, with promises of additional increments contingent on judicious management.(28)

COVID-19

As of the 26th July 2023, a total of 266,675 cases of COVID-19 had been confirmed in Nigeria and 3,155 deaths recorded.(35) Nigeria received the first shipment of 3.9 million doses of the Oxford-AstraZeneca vaccine through the COVAX facility in March 2021.(37,38) In response to the COVID-19 pandemic, the Coalition Against COVID-19 (CACOVID), a private sector-led organization in collaboration with the Federal Government, the Nigeria Centre for Disease Control (NCDC) and the WHO was launched on March 26, 2020. The coalition aimed to bolster the government's response and address the challenges posed by the spread of COVID-19 in Nigeria.(39,40) CACOVID's mandate included pooling resources from various industries to offer technical and operational support, as well as providing financial assistance and fostering advocacy through robust awareness campaigns.

Playing a pivotal role in enhancing the country's healthcare infrastructure, CACOVID strategically established medical facilities, including testing, isolation, and treatment centres, equipped with Intensive Care Units (ICUs) and molecular testing laboratories. This was implemented across all six geopolitical zones in Nigeria to strengthen the nation's ability to manage and respond to the challenges posed by the COVID-19 pandemic. (39) This initiative earned the coalition

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recognition as the third-largest contributor globally to the fight against COVID-19 virus. By the time the Coalition concluded its efforts in 2023, it had mobilised 62 billion naira, established 39 isolation centres in all 36 States and the FCT of Abuja, testing supplies for almost one million tests, food for 10 million vulnerable individuals, oxygen and oxygen cylinders for the most affected states, support for vaccines delivery and distribution, and assistance in reopening the economy during lockdown.

However, the pandemic negatively affected the healthcare system, particularly in the area of medical oxygen supply. Health facilities in Nigeria that were grappling with pre-existing deficiencies in their oxygen systems were further burdened – Table 2. The Federal Ministry of Health, led by the Minister of Health, recognized this critical need and took proactive measures. These included repairing non-functional Pressure Swing Adsorption (PSA) plants nationwide and collaborating with industrial oxygen producers to repurpose their facilities for the production of medical-grade oxygen, aiming to bolster the country's oxygen production capacity.(42)

However, research findings paint a picture of inadequate oxygen access. Findings from public primary and secondary facilities, and private facilities in Lagos, Nigeria, found none of the facilities were equipped to meet minimum oxygen demands.(41) The demand for medical oxygen increased by seven-fold in Lagos Stata, the epicentre of the pandemic, and hospitals in the capital city of Abuja were on the brink of running out of supplemental oxygen during the second wave.(43) Tertiary hospitals, such as University of Nigeria Teaching Hospital Enugu, Southeastern Nigeria and Lagos University Teaching Hospital, reported acute shortages of oxygen at some points during the pandemic.(44) According to the Chief Medical Director of Lagos University Teaching Hospital, several months after the pandemic began, the PSA plant at their facility was upgraded on request; however, the facility used over 120 oxygen cylinders a day and oxygen demand overwhelmed their PSA plant. He stressed that patients in the wards required a high flow of oxygen, and all admitted patients needed oxygen, meaning cylinders often ran out.(44)

Anecdotal evidence from COVID-19 patients highlighted the immense struggle healthcare workers faced in managing patients in public hospitals, due to the scarcity of oxygen.(43) Wealthier COVID-19 patients sought treatment in private hospitals where medical oxygen was more readily available but at a higher cost. (43,44) The national health insurance package did not cover the management of COVID-19, making it difficult for the working poor to afford the unexpected costs of testing and treatment at private facilities.(45) On 6th August 2022, UNICEF announced an 18- month partnership with IHS Nigeria – a private company specializing in telecommunication infrastructure, to support the Federal Ministry of Health in strengthening oxygen supply in hospitals across eight States in Nigeria citing the potential consequence of limited access to medical oxygen for critically ill patients with severe COVID-19 and pneumonia.(46)

Table 2 presents findings on the availability of oxygen and/or pulse oximetry in various clinical settings before and during the pandemic, with limited access and infrastructural gaps evident, especially in rural

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and paediatric care settings. In addition, there were challenges in continuous monitoring and cost barriers affecting quality of care before pandemic. During the pandemic, published data shows interventions and stakeholder awareness initiatives improved oxygen access in paediatric care; however, challenges in oxygen access persisted, cost remained a barrier to treatment, and ongoing efforts are crucial to address disparities and ensure sustained enhancements in healthcare infrastructure. The pandemic underscored the importance of adaptive interventions and health system strengthening to meet the evolving demands for oxygen therapy.

Oxygen supply and clinical use landscape in Nigeria

The findings from the first comprehensive health facility assessment for medical oxygen was conducted across all 36 states and the Federal Capital Territory between June and September 2022. It was conducted by the Federal MOH supported by FHI360, UNICEF and Clinton Health Access Initiative (CHAI) and included 6,786 health facilities, comprising primary health centres, secondary and tertiary health facilities, specialized hospitals and private hospitals. The assessment identified 39 PSA plants in secondary and tertiary facilities in Nigeria, of which 30 (77%) were functional (22 in tertiary hospitals, eight in secondary facilities).

While additional PSA plants exist in the country, ownership lies within the private sector, which operates various types of public private partnership (PPP) models with health facilities and often operate hub-and- spoke models to support adjacent health facilities.

Examples of PSA plants supplying through PPP models include: the PSA plant provided by CHAI at the Infectious Disease Hospital in Lagos; the Life Bank PSA plant in Orozo LGA, Nassarawa state, installed in 2021 through a PSA plant franchising model; Healthport's solar powered micro-PSA plant installed and operational in the 50-bed hospital, Harvey Health Centre and Maternity in Yaba, Lagos.

The COVID-19 pandemic presented an opportunity to acquire an additional 122 PSA plants, with plans for installation spanning across the six geopolitical zones. The procurement of these plants holds significant importance, given that many regions in the country lack access to private sector supply channels. Notably, the Federal Government of Nigeria procured 38 of these plants to ensure coverage across all 36 states and FCT (with two plants for Lagos state). Additionally, nine plants were obtained through UNICEF, and another 75 via the Global Fund COVID-19 response mechanism (C19-RM). As of early 2024, 12 of the 75 C19-RM PSA plants were installed.(78)

Oxygen cylinders and oxygen concentrators at the bedside are the most common oxygen sources in most health facilities in Nigeria. Some larger secondary and tertiary health facilities have bedside oxygen piping systems and on-site PSA plants of varying capacities and efficiency. Unfortunately, many have become redundant and inefficient due to poor maintenance practices. The 2022 national assessment identified a total of 5,741 oxygen concentrators, of which 76% were functional, and 49% had a 5L/minute maximum capacity. Comparing these findings with previous smaller assessments, a relatively consistent trend in concentrator functionality emerges, with 72%

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Authors	Patient/health workers group	Setting	Key findings
		Pre COVID-19	
Mokuolu and Ajayi (2002)	Neonates	Neonatal unit	Oxygen concentrators were recommended as cost-effective for neonatal units in Nigeria. Demonstrated significant cost savings with concentrators compared to cylinder.[51]
Desalu *et al.* (2011)	Asthma patients	Tertiary hospitals	Limited availability of pulse oximeters in teaching hospitals in Nigeria.[52]
Ogunbosi *et al.* (2011)	Children under 15 years	Paediatric emergency room at a tertiary hospital	About 32.2% of children received oxygen therapy in the emergency room.[53]
Orimadegun *et al.* (2011)	Paediatricians	Healthcare centres in Nigeria	Limited knowledge and access to pulse oximeters among paediatricians.[54]
Nwokediuko and Obienu (2012)	GI endoscopists	Scientific conference	Only 57.1% of endoscopists monitored oxygen saturation during sedation.[16]
Henry et al. (2012)	Surgeons	41 private, rural hospitals in southern Nigeria	44.5% of private, rural hospitals had a pulse oximeter.[55]
Abdulraheem *et al.* (2015)	Neonates referred and transported to facility	Tertiary hospital	Study on neonates revealed 66.2% had hypoxemia, and failure to administer oxygen during transport was associated with hypoxemia.[56]
Desalu *et al.* (2016)	Patients with acute exacerbation of asthma	Two tertiary hospitals in a state in Southwestern Nigeria	Inadequate measurement of oxygen saturation and limited use of continuous monitoring in asthma care.[15]
Iroezindu *et al.* (2016)	Adults with community-acquired pneumonia	Four major tertiary care hospitals in South-East Nigeria	Need for supplemental oxygen identified as an independent predictor of in-hospital mortality among adult patients with pneumonia.[57]
Graham *et al.* (2016)	Children and newborns	Non-tertiary hospitals in south-west Nigeria	Structural, technical, and clinical barriers to safe and effective oxygen therapy were identified in non-tertiary hospitals.[58]
CHAI (2017)	Patients in health facilities in Nigeria, with a specific focus	Hospitals and paediatric wards in Nigeria.	Oxygen and pulse oximeter availability in health facilities were assessed. Only 55% of 169 hospitals provided oxygen therapy,

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	on paediatric wards.		with only 17% in paediatric wards. Pulse oximeters were available in 11% of hospitals. In the emergency paediatric unit of Barau Dikko Teaching Hospital, 80% percent of the concentrators were initially found to deliver oxygen at very low concentrations. After routine maintenance and repair by trained engineers, all concentrators were reported to be working optimally.[59]
Aneji *et al.* (2020)	HCW and hospital administrators	Hospitals involved in the bCPAP program	Survey of hospitals indicated that only 64.3% reported the presence of pulse oximeters.[61]
King *et al.* (2020)	Stakeholders involved in paediatric pneumonia	National, Jigawa and Lagos states	Stakeholders identified insufficient and inadequate access to essential equipment, including oxygen and pulse oximeters, in paediatric pneumonia management.[60]
During COVID-19			
Bakare *et al.* (2020)	Children and neonates	12 Secondary health facilities in southwest Nigeria	Cross-sectional facility assessment revealed varied availability and functionality of oxygen equipment in secondary health facilities.[62]
Briggs and Eneh (2020)	HCWs providing obstetrics and newborn services	28 PHC Centres in Port Harcourt, South-South Nigeria.	Only 5 out of 28 primary health care centres in Port Harcourt, Nigeria, had oxygen cylinders, and none had oxygen readily available for use.[63]
Walker *et al.* (2020)	Neonates	Three hospitals in southwest Nigeria	Prospective study on the effectiveness of intermittent pulse oximetry in guiding oxygen therapy in neonates in a low-resource setting.[64]
Banke-Thomas *et al.* (2021)	Pregnant women with COVID-19	Tertiary hospital in Lagos, Southwestern Nigeria	Hospital-based cost analysis revealed medical oxygen as a major cost driver for managing severe COVID-19 symptoms.[65]
Graham *et al.* (2021)	Children and neonates	58 health facilities in Lagos state including primary, secondary, government, and	Case study on oxygen access in health facilities in Lagos state, Nigeria, revealed disparities in availability, cost, and use.[66]

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		private health facilities	
Graham *et al.* (2021)	Children with severe pneumonia, severe malaria, and severe diarrhoea	12 hospitals in South-west Nigeria	Stepped-wedge cluster randomized trial showed improved quality of care for children with severe pneumonia and severe malaria with enhanced oxygen systems.[67]
Ogunbiyi *et al.* (2021)	Children and adults	30 public and private intensive care units	Cross-sectional survey of 30 public and private intensive care units in 6 geo-political zones of Nigeria revealed varying costs for ICU admission and challenges in equipment functional.[68]
Bolu *et al.* (2022)	Children and adults	National end-of-year review of findings of the Presidential Task Force on Health	End-of-year review of Nigeria's response to the COVID-19 pandemic, highlighting the challenges and improvements in healthcare infrastructure.[69]
Graham *et al.* (2022)	Children and neonates	12 secondary health facilities in four states (Oyo, Ondo, Osun, and Ogun) in south-west Nigeria.	Prospective evaluation of the sustainability and effectiveness of improved oxygen systems in secondary health facilities in southwestern Nigeria.[70]
Kalu *et al.* (2022)	Children and adults	205 health care facilities in 18 LGAs, across the three senatorial districts of Cross River State	Descriptive cross-sectional study on the availability of Basic Life Support devices and essential drugs in health care facilities in Cross River State, Nigeria.[71]
Okeke *et al.* (2022)	HCWs	Literature review of responses to COVID-19 in Nigerian health facilities	Rapid assessment of the health system's response to COVID-19 in Nigeria, highlighting the training of healthcare workers and acquisition of ventilators and oxygen concentrators.[72]
CHAI (2023)	Biomedical engineers and HCWs involved in oxygen equipment	Assessment in health facilities across five Nigerian states	CHAI collaborated with LUTH for national training of biomedical engineers, resulting in peer-led mentoring programs for equipment maintenance.[73]

Table 2: Evidence of the presence or absence of oxygen/oximetry in various clinical settings. HCW = healthcare workers

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functionality reported in 12 secondary facilities across four states (Oyo, Ondo, Osun and Ogun),. (70) and 64% in 58 health facilities (28 private and 30 public facilities) in Lagos.(41) Both National and the smaller assessments highlighted maintenance issues, broken concentrators and retired and broken cylinders.

For liquid oxygen (LOX), Industrial and Medical Gases (IMG) and Air Liquide are the key suppliers, concentrated in the southern region of the country. These suppliers also produce other industrial gases for private businesses including bottling companies, mining and oil sectors. The national assessment found only two facilities with functional LOX storage capacity: the National Hospital Abuja and Jos University Teaching Hospital, with a total storage capacity of 18,000L of oxygen. Facilities operating the LOX system perennially experience refilling challenges with an estimated delay of 3-4 weeks between order and delivery. With support from the Global Fund C19-RM, USAID and FHI360, the country is enhancing its LOX capacity. This involves acquiring an additional 18 LOX tanks (12 funded through the C19-RM and six through USAID). This expansion will boost the storage capacity 10-times, up to approximately 188,800 litres, with two tanks located in each of the six geopolitical zones.

There were 8,824 pulse oximeters in the National assessment, averaging approximately 1 pulse oximeter per facility, with a higher concentration in secondary and tertiary facilities. Overall, 77% of these assessed pulse oximeters were found to be functional, and 51% of the functional pulse oximeters were fingertip pulse oximeters (Table 3).

Type	Functional	Total	Health facilities				
			Primary	Secondary	Tertiary	Specialized hospitals	Private
Table-top	Functional	1431 (76%)	309 (64%)	697 (81%)	388 (77%)	0 (0%)	37 (79%)
	Non-functional	460 (24%)	175 (36%)	161 (19%)	114 (23%)	0 (0%)	10 (21%)
Hand-held	Functional	1728 (70%)	291 (40%)	1012 (85%)	369 (78%)	1 (100%)	55 (82%)
	Non-functional	725 (30%)	429 (60%)	182 (15%)	102 (22%)	0 (0%)	12 (18%)
Fingertip	Functional	3638 (81%)	476 (75%)	2037 (83%)	1044 (81%)	6 (100%)	75 (74%)
	Non-functional	842 (19)	157 (25%)	415 (17%)	244 (19%)	0 (0%)	26 (26%)

Table 3: Pulse Oximeter Access from the Federal Ministry of Health National Oxygen System Assessment (2022) –

A comparison with previous smaller assessments suggests a higher overall functionality rate for pulse oximeters in the national survey,(41,62) but similar percentage of fingertip pulse oximeters.(41)

Among frontline healthcare workers trained in the last 5 years, many facilities assessed training to nurses (30%) and doctors (28%) within the last 1-3 years. However, only 132 (16%) assessed public secondary and tertiary health facilities reported having the capacity for equipment maintenance and installation. Both the national and subnational assessments underscore the persistent challenge of maintenance practices for oxygen equipment.

While the national assessment provides a broad overview of pulse oximeter distribution and functionality across facilities, the subnational assessments offer detailed insights into specific factors like coverage, changes over time, and the presence of guidelines. Nevertheless, both the national survey and the smaller assessments indicated a clear need for the adoption and implementation of guidelines and policies to ensure proper use and management of oxygen sources and equipment at national and sub-national levels.

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From a National Plan to local implementation
Early adopters of a National Oxygen Plan
Before the adoption of the WHO executive board draft resolution by the 76th World Health Assembly in May 2023,(75) the Nigerian government had already published National Policy on Medical Oxygen in 2016, and a National Strategy for the Scale-up of Medical Oxygen in Health Facilities 2017–2022.(76) Its development garnered attention for medical oxygen and interest from the wider government, leading to investments in medical oxygen systems before COVID-19 arrived.

A National multi-stakeholder coordinating platform, United for Oxygen (U4O), was developed in the same year. U4O is chaired by the Oxygen Desk of the Department of Hospital Services of the Federal Ministry of Health. This platform includes stakeholders such as the Federal MOH, academics, implementation partners and private sectors, and is responsible for providing reports on the implementation status to the government and President.

Three years after the launch of the first roadmap, the world was hit by the COVID-19 pandemic, substantially increasing oxygen demand and reshaping the medical oxygen landscape. This crisis prompted unprecedented investments in oxygen systems by the Nigerian government, donor agencies, and implementing partners,(20) contributing to gains such as the establishment of oxygen coordinating platforms at sub-national levels, procurement of oxygen commodities and consumables to meet demand, conduct of rapid assessments and national quantification exercises, and increased awareness of oxygen as an essential medicine.

Following the expiration of the five-year validity period of the first strategy roadmap, the Federal Government and its partners revised the strategy in 2022, incorporating lessons learned to respond to COVID-19 context – launching the new National Strategy for the Scale-up of Medical Oxygen in Health Facilities (2023 – 2027). The new strategy builds on the implementation gap in the previous document, with a costed implementation plan that includes dissemination and a performance tracking framework.

The National Clinical Guidelines on Oxygen Use was developed just prior to the revision of the National strategy in 2022. These guidelines provide specific recommendations to various healthcare professionals, encompassing the clinicians, biomedical engineers, administrators, and health officers. They aim to guide these professionals in the appropriate treatment and care of patients requiring oxygen, and on the appropriate screening of hypoxaemia in patients visiting all tiers of the healthcare system and handling of oxygen equipment (including diagnostic equipment and oxygen delivery devices). This document proves particularly valuable by offering guidance on management of hypoxaemia in all patient groups including neonates, children and adults. Furthermore, they assist individual health facilities in selecting the appropriate oxygen delivery systems.(77)

Multi-stakeholder coordination

With the launch of the second National Oxygen Strategy in 2022, roles of stakeholders in implementation, particularly at the subnational level, were clearly defined. The established subnational oxygen coordinating platforms and oxygen desks now play pivotal role, guided by

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clear terms of reference that align with the overarching National Strategy for the Scale-up of medical oxygen. Their establishment aimed to address the need for improved inventory coordination, enhanced visibility of oxygen delivery services, and more effective management of resources.

This U4O multi-stakeholder coordinating platform played a pivotal role in aligning the National Strategy's goals with the broader healthcare landscape, ensuring a unified approach towards achieving the strategy's objectives. At the subnational level, the coalition leveraged support from State Ministries of Health (SMOH), State Health Care Boards, and Hospital Management Boards for implementing the strategy. However, significant challenges emerged in the strategy's implementation, including low adoption and prioritization, inadequate financing mechanisms leading to oxygen scarcity, and high oxygen prices, particularly at subnational levels.

These challenges were apparent in health facilities struggling to meet oxygen demand and an inequitable delivery of medical oxygen to patients.(41) Weak equipment maintenance services, undefined oxygen production operating models and public private partnership structures, low health capacity, and lack of quality data were identified as persistent gaps. Table 4 describes key stakeholders and stakeholder groups related to medical oxygen in Nigeria.

The timeliness of COVID-19 for the first strategic plan

Nigeria's first national roadmap on medical oxygen preceded the COVID-19 pandemic, and at the Federal level, there were some positive gains, especially the creation of a budget line for medical oxygen. Pre-COVID, the Federal government was conducting regional trainings, rather than State level, due to limited funds. Awareness of the policy document at that time was poor due to a lack of funding and pre-defined dissemination plan. Nevertheless, the policy proved valuable during the pandemic for resource mapping and gap quantification.

The COVID-19 pandemic was a game changer in medical oxygen security in Nigeria. Firstly, there was re-orientation of stakeholders on the importance of medical oxygen—a shift from end-of-life therapy to an essential medication that should be always available. The pandemic created awareness about the existing medical oxygen roadmap, spawned interest in many partners on medical oxygen, and consequently increased investment in the medical oxygen system not limited to procurement and installation of oxygen plants and capacity building of healthcare workers including biomedical engineers and technicians. Post-COVID-19, there is a belief that access to oxygen has improved. The following are testimonies from some of the key stakeholders we interviewed:

"When the pandemic came, surprisingly Nigeria is one the very few African countries that had a strategy on ground, even though we had the strategy, the reality is that how much were you using the strategy, that's the question, but you

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Partner	Role and Area of Collaboration
Federal MOH	• The National Oxygen Desk sits in the FMOH. Provides overall Oxygen programme coordination in the country through the national and subnational coordinating mechanisms. • The National Oxygen Desk maintains a national database to map and coordinate oxygen investments and interventions. • Increasing domestic resource mobilization for oxygen systems through advocacy, budgets etc. • Convenes biannual National Oxygen Coordination Meeting with state oxygen desk officers and other U4O partners. • Second edition was held in August 2023.
United for Oxygen (U4O)	• National multi-stakeholder coordinating platform for oxygen in Nigeria, set up to align approaches and provide strategic guidance to government, donors and partners implementing medical oxygen-related interventions at national and sub-national levels. • Facilitated the review of the National Oxygen Strategy and will be driving implementation.
Bill and Melinda Gates Foundation	• Provided direct funding to CHAI support for the C-19 response in Lagos state, including installation of a PSA plant in the C-19 treatment facility and establish and rolling out oxygen triage centres as part of the C-19 response. • Support through direct funding to CHAI for respiratory care systems strengthening for the C-19 response across 8 states in Nigeria. • Providing direct funding supply to CHAI to strengthen oxygen systems nationally and in five states through the MOXY project.
Unitaid	• Unitaid has funded CHAI through two grants to improve oxygen systems for the C-19 response through direct capital and equipment investments and in system strengthening to build resilient oxygen systems: • *Grant One Emergency Procurements*: Emergency procurement of 11 200kVA generators to support new PSAs plants procured by the Government of Nigeria across 11 Tertiary Health Facilities in the country • *Grant Two Resilient Oxygen Systems*: Supported C-19 oxygen systems strengthening work across 6 states in Nigeria and the FCT, including building oxygen systems and support to revise the National Oxygen Strategy; training of Biomedical Engineers (BMEs) on repair and maintenance of PSA oxygen plants; training of HCWs on hypoxaemia management (45 Trainers and 1,296 HCWs); procurement of tool kits for trained BMEs and repair drives in ~130HFs across 5 states. • *Optimizing equipment and supply*: Roll out of facility assessments in 578 facilities and supporting national oxygen gap assessments
Global Fund	• The Global Fund, through the C19-RM, has supported investments in strengthening oxygen and respiratory care systems for the C19 response. • As PRs to the C19-RM grant, the National Aids Control Agency (NACA) and the NTBLCP have supported CHAI, WHO and other partners to expand supply through direct investments in equipment procurement, installation of PSA plants and liquid oxygen tanks as well as the necessary systems support to optimize these investments.

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	• Under this grant, CHAI is undertaking: Oxygen piping expansion in 44 tertiary facilities; Nationwide COVID-19 and hypoxemia case management trainings for ~1700 HCWs from secondary and tertiary facilities; Scale up of subnational Oxygen coordinating mechanisms across the country; BME trainings and repair drives across 36 states and the FCT
WHO	• WHO is a member of the U4O coalition and provided support for oxygen for the C19 response and for overall systems strengthening. • Collaborated with CHAI to update the national C-19 guidelines and training materials to include hypoxemia. • Supported a national Training of Trainers on COVID-19 and hypoxemia case management for case managers. • Worked collaboratively with CHAI and the FMOH to support dissemination of the revised national strategy at the sub-national level
UNICEF	• Active member of the U4O platform • Joined and supported the review of the National Oxygen strategy along with CHAI and other partners • Supporting the government to expand oxygen supply through the procurement and installation of 9 PSA plants in 9 HFs • Successfully included oxygen in IMCI training packages that have been used to roll out IMCI trainings for HCWs • Working closely with CHAI to define priority indicators for oxygen and in rolling appropriate HMIS systems for oxygen • Worked closely with CHAI to adapt the OSPT tool and roll out national supply assessments that were used to develop national gap quantifications
FHI360	• FHI-360 receives funding through USAID's EPIC program for direct oxygen infrastructure investments and for overall oxygen systems strengthening. • Providing overall TA support to the C19-RM grant across three thematic areas including for Oxygen • Through this grant, FHI is procuring and installing 6 liquid oxygen tanks and are providing overall support for the filling of 2 existing LOX tanks. This also includes oxygen piping expansion in these prioritized facilities • Jointly supported the revision of the National Oxygen Strategy with CHAI, and working with CHAI to establish a working group to review all investments and supply in order to develop appropriate business plans and support oxygen market shaping efforts
Oxygen for Life Initiative (OLI)	• Provides support for review of clinical guidelines and training resources • Support the FMOH with HCW capacity building efforts • Engaged by CHAI to directly support the revision of the National Oxygen Strategy

Table 4: Key medical oxygen stakeholders in Nigeria

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know, since the pandemic came, awareness, a lot of awareness has been created and a lot of people got to know about the strategy." Participant 7

"From 2016, 2017, 2018, if you look at the conversation around oxygen and the management of oxygen, it has significantly improved because check around and see, 2017 and 2018, most of our health care workers actually never knew how to manage oxygen, but you can see, if you're going to take a statistics now across the health facilities, you'll find out that on an average on yearly basis, over a hundred to a hundred and fifty health care workers have been trained either by UNICEF, WHO, or by CHAI across the country." Participant 6

"Having medical oxygen security post-COVID became an issue that the government, health facilities, policymakers started to pay attention to." Participant 3

This underscores the importance of proactive planning, effective dissemination, and strategic allocation of resources in healthcare. It also highlights how a crisis can serve as a catalyst for positive change, resulting in increased investments and improvements in healthcare systems. The focus on medical oxygen, a critical resource during the pandemic, serves as a case study for the broader principles of preparedness and response to public health emergencies.

Multiple actors, with competing agendas, can hinder effective financing

Sources of funding for medical oxygen in Nigeria include governments, private sector, donor agencies and philanthropists. Publicly owned medical oxygen equipment and technologies are procured by the Federal and State Ministries or donors.(20,76) However, divergent opinions exist on the major financier of medical oxygen. On one hand, the government is regarded as the major financier of medical oxygen systems, yet funding from the government was limited prior to the COVID-19 pandemic. This is attributed to insufficient advocacy for oxygen scale-up and low prioritization of medical oxygen at national and sub-national levels.(20) On the other hand, donor agencies are perceived as the major source of funds for oxygen, with government expenditure on medical oxygen only increasing after the COVID-19 pandemic.

Nevertheless, release of appropriated funds by the government for oxygen related activities was highlighted as a major problem—erratic and insufficient. Government funding for health is generally below the international benchmarks. Security challenges in the country were identified as a competing priority for government funding, sometimes resulting in conflicts between governments and partners. Evidence suggests that facilities across States occasionally partner with private sector players and financing systems to sustain supply of medical oxygen through various PPP arrangements.(20)

However, out-of-pocket expenditure was not mentioned as part of financing mechanism for medical oxygen, despite direct costs of oxygen

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to patients being common place, and a major barrier to effective oxygen delivery. One participant highlighted that funding opportunities from private individuals (philanthropists) have not been fully explored.

"*Affordability is a major issue. So, I work in a facility where most ailment care is out of pocket. If the parents of a child do not have the funds, then they cannot get oxygen even if it is available, so affordability is key for the provision of oxygen*." Participant 3

"*If there is a possibility of engaging NGOs or people who are well to do in the society that can donate for oxygen provision. Possibility of involving people that can donate freely, so if you have people in the society that can be donating money for the procurement of oxygen*." Participant 1

However, a crucial milestone was reached during the 64th National Council of Health in November 2023. The approval of a memo titled "Medical Oxygen Investment (Pressure Swing Adsorption Plant, Liquid Oxygen Tank and Other Medical Oxygen Accessories) Sustainability" signifies a step towards establishing a policy framework for sustaining investment in medical oxygen. The National Council of Health resolution mandates collaborative efforts between the Federal Ministry of Health, related agencies, parastatals, and the State Ministries of Health to:

"*Secure a dedicated account for medical oxygen investment which shall be managed by the Federal Government of Nigeria and to also develop and implement a Standard Operation Procedure (SOP) for the management of these equipment*".(79,80)

Oxygen desks as an accountability solution, but sustainability needs to be prioritised

The Department of Hospital Services of the Federal MOH coordinates medical oxygen and medical oxygen service interventions in Nigeria, offering strategic guidance to the government, partners, and stakeholders.(20) Various government ministries, departments and agencies are involved in regulation of medical oxygen in the country. Specifically, the Federal Ministry of Health, Standard Organization of Nigeria, and the National Agency for Food and Drug Administration and Control (NAFDAC). Participants highlighted that the roles of these bodies are not clearly defined, and there is lack of synergy among them. These bodies are also hindered by inadequate funding and insufficient personnel.

Within the Federal MOH, there is an 'oxygen desk' tasked with the responsibility to coordinate, supervise and implement oxygen related activities. The desk superintends procurement and installation processes for oxygen plants and ensures that they conform with international standards. The concept of the oxygen desk has been expanded to the State level, where they are responsible for assessing oxygen gaps, demand and supply, as well as advocating for medical oxygen in their respective States. At the time of the national strategy review, oxygen desks were established in 34 of 36 States, with coordinating fora in 16 through support from partners.(20) However, by the end of 2023, oxygen desks and multi-sectoral oxygen coordinating forums have been successfully established in all states in the country, operating under the oversight of the U4O coordinating platform.

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Prior to 2021, when the coordination platforms or desks responsible for the management of medical oxygen systems at the State Ministries of Health were non-existent, there was a notable gap in accountability. These included poorly coordinated inventory, lack of visibility of oxygen delivery services and management of resources.(20) At subnational level, oxygen desks aim to bridge this accountability gap by improving inventory coordination and effective resource management.

As a result, state oxygen desks play a crucial role in the adoption, adaptation, and domestication of policy documents and strategies at the subnational level. This is particularly vital due to the heterogeneity in contexts across Nigeria. However, one participant we interviewed expressed the desire for State oxygen desks to be government funded, rather than externally supported and donor driven. To further empower State oxygen desks and coordinating platforms, essential tools, resources, and capacity-building initiatives are being provided, to ensure they offer strategic support for oxygen programming at state level.

Healthcare workers were also identified as key players of accountability mechanisms for medical oxygen. It is the responsibility of the healthcare workers to ensure that the patients receive medical oxygen in appropriate dose, delivery method and required duration:

"*So, oxygen security in Nigeria is a responsibility of every health worker as well as all the partners involved in oxygen support and intervention... Then we also have the biomedical engineers, and then we also have the end users, those are the health workers*." Participant 2

"*Well, I guess both the physician and the nurses, we try to make sure the child gets it. We try to overcome every obstacle and make sure the child gets it and then we monitor. So, I think it's everybody's responsibility in terms of both doctors and nurses*." Participant 3

Beyond oxygen availability, other challenges continue to inhibit equitable access

While there is a growing recognition of the importance of medical oxygen and its improved availability, other barriers to oxygen provision at the facility level persist, relating to financing,(58,65,81) infrastructure (e.g., power supply and poor oxygen/oximetry equipment),(54,58,60,61,82) knowledge gaps, (54,61,72,83) and the need for and implementation of comprehensive guidelines and policies – Table 5.(52,64)

The cost of medical oxygen is consistently identified as a significant barrier, both in routine healthcare and in the context of managing conditions like COVID-19.58,65,81 The financial burden extends to both healthcare facilities and patients. Beyond oxygen availability on the ward, oxygen needs to be affordable to patient. One participant stressed the need for free healthcare services for children and called for policy to ensure unhindered provision of medical oxygen for patients in need during emergencies irrespective of caregiver's ability to pay:

"*For the care of children, especially in emergencies, policy should be stated that allows the free provision of oxygen, medical oxygen, for the care of children*." Participant 3

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Reference	Population	Setting	Main findings
Orimadegun *et al.* (2011)	Paediatricians	Various children healthcare centres in Nigeria	The nationwide survey assessed paediatricians' knowledge of pulse oximetry, revealing gaps in training and knowledge among healthcare providers. It also highlighted equipment availability challenges in healthcare centres. Most respondents reported that they had no pulse oximeters in their neonatal care units (79%) and emergency units (70%).[54]
Desalu *et al.* (2011)	Asthma patients	Tertiary hospitals	The cross-sectional study assessed facilities' readiness for asthma care, pointing out challenges in adherence to internationally endorsed standards. It indicated gaps in the availability of essential equipment (38.2% had pulse oximeter) and clinical guidelines.[52]
Graham *et al.* (2016)	Children and neonates	Non-tertiary hospitals in south-west Nigeria	The needs assessment of non-tertiary hospitals highlighted structural, technical, and clinical barriers to safe and effective oxygen therapy, emphasizing issues with power supply, equipment, and the high cost of oxygen.[58]
Aneji *et al.* (2020)	HCWs and hospital administrators	Hospitals involved in the bCPAP program	A qualitative study assessing the implementation of a bCPAP program revealed challenges in oxygen infrastructure. However, the hands-on training had a positive impact on staff development, indicating the importance of training in improving healthcare practices.[61]
Walker *et al.* (2020)	Neonates	Three hospitals in southwest Nigeria	The prospective validation study evaluated the effectiveness of intermittent pulse oximetry in guiding oxygen therapy in neonates, emphasizing the need for more frequent monitoring to improve oxygen targeting and potentially prevent harm from ROP and BPD , particularly in low-resource settings.[64]

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Shittu *et al.* (2020)	HCWs	Health facilities in Lagos and Jigawa states, Nigeria	The mixed-methods study conducted facility audits, surveys and focus group discussion, indicating the availability of oxygen and pulse oximeters in secondary care facilities. However, challenges in primary facilities were identified, emphasizing disparities in infrastructure.[82]
King *et al.* (2020)	Stakeholders involved in paediatric pneumonia	National, Jigawa and Lagos states	The concurrent mixed-methods study explored stakeholder perspectives on paediatric pneumonia, emphasizing insufficient equipment, particularly oxygen and pulse oximeters. The study also noted challenges related to the power supply, a critical aspect during the COVID-19 pandemic.[60]
Banke-Thomas *et al.* (2021)	Pregnant women with COVID-19	Tertiary hospital in Lagos, Southwestern Nigeria	The hospital-based cost analysis during the COVID-19 pandemic highlighted medical oxygen as a major cost driver, emphasizing the financial implications of managing severe COVID-19 cases.[65]
Desalu *et al.* (2022)	HCWs	Public tertiary hospital in the Middle Belt region in Nigeria	The cross-sectional study among healthcare providers revealed knowledge gaps in acute oxygen therapy. It also highlighted barriers in oxygen delivery, such as a shortage of supply, inadequate delivery devices, power outages, and out-of-pocket costs.[83]
Adeoti *et al.* (2022)	Patients and caregivers	Tertiary hospital in Ado Ekiti, southwestern Nigeria	The study in Ekiti State University Teaching Hospital emphasized the perception of patients and caregivers, highlighting beliefs in the benefits of oxygen therapy and concerns about its cost. This speaks to financing challenges and the need for addressing patient perspectives.[81]

Table 5: Challenges and barriers to the availability and effective use of oxygen and oximetry. HCW = healthcare worker

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During the COVID-19 pandemic there were concerns regarding the huge cost of medical oxygen including the financial implications of managing severe COVID-19 cases.(65,81) Post pandemic, medical oxygen remains expensive to patients. There are currently no clear strategies to make oxygen free or affordable, though efforts to include it in the national insurance scheme are ongoing. Besides oxygen cost, inadequate infrastructure and equipment pose significant challenges. These include issues with power supply, lack of clinical guidelines, and limited access to essential equipment like pulse oximeters and oxygen concentrators, and other consumables and ancillary oxygen equipment, particularly in non-tertiary hospitals.(54,58,60,61,82)

Non-availability of the appropriate medical oxygen equipment at the point of care is a source of stress for healthcare workers. There are also challenges in implementing comprehensive oxygen therapy programmes, including the lack of piped oxygen, limited on-site oxygen generation capabilities, and challenges in the supply chain for oxygen cylinders and concentrators.(61) There was a recurring theme of knowledge gaps among healthcare providers regarding acute oxygen therapy in the literature. This includes misconceptions about oxygen as a drug, prescribing practices, and appropriate device usage.(54,61,72,83)

Key informant interviews

Participants were purposively sampled to ensure at least one representative is included from the following groups: government, non-governmental organizations and professional body. A process of stakeholder mapping using the Lancet Oxygen Commission's networks, from academic and grey literature, and snowballing informed the participant selection. We ensured a diversity in roles, interest and power amongst the participants.

Individuals were contacted initially by email from Professor A. G. Falade, or anyone assigned by him. Participants were emailed up to three times to try and make initial contact and then followed with a phone call or approached in person at a meeting (e.g., Academic conference). In situations where none of these approaches were successful, the participant was considered as a "non-respondent" and an alternative participant was approached.

	Organisation	Role	Gender
1	University of Medical Sciences, Teaching Hospital, Akure, Ondo State.	Biomedical Technologist	Female
2	Federal Ministry of Health, Department of Hospital Services	Principal Medical Officer	Male
3	University College Hospital, Ibadan	Paediatric Cardiologist, Senior Lecturer/ Consultant	Female
4	UNICEF	Health Specialist	Female
5	CHAI	Public Health Analyst	Female
6	Kaduna State Ministry of Health	Biomedical Engineer	Male
7	Jos University Teaching Hospital	Public Health Physician	Male
8	FHI360	Background in Medicine and Public Health	Male

Table 6: Key informant participants

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Position and Organization	Relevance
Chief Procurement Officer, Ministry of Health	Highlight MOH role in medical device procurement
Procurement Officer, Central Medical Stores Trust	Role of CMST in medical device and oxygen procurement; relationship with PAM
Director, JM Diagnostics	Private sector distributor perspective on medical device supply and relationships with public sector stakeholders
Chief Operations Officer, Medical Consultants Africa Ltd	Private sector distributor perspective on medical device supply and relationships with public sector stakeholders
Deputy Director, Physical Assets Management Division, MOH	Detail PAM role in oxygen and medical device financing, procurement, and maintenance
Acting Head, Department of Emergency and Clinical Services, MOH	Illustrate the MOH Pharmacy division's role in oxygen management, and relationship with other MOH entities
Medical Council of Malawi	General overview of medical device stakeholders; role of civil society organizations
Pediatric and Child Health Association	General overview of medical device stakeholders; role of civil society organizations
Chief Economist, Planning Department, MOH	Detail the strategic role of MOH Planning Department; interaction with Ministry of Finance
Principal Economist, Planning Department, MOH	Detail tactical role of MOH Planning Department; interactions with PAM and other operational stakeholders
Principal Economist, Planning Department, MOH	Detail tactical role of MOH Planning Department; interactions with PAM and other operational stakeholders
Regional Management Unit engineer, PAM, MOH	General overview of medical device and oxygen management at subnational level; role of stakeholders in financing and directing device maintenance
Regional Management Unit engineer, PAM, MOH	General overview of medical device and oxygen management at subnational level; role of stakeholders in financing and directing device maintenance
Director of Programs, CHAM	CHAMS offers 40% of health services in Malawi and trains 80% of health workforce.
Marketing Manager, AFROX	Largest/Majority private supplier of medical oxygen in Malawi.

Table 6: Key informant interview participants

THE LANCET Global Health

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Additional methods information

Desk-based review

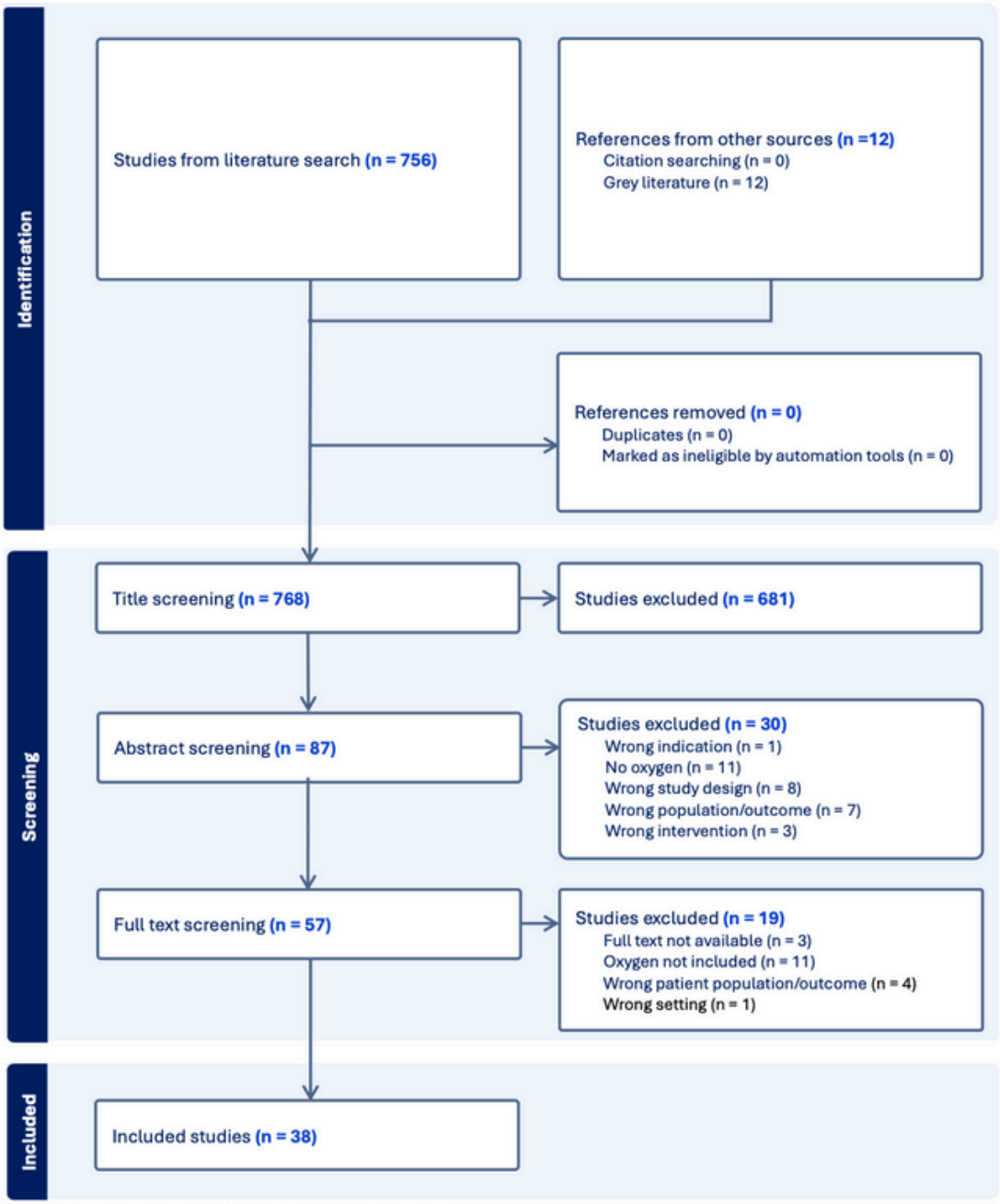

Figure 3: Academic and grey literature inclusion

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References

1 United Nations Population Fund. World Population Dashboard -Nigeria. Published 2022. Accessed July 29, 2023. https://www.unfpa.org/data/world-population/NG
2 UNICEF. UNICEF Data: Monitoring the situation of children and women - Nigeria. UNICEF Data. Published 2023. Accessed July 29, 2023. https://data.unicef.org/country/nga/
3 National Bureau of Statistics (NBS). Nigeria 2021 Multiple Indicator Cluster Survey (MICS) & National Immunization Coverage Survey (NICS): Survey Findings Report. 2022;(August).
4 International Monetary Fund. IMF Data Mapper. Published 2023. Accessed July 29, 2023. https://www.imf.org/external/datamapper/profile/NGA
5 The World Bank. Current health expenditure per capita (current US$) - Nigeria. Published 2023. Accessed July 29, 2023. https://data.worldbank.org/indicator/SH.XPD.CHEX.PC.CD?locations=NG
6 The World Bank. World Bank Country and Lending Groups – World Bank Data Help Desk. Published 2023. Accessed September 11, 2023. https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups
7 World Bank Group. Poverty & Equity Brief: Africa Western & Central - Nigeria. 2023;(April).
8 World Health Organization. Global Health Estimates 2020: Deaths by Cause, Age, Sex, by Country and by Region, 2000-2019. Published 2020. Accessed September 11, 2023. https://www.who.int/data/gho/data/themes/mortality-and-global-health-estimates/ghe- leading-causes-of-death
9 Odejimi A, Quinley J, Eluwa GI, et al. Causes of deaths in neonates and children aged 1 – 59 months in Nigeria : verbal autopsy findings of 2019 Verbal and Social Autopsy study. BMC Public Health. Published online 2022:1-15. doi:10.1186/s12889-022-13507-z
10 United Nations. SDG Indicators — Global indicator framework for the Sustainable Development Goals and targets of the 2030 Agenda for Sustainable Development. Published 2023. Accessed July 29, 2023. https://unstats.un.org/sdgs/indicators/indicators-list/
11 Clinton Health Access Initiative. Oxygen Therapy. Published 2023. Accessed September 11, 2023. https://www.clintonhealthaccess.org/our-programs/oxygen/
12 Federal Ministry of Health. National Policy on Medical Oxygen in Health Facilities. Published online 2017. http://www.health.gov.ng/doc/NATIONAL POLICY ON MEDICALOXYGEN.pdf
13 Graham H, Bakare AA, Ayede AI, et al. Hypoxaemia in hospitalised children and neonates: A prospective cohort study in Nigerian secondary-level hospitals. EClinicalMedicine. 2019;16:51-63. doi:10.1016/j.eclinm.2019.10.009
14 Ozoh OB, Aderibigbe SA, Ayuk AC, et al. The prevalence of asthma and allergic rhinitis in Nigeria: A nationwide survey among children, adolescents and adults. Published online 2019. doi:10.1371/journal.pone.0222281
15 Desalu OO, Adeoti AO, Ogunmola OJ, Fadare JO, Kolawole TF. Quality of acute asthma care in two tertiary hospitals in a state in South Western Nigeria: A report of clinical audit. Niger Med J. 2016;57(6):339-346. http://ovidsp.ovid.com/ovidweb.cgi?T=JS&PAGE=reference&D=pmnm3&NEWS=N&AN=27942102
16 Nwokediuko SC, Obienu O. Sedation practices for routine diagnostic upper gastrointestinal endoscopy in Nigeria. World J Gastrointest Endosc. 2012;4(6):260-265. doi:10.4253/wjge.v4.i6.260
17 Ale BM, Ozoh OB, Gadanya MA, et al. Estimating the prevalence of COPD in an African country: evidence from southern Nigeria. J Glob Heal reports. 2022;6. doi:10.29392/001C.38200
18 World Health Organization. Primary health care systems (PRIMASYS): case study from Nigeria. Geneva. Published online 2017:1-16. https://apps.who.int/iris/rest/bitstreams/1346150/retrieve
19 Primary Health care in Nigeria. Nphcda. Published online 2010:1-71.
20 Federal Ministry of Health. National Strategy for the Scale-up of Medical Oxygen in Health Facilities 2023-2027.; 2023.

COMMISSION ON MEDICAL OXYGEN SECURITY

References cont.

21 Federal Ministry of Health. Nigeria Health Facility Registry. Published 2023. Accessed July 30, 2023. https://hfr.health.gov.ng/statistics/tables
22 Ahmat A, Okoroafor SC, Kazanga I, et al. The health workforce status in the WHO African Region: findings of a cross-sectional study. BMJ Glob Heal. 2022;7:1-8. doi:10.1136/bmjgh-2021-008317
23 World Health Organization. Global strategy on human resources for health: Workforce 2030. Who. Published online 2016:64. Accessed January 6, 2024. https://www.who.int/hrh/resources/global_strategy_workforce2030_14_print.pdf?ua=1
24 Federal Ministry of Health. National Health Accounts 2017. 2019;(April). https://www.health.gov.ng/doc/FINAL-VERSION-NHA-2017.pdf
25 Uzochukwu BSC, Ughasoro MD, Etiaba E, Okwuosa C, Envuladu E, Onwujekwe OE. Health care financing in Nigeria: Implications for achieving universal health coverage. Niger J Clin Pract. 2015;18(4):437-444. doi:10.4103/1119-3077.154196
26 Aregbeshola BS, Khan SM. Predictors of Enrolment in the National Health Insurance Scheme Among Women of Reproductive Age in Nigeria. Int J Heal policy Manag. 2018;7(11):1015-1023. doi:10.15171/IJHPM.2018.68
27 Sasu DD. Health insurance coverage in Nigeria 2018, by type and gender. Statista. Published February 1, 2022. Accessed January 6, 2024. https://www.statista.com/statistics/1124773/health-insurance-coverage-in-nigeria-by-type-and-gender/
28 Adebowale-Tambe N. Tinubu to increase health allocation to 10% of total budget - Aide. Premium Times Nigeria. Published July 25, 2023. Accessed September 29, 2023. https://www.premiumtimesng.com/news/top-news/611918-tinubu-to-increase-health-allocation-to-10-of-total-budget-aide.html
29 Odunyemi AE. The Implications of Health Financing for Health Access and Equity in Nigeria. Healthc Access. Published online August 26, 2021. doi:10.5772/INTECHOPEN.98565
30 One. Post-Pandemic Health Financing by State Governments in Nigeria, 2020 to 2022. Published online 2022.
31 Ajala-Damisa D, Agbaoye K. From A Scheme to an Authority - 5 Things You Need to Know About the New NHIA Act. Nigeria Health Watch. Published May 25, 2022. Accessed September 17, 2023. https://articles.nigeriahealthwatch.com/from-a-scheme-to-an-authority-5-things-you-need-to-know-about-the-new-nhia-act/
32 World Health Organization. WHO supports Nigeria in operationalizing the National Health Insurance Authority Act 2022. Published August 1, 2022. Accessed September 17, 2023. https://www.afro.who.int/countries/nigeria/news/who-supports-nigeria-operationalizing-national-health-insurance-authority-act-2022
33 Onyekpere E. Review of the 2024 federal health budget proposal (1). Punch Newspaper. Published December 18, 2023. Accessed January 14, 2024. https://punchng.com/review-of-the-2024-federal-health-budget-proposal-1/?utm_source=auto-read-also&utm_medium=web
34 Angbulu S. Why FG chose N800/dollar exchange rate for 2024 budget. Punch Newspaper. Published January 12, 2024. Accessed January 14, 2024. https://punchng.com/why-fg-chose-n800-dollar-exchange-rate-for-2024-budget-minister/
35 World Health Organization. Nigeria: WHO Coronavirus Disease (COVID-19) Dashboard With Vaccination Data. Published 2023. Accessed August 1, 2023. https://covid19.who.int/region/afro/country/ng
36 Federal Ministry of Health. Health Minister: First Case Of COVID-19 Confirmed In Nigeria. Published February 28, 2020. Accessed August 1, 2023.https://www.health.gov.ng/index.php?option=com_k2&view=item&id=613:health-minister-first-case-of-covid-19-confirmed-in-nigeria

COMMISSION ON MEDICAL OXYGEN SECURITY

References cont.

37 Olawale G. COVID-19 : Experts worry over challenges as Nigeria rolls out vaccines. Published online 2021:1-6.
38 UNICEF Nigeria. UNICEF Nigeria on Twitter: History is made! Published March 11, 2021. Accessed August 1, 2023. https://twitter.com/UNICEF_Nigeria/status/1367809774100877319
39 CACOVID. Private sector coalition against COVID-19. Published 2020. Accessed January 8, 2024. https://www.cacovid.org/
40 Business Day. CACOVID: Nigeria's private-sector response to COVID-19 - Businessday NG. Published April 15, 2020. Accessed January 8, 2024. https://businessday.ng/coronavirus/article/cacovid-nigerias-private-sector-response-to-covid-19/
41 Graham HR, Olojede OE, Bakare AA, et al. Measuring oxygen access: Lessons from health facility assessments in Lagos, Nigeria. BMJ Glob Heal. 2021;6(8):1-10. doi:10.1136/bmjgh-2021-006069
42 Adepoju P. How COVID-19 laid bare Africa's medical oxygen crisis. Devex. Published March 22, 2022. Accessed September 16, 2023. https://www.devex.com/news/how-covid-19-laid-bare-africa-s-medical-oxygen-crisis-102845
43 George L, Akwagyiram A. "Oxygen, oxygen, oxygen": Nigeria battles shortages amid COVID-19 surge. Reuters. Published February 2, 2021. Accessed September 16, 2023. https://www.reuters.com/business/healthcare-pharmaceuticals/oxygen-oxygen-oxygen-nigeria-battles-shortages-amid-covid-19-surge-2021-02-02/
44 Njoku L, Daniel E, Edward O. Oxygen crisis hits Nigeria's COVID-19 response scheme — Nigeria. The Guardian Nigeria News. Published January 7, 2021. Accessed September 16, 2023. https://guardian.ng/news/oxygen-crisis-hits-nigerias-covid-19-response-scheme/
45 Aregbeshola BS, Folayan MO. Nigeria's financing of health care during the COVID-19 pandemic: Challenges and recommendations. World Med Heal Policy. 2022;14(1):195. doi:10.1002/WMH3.484
46 UNICEF Nigeria. UNICEF and IHS Nigeria partner to expand access to oxygen for pneumonia and COVID-19 patients. Published August 26, 2022. Accessed September 16, 2023. https://www.unicef.org/nigeria/press-releases/unicef-and-ihs-nigeria-partner-expand-access-oxygen-pneumonia-and-covid-19-patients
47 United Nations Development Programme. UN procures ventilators and other medical supplies to boost the Government of Nigeria's response to COVID-19. Published April 14, 2020. Accessed August 1, 2023. https://www.undp.org/nigeria/press-releases/un-procures-ventilators-and-other-medical-supplies-boost-government-nigeria's-response-covid-19
48 Federal Ministry of Health. FG Distributes Oxygen Concentrators & Ventilators To Various Health Institutions, Trains 176 Specialists. Published September 11, 2020. Accessed August 1, 2023. https://health.gov.ng/index.php?option=com_k2&view=item&id=765:fg-distributes-oxygen-concentrators-ventilators-to-various-health-institutions-trains-176-specialists
49 Nigeria Centre for Disease Control. NCDC COVID-19 Case Update. Published March 23, 2020. Accessed August 1, 2023. https://twitter.com/NCDCgov/status/1242025530070687750?lang=en
50 Federal Ministry of Health. COVID-19: US Donates 200 Life Saving Ventilators To Nigeria. Published August 11, 2020. Accessed August 1, 2023. https://health.gov.ng/index.php?option=com_k2&view=item&id=739:covid-19-us-donates-200-life-saving-ventilators-to-nigeria
51 Mokuolu OA, Ajayi OA. Use of an oxygen concentrator in a Nigerian neonatal unit: economic implications and reliability. Ann Trop Paediatr. 2002;22(3):209-212. http://ovidsp.ovid.com/ovidweb.cgi?T=JS&PAGE=reference&D=med4&NEWS=N&AN=12369483
52 Desalu OO, Onyedum CC, Iseh KR, Salawu FK, Salami AK. Asthma in Nigeria: are the facilities and resources available to support internationally endorsed standards of care? Health Policy. 2011;99(3):250-254. doi:10.1016/j.healthpol.2010.10.006

COMMISSION ON MEDICAL OXYGEN SECURITY

References cont.

53 Ogunbosi BO, Orimadegun AE, Carson S. Clinical features associated with oxygen use in children presenting to emergency care in Ibadan, Nigeria. Am J Respir Crit Care Med. 2011;183(1). https://www.embase.com/search/results?subaction=viewrecord&id=L70847738&from=export
54 Orimadegu AE, Ogunbosi BO, Akinbami FO. Knowledge and Views of Paediatricians about Pulse Oximetry: a Nationwide Online Survey in Nigeria. Afr j respir Med. 2011;7(1):14-18. http://www.africanjournalofrespiratorymedicine.com/articles/september_2011/AJRM Sept pp 14-18.pdf
55 Henry JA, Windapo O, Kushner AL, Groen RS, Nwomeh BC. A survey of surgical capacity in rural southern Nigeria: opportunities for change. World J Surg. 2012;36(12):2811-2818. doi:10.1007/s00268-012-1764-0
56 Abdulraheem MA, Orimadegun AE, Tongo O. Pre- and intra-transport neonatal care oxygen saturation hypoxemia among referred neonate in a tertiary hospital in Nigeria. Am J Respir Crit Care Med. 2015;191. https://www.embase.com/search/results?subaction=viewrecord&id=L72049701&from=export
57 Iroezindu MO, Isiguzo GC, Chima EI, et al. Predictors of in-hospital mortality and length of stay in community-acquired pneumonia: a 5-year multi-centre case control study of adults in a developing country. Trans R Soc Trop Med Hyg. 2016;110(8):445-455. doi:10.1093/trstmh/trw057
58 Graham HR, Ayede AI, Bakare AA, et al. Oxygen for children and newborns in non-tertiary hospitals in South-west Nigeria: A needs assessment. Afr J Med Med Sci. 2016;45(1):31-49.
59 CHAI. A government-led approach to increasing access to oxygen in Nigeria. Published November 2017. Accessed December 23, 2023. https://www.clintonhealthaccess.org/blog/government-led-approach-accessing-oxygen-nigeria/
60 King C, Iuliano A, Burgess RA, et al. A mixed-methods evaluation of stakeholder perspectives on pediatric pneumonia in Nigeria-priorities, challenges, and champions. Pediatr Pulmonol. 2020;55 Suppl 1:S25-S33. doi:10.1002/ppul.24607
61 Aneji C, Hartman T, Olutunde O, et al. Implementing bubble continuous positive airway pressure in a lower middle-income country: A nigerian experience. Pan Afr Med J. 2020;37:1-9. doi:10.11604/pamj.2020.37.10.24911
62 Bakare AA, Graham H, Ayede AI, et al. Providing oxygen to children and newborns: a multi-faceted technical and clinical assessment of oxygen access and oxygen use in secondary-level hospitals in southwest Nigeria. Int Health. 2020;12(1):60-68. doi:10.1093/inthealth/ihz009
63 Briggs DC, Eneh AU. Preparedness of primary health care workers and audit of primary health centres for newborn resuscitation in Port Harcourt, Rivers State, Southern Nigeria. Pan Afr Med J. 2020;36:68. doi:10.11604/pamj.2020.36.68.22164
64 Walker PJB, Bakare AA, Ayede AI, et al. Using intermittent pulse oximetry to guide neonatal oxygen therapy in a low-resource context. Arch Dis Child Fetal Neonatal Ed. 2020;105(3):316-321. doi:10.1136/archdischild-2019-317630
65 Banke-Thomas A, Makwe CC, Balogun M, Afolabi BB, Alex-Nwangwu TA, Ameh CA. Utilization cost of maternity services for childbirth among pregnant women with coronavirus disease 2019 in Nigeria's epicenter. Int J Gynaecol Obstet. 2021;152(2):242- 248. doi:10.1002/ijgo.13436
66 Graham HR, Olojede OE, Bakare AA, et al. Measuring oxygen access: lessons from health facility assessments in Lagos, Nigeria. BMJ Glob Heal. 2021;6(8):6069. doi:10.1136/BMJGH-2021-006069
67 Graham HR, Maher J, Bakare AA, et al. Oxygen systems and quality of care for children with pneumonia, malaria and diarrhoea: Analysis of a stepped-wedge trial in Nigeria. PLoS One. 2021;16(7 July). doi:10.1371/journal.pone.0254229
68 Ogunbiyi O, Sanusi A, Osinaike B, Yakubu S, Rotimi M, Fatungase O. An overview of intensive care unit services in Nigeria. J Crit Care. 2021;66:160-165. doi:10.1016/j.jcrc.2021.07.007

COMMISSION ON MEDICAL OXYGEN SECURITY

References cont.

69 Bolu O, Mustapha B, Ihekweazu C, et al. Effect of Nigeria Presidential Task Force on COVID-19 Pandemic, Nigeria. Emerg Infect Dis. 2022;28(13):S168-S176. doi:10.3201/eid2813.220254
70 Graham HR, Bakare AA, Ayede AI, et al. Cost-effectiveness and sustainability of improved hospital oxygen systems in Nigeria. BMJ Glob Heal. 2022;7(8). doi:10.1136/bmjgh-2022-009278
71 Kalu QN, Edentekhe TA, Omoronyia OE, Nakanda BE, Archibong AA. State-wide situation analysis of availability of basic resuscitation devices and essential drugs in primary and secondary healthcare facilities in Cross River State, Nigeria. Pan Afr Med J. 2022;42:225. doi:10.11604/pamj.2022.42.225.35452
72 Okeke C, Uzochukwu B, Onyedinma C, Onwujekwe O. An assessment of Nigeria's health systems response to COVID-19. Ghana med j. 2022;56(3 suppl):74-84. doi:10.4314/gmj.v56i3s.9
73 CHAI. Biomedical engineers peer-led mentorship program increases workforce capacity and access to oxygen in Akwa Ibom State, Nigeria. Published March 28, 2023. Accessed December 23, 2023. https://www.clintonhealthaccess.org/blog/biomedical-engineers-increase-medical-oxygen-access-in-nigeria/
74 Kitutu FE, Rahman AE, Graham H, others. Announcing the Lancet Global Health Commission on medical oxygen security. Lancet Glob Heal. 2022;10:11.
75 Word Health Organization. WHO Resolution: Increasing access to medical oxygen. WHO. Published online May 2023.
76 Federal Republic of Nigeria. National Strategy for the Scale-up of Medical Oxygen in Health Facilities 2017 - 2022.; 2017.
77 Federal Ministry of Health. National Clinical Guidelines on Oxygen Use.; 2022.
78 Federal Ministry of Health. National Strategy For the Scale-up of Medical Oxygen in Health Facilities 2017 - 2022. Fed Minist mof Heal. Published online 2017.
79 Nigeria Medical World. FEDERAL MINISTRY OF HEALTH & SOCIAL WELFARE COMMUNIQUE ISSUED AT THE END OF THE 64TH NATIONAL COUNCIL OF HEALTH (NCH) MEETING HELD AT AB FOUNDATION CIVIL CENTRE, ADO-EKITI FROM 13TH - 17TH NOVEMBER, 2023. Published November 30, 2023. Accessed January 16, 2024. https://medicalworldnigeria.com/post/Federal-Ministry-of-Health-and-Social-Welfare-Communique-Issued-at-the-End-of-the-64th-National-Council-of-Health-NCH-Meeting-Held-at-AB-Foundation-Civil-Centre-Ado-Ekiti-from-13th-17th-November-2023?pid=67684
80 Nigeria Health Watch. Federal Ministry of Health in Collaboration with USAID funded EpiC Project Hosts a National Dialogue on Medical Oxygen Security. Published 2023. Accessed January 16, 2024. https://articles.nigeriahealthwatch.com/federal-ministry-of-health-in-collaboration-with-usaid-funded-epic-project-hosts-a-national-dialogue-on-medical-oxygen-security/
81 Adeoti A, Desalu O, Elebiyo T, Aremu O. Misconception on oxygen administration among patients and their caregivers in Ado Ekiti, Nigeria. Ann Afr Med. 2022;21(3):269-273. doi:10.4103/aam.aam_63_21
82 Shittu F, Agwai IC, Falade AG, et al. Health system challenges for improved childhood pneumonia case management in Lagos and Jigawa, Nigeria. Pediatr Pulmonol. 2020;55 Suppl 1:S78-S90. doi:10.1002/ppul.24660
83 Desalu OO, Ojuawo OB, Adeoti AO, et al. Doctors' and Nurses' Knowledge and Perceived Barriers Regarding Acute Oxygen Therapy in a Tertiary Care Hospital in Nigeria. Adv Med Educ Pract. 2022;13:1535-1545. doi:10.2147/AMEP.S378533

THE LANCET Global Health

COMMISSION ON MEDICAL OXYGEN SECURITY

ABOUT THE COMMISSION

Announced in September 2022, *The Lancet Global Health* Commission on Medical Oxygen Security provides a thorough exploration of medical oxygen coverage gaps, with recommendations to ensure that no patient dies for lack of access to this essential medicine, including during public health emergencies like COVID-19.

The Commission was led by 18 Commissioners - multi-disciplinary academics with clinical, economic, engineering, epidemiological, and public policy expertise - representing all regions of the world. Forty Advisors representing United Nations and global health agencies, donors, academic institutions, and non-governmental organizations provided guidance. A large global network of Oxygen Access Collaborators provided constant input to the Commission and included representatives from industry and Ministries of Health. Special consultations were conducted with patients, caregivers, and clinicians to ensure that their voices and experiences shaped the Commission's recommendations.

An Executive Committee coordinated the work of the Commission and included representatives from **Makerere University**, Uganda; **International Centre for Diarrheal Disease Research** (icddr,b), Bangladesh; **Murdoch Children's Research Institute** (MCRI), Australia; **Karolinska Institutet**, Sweden; and **Every Breath Counts Coalition**, USA.

You can find the Commission report here and the advocacy package here, including:

- ***Report with Comments***
- ***Policy Brief (English, French, Spanish, Arabic, Chinese, and Russian)***
- ***Spotlight Brief: Access to Medical Oxygen Scorecard ($ATMO_2S$)***
- ***Spotlight Brief: Patient and Caregiver Testimonials***
- ***Spotlight Brief: 10 Oxygen Coverage Indicators***
- ***Spotlight Brief: 20 Priority Areas for Oxygen Innovation***
- ***Country Case Studies***

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