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Medical gases and long-term oxygen therapy: reducing the chronic obstructive pulmonary disease burden in aging populations in Sub-Saharan Africa

Matthew Chibunna Igwe[1,*,#], Esther Ugo Alum[2,#], Alphonsus Ogbonna Ogbuabor[3,#]

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From the Contents

Abstract

Chronic obstructive pulmonary disease (COPD) is a major global health challenge, disproportionately affecting aging populations in low- and middle-income countries, including Sub-Saharan Africa (SSA). With an increasing prevalence driven by indoor air pollution, tobacco use, and occupational hazards, COPD remains underdiagnosed underdiagnosed and undertreated in the region due to inadequate healthcare infrastructure and resource constraints. This review highlights the critical role of medical gases, particularly long-term oxygen therapy (LTOT), in managing COPD, improving quality of life, and reducing mortality in patients with severe hypoxemia. Although LTOT is well-established in high-income countries, its implementation in SSA faces significant barriers, including limited access, cost, and insufficient awareness. This review analyzes COPD management, LTOT benefits, healthcare policies, and aging demographics in SSA, focusing on experimental studies and synthesizing data for coherence. Relevant articles in English published from 2014 to 2025 were retrieved from PubMed, Scopus, and WHO. Through a comprehensive analysis of the epidemiology of COPD in SSA, the challenges of integrating LTOT, and successful case studies from comparable regions, this review identifies key opportunities for addressing these gaps. Recommendations include strengthening healthcare infrastructure, fostering policy frameworks for LTOT integration, leveraging community engagement, and enhancing patient education. By addressing these challenges holistically and fostering regional and global collaborations, SSA can mitigate the growing burden of COPD and improve health outcomes for its aging populations.

Key Words: hypoxemia; indoor air pollution; infrastructure challenges; low-income region; medical gases; oxygen therapy; reduced mortality; respiratory health; risk factors; SSA

Introduction

Chronic obstructive pulmonary disease (COPD) is a progressive respiratory disorder marked by airflow restriction and lung tissue degradation.[1] It includes chronic bronchitis and emphysema, arising from extended exposure to harmful particles, chiefly tobacco smoke. Symptoms of COPD encompass dyspnea, cough, and sputum production, which may vary from mild to severe respiratory failure.[2] Symptoms deteriorate progressively, particularly in the absence of intervention. Risk factors encompass smoking, air pollution, occupational exposures, and genetic predispositions, such as alpha-1 antitrypsin deficiency.[3] The diagnosis of COPD involves lung function testing, such as spirometry, to confirm airflow blockage. Imaging and hematological analyses facilitate the evaluation of the severity and exclude alternative diagnoses.[4] The treatment emphasizes alleviating symptoms, decelerating illness progress, and enhancing the quality of life. Options comprise bronchodilators, corticosteroids, pulmonary rehabilitation, oxygen therapy, and lifestyle modifications such as smoking cessation.[5]

COPD represents a major global health issue, with an anticipated prevalence of over 600 million patients globally by 2050.[6] Low- and middle-income countries (LMICs) disproportionately bear nearly 80% of COPD cases.[7] The estimated prevalence of COPD in LMICs is 7.2%, adversely affecting physical function, quality of life, and socioeconomic well-being.[8] Factors such as heightened exposure to risk factors, including hunger, air pollution, and smoking, contribute to the elevated prevalence of COPD in LMICs.[9] The inadequate understanding of COPD among the population, healthcare professionals, and policymakers in LMICs intensifies the issue, resulting in poor treatment compliance and heightened suffering.[7] Mitigating this escalating burden requires strengthening prevention tactics, diagnostic capabilities, and acess to treatment in primary care environments, alongside increasing awareness and educating healthcare professionals and communities.[9] The incidence of COPD in Sub-Saharan Africa (SSA), a low- and middle-income region, has escalated markedly, with prevalent cases across all age groups totaling 10.3 million in 2019, representing a 117% increase since 1990.[10] Primary variables contributing to this increase encompass tobacco smoking, exposure to biomass fuels, and home air pollution.[11] A greater percentage of households in rural areas rely on biomass fuel for cooking and heating, which considerably affects the respiratory health of women and children.[12] Additional risk factors encompass low birth weight, malnutrition, severe respiratory infections in childhood, occupational exposures, outdoor pollution, human immunodeficiency virus, and tuberculosis.[13] Notwithstanding its increasing prevalence, COPD continues to be insufficiently recognized, diagnosed, and treated in the region.[14] The inadequate healthcare infrastructure and absence of inexpensive inhaled medications exacerbate COPD therapy in SSA.[13] The aging demographic in SSA exacerbates the rising frequency of COPD, as the condition correlates with older age.[11] To tackle this escalating health issue, especially in aging

[1]Department of Public Health, School of Allied Health Sciences, Kampala International University, Western Campus, Kansanga, Uganda; [2]Department of Research and Publications, Kampala International University, Kampala, Uganda; [3]Department of Medical Laboratory Science, Faculty of Allied Health Sciences, Enugu State University of Science and Technology, Enugu, Enugu State, Nigeria

***Correspondence to:** Esther Ugo Alum, PhD, esther.alum@kiu.ac.ug or alumesther79@gmail.com.

https://orcid.org/0000-0003-3086-6369 (Matthew Chibunna Igwe); https://orcid.org/0000-0003-4105-8615 (Esther Ugo Alum); https://orcid.org/0000-0001-6064-2608 (Ogbonna Alphonsus Ogbuabor)

#These authors contributed equally to this work.

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population, it is essential to enhance awareness, refine diagnostic methods, and implement focused preventative initiatives in the region.

Medical gases play a critical role in managing COPD, particularly in alleviating symptoms and improving oxygenation. Key gases used include oxygen which is delivered through devices like nasal cannulas or masks to manage hypoxemia, helium-oxygen mixture used in acute exacerbations to reduce airway resistance and improve airflow in severe obstruction, and carbon dioxide which is occasionally administered in specialized settings to stimulate respiratory drive in patients with COPD-induced hypoventilation.[15] Long-term oxygen therapy (LTOT) is an essential intervention for patients with COPD experiencing severe hypoxemia, demonstrated to enhance survival rates.[16] The guideline for 15–24 hours of daily LTOT usage is founded on pivotal studies from the 1980s, which indicated decreased mortality in comparison to the absence of LTOT.[17] LTOT enhances survival, alleviates breathlessness, improves sleep, and reduces pulmonary hypertension by maintaining oxygen saturation levels.[18] LTOT remains the cornerstone of medical gas therapy in COPD, significantly improving the quality of life and prognosis for patients with chronic hypoxemia. Regular monitoring ensures optimal benefits and minimizes risks, such as hypercapnia in carbon dioxide-retaining individuals. COPD is a growing public health concern, particularly in aging populations across SSA, where limited resources and healthcare disparities exacerbate its burden. While medical gases, LTOT, are well-established in COPD management in high-income countries, their implementation and impact in resource-limited settings remain underexplored. **Figure 1** illustrates an overview of COPD, LTOT benefits, and barriers to LTOT implementation in SSA.

This review highlights the clinical importance of medical gases in reducing COPD morbidity and mortality. It examines the challenges and opportunities of implementing LTOT in SSA, considering factors like infrastructure gaps, cost, and accessibility. Through an extensive literature search, this study provides evidence-based recommendations to inform policy, healthcare strategies, and research priorities tailored to the unique needs of the SSA. It explores strategies for integrating LTOT into public health policies in SSA. By addressing the challenges mitigating the utilization of LTOT in SSA, the review seeks to advance COPD management, reduce disease burden, and improve the quality of life for aging populations in SSA.

Methodology

In this comprehensive review, we retrieved and assessed articles pertaining to COPD management, LTOT benefits, healthcare policies in SSA, and aging demographics. The databases used were PubMed, Scopus, and WHO reports, utilizing search terms such as "COPD," "oxygen therapy," "Sub-Saharan Africa," and "aging populations." We selected articles published in English in 2014–2025, and we performed a preliminary screening with an emphasis on experimental studies. Data were synthesized and discussed in smaller sections to enhance flow and coherence.

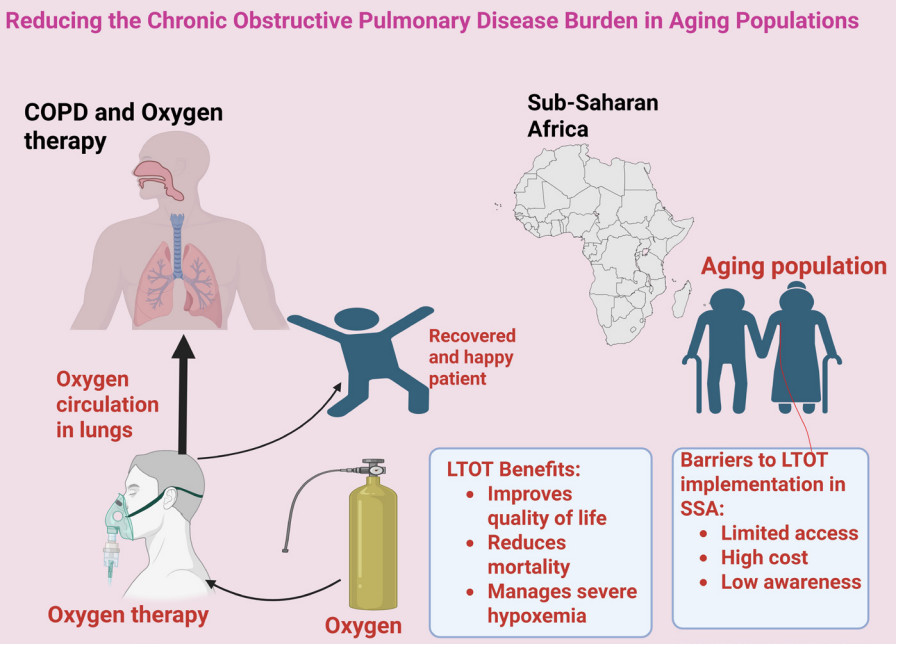

Figure 1 | **An overview of COPD, LTOT benefits, and barriers to LTOT implementation in SSA.**
Created with BioRender.com. COPD: Chronic obstructive pulmonary disease; LTOT: long-term oxygen therapy; SSA: Sub-Saharan Africa.

Thematic Review of Evidence

Epidemiology of chronic obstructive pulmonary disease in Sub-Saharan Africa

COPD is a significant public health concern globally, with varying prevalence rates across regions. In SSA, the prevalence of COPD is estimated to range between 1.7% and 24.8%, with a combined frequency of 8%, 11 depending on the population studied and diagnostic criteria used. This is slightly lower than or comparable to the global average prevalence of approximately 11.7% reported by the Global Burden of Disease study.[19] In developed regions, COPD is primarily driven by long-term tobacco use and aging populations, whereas in SSA, biomass smoke from cooking, occupational exposures, and recurrent respiratory infections are key contributors.[11] Despite similar prevalence rates, the burden of COPD in SSA is heightened by underdiagnosis, limited healthcare access, and inadequate management resources, unlike the advanced diagnostic and treatment options available in developed regions.[9] This contrast highlights disparities in healthcare infrastructure and resource allocation between these regions, emphasizing the need for region-specific public health interventions. Despite the significant COPD-related mortality in SSA, there exists a dearth of research in numerous countries, underscoring the necessity for more extensive investigations to inform public health strategies.[20]

Aging populations and chronic obstructive pulmonary disease

Aging populations are closely linked to the rising prevalence of COPD globally.[21] Liu et al.[21] reported an increased incidence of COPD in individuals over 75 years. Aging-related changes, including increasing multimorbidity and airflow limitation, complicate COPD diagnosis and management in elderly individuals.[22] The pathophysiology of COPD is connected to the nine hallmarks of aging, suggesting common molecular processes.[23] Additionally, cumulative exposure to risk factors like smoking, air pollution, and occupational hazards over a lifetime contributes to disease onset and progression.[11] The global trend of population aging is expected to exacerbate the burden of COPD. This demographic shift poses challenges for healthcare systems, requiring tailored strategies for early diagnosis, effective management, and addressing comorbidities that commonly accompany COPD in elderly individuals, such as cardiovascular diseases and osteoporosis.[24] Management options for elderly COPD patients should be adjusted to address age-specific issues, including mental health, end-of-life care, and caregiver assistance.[25] Novel techniques, such as nonrespiratory therapies and strength training, show promise in COPD therapy for older persons.[26] Managing COPD in aging populations necessitates an integrated approach to improve quality of life and reduce healthcare costs. Future research should focus on creating biomarkers for early diagnosis and investigating new therapeutic approaches to maximize care for this vulnerable population.[25]

Role of long-term oxygen therapy

LTOT has demonstrated considerable advantages for individuals with COPD. A recent meta-analysis indicated that LTOT diminishes the incidence of moderate to severe exacerbations by 28%, reduces hospitalizations, and decreases all-cause mortality in patients with COPD.[27] A prospective clinical investigation corroborated these findings, showing enhancements in health-related quality of life and diminished exacerbations in COPD patients utilizing LTOT for a minimum of 15 hours daily.[28] The therapeutic advantages of LTOT in COPD are numerous. LTOT not only gives a clear survival advantage, but it also improves exercise capacity, pulmonary hemodynamics, and secondary polycythemia. It possesses the capacity to enhance cognitive function and sleep quality.[29] Nonetheless, compliance with LTOT is unsatisfactory. Research

indicates that patients frequently do not adhere to the advised 15–18 hours of daily oxygen utilization.[30,31] Determinants of adherence encompass age, utilization of ambulatory oxygen, and effective patient education. Insufficient medical supervision and inadequate patient comprehension lead to suboptimal compliance.[31] Researchers underscore the necessity for interventions to increase adherence, including behavioural and psychological techniques, including enhanced patient education and counseling.[30,31] LTOT in patients with COPD experiencing severe hypoxemia has been demonstrated to enhance survival and quality of life.[17] LTOT has advantages including enhanced social engagement and better self-management in daily tasks, but it also poses obstacles such as stigma and dependency issues.[32] Social participation among LTOT users reduces dyspnea and depressive symptoms while enhancing exercise capacity, muscle strength, and quality of life.[33] Challenges in the adoption of LTOT include accurate prescription, patient adherence, and technological constraints.[34] Recent modifications in reimbursement regulations have exacerbated the complexities of LTOT provision.[17] To enhance LTOT advantages, healthcare practitioners must deliver improved support, monitoring, and information to patients and caregivers.[32] Healthcare practitioners indicate that LTOT is occasionally misprescribed and underutilized, advocating for proactive patient management to rectify these concerns.[32] Notwithstanding obstacles, LTOT continues to be an essential therapeutic choice for hypoxemic COPD patients, offering both psychosocial and economic advantages by reducing hospital and nursing home admissions.[29]

Current status of medical gases in Sub-Saharan Africa

Recent studies underscore the severe deficiency of medical oxygen in SSA, an essential resource for the treatment of respiratory disorders and other ailments.[35,36] Oxygen availability in healthcare facilities varies from 42% to 94%, although maintaining a regular supply poses a challenge.[35] The coronavirus disease 2019 (COVID-19) epidemic has underscored the necessity for enhanced oxygen infrastructure in SSA, with oxygen supply being prioritized alongside personal protective equipment.[36] In neonatal hospitals, insufficient oxygen control endangers neonates, with merely 50% of studied facilities possessing oxygen-air blending capabilities.[37] Several studies underscore considerable differences in the availability and utilization of maternity, neonatal, and child health services between urban and rural regions in SSA. Urban areas typically possess superior access to healthcare facilities and services in comparison to rural locations.[38,39] Nonetheless, urban regions have difficulties, as hardly 19–50% of hospitals can offer 24-hour emergency services, and numerous facilities are deficient in fundamental infrastructure such as consistent water and electricity supply.[40] Rural regions face challenges due to restricted access to imaging services, with about 10-13% of eligible patients obtaining imaging, in contrast to 50% in urban locales.[41] Socioeconomic characteristics, such as affluence, education, and media exposure, greatly contribute to these differences.[39] To rectify these deficiencies, it is advisable to implement interventions that emphasize socioeconomic empowerment, conduct targeted awareness campaigns, and enhance healthcare infrastructure.[39] Recent projects in SSA have demonstrated encouraging outcomes in enhancing the supply of medical gases, especially oxygen. A social entrepreneurship strategy executed in Kenya, Rwanda, and Ethiopia has effectively augmented oxygen procurement by 112–220% in involved hospitals, with an estimated cost of $7.34 per treated patient.[42] Ethiopia's anticipatory strategy in formulating a national oxygen policy prior to the pandemic has been recognized as an exemplary model for other African nations to emulate.[43] The University of Nairobi implemented the Washington, Wyoming, Alaska, Montana, and Idaho (WWAMI) approach to provide clinical training possibilities without significant infrastructure expenditures.44 Notwithstanding these advancements, oxygen shortages persist as a significant concern in SSA. Experts contend that prioritizing the provision of oxygen and personal protective equipment should take precedence over investments in intensive care units and ventilators to optimize lives saved during the COVID-19 pandemic.[36] Confronting these difficulties necessitate a comprehensive strategy, encompassing infrastructure enhancement, equipment supply, and healthcare personnel training.[35]

Barriers to integrating long-term oxygen therapy

Barriers exist to the integration of medical gases, especially oxygen, in SSA as illustrated in **Figure 2**. The restricted availability and erratic supply of oxygen delivery systems in healthcare settings present significant issues.[35] Staffing shortages, elevated turnover rates, and insufficient training of healthcare personnel impede the proper execution of oxygen treatment and other therapies for neonates.[45] Engaging and informing caregivers is essential, but frequently neglected.[45] The cost-effectiveness and affordability of new oxygen systems are essential factors for their introduction.[45] Policy gaps and insufficient governmental prioritization are significant barriers, compounded by policymakers' poor capacity to utilize evidence and the inaccessibility of research findings, which impede evidence-informed decision-making.[46]

The implementation of LTOT encounters obstacles, including regulatory problems and wrong cultural beliefs in the SSA. These obstacles may affect patient access to suitable oxygen delivery systems and need meticulous prescription, teaching, and monitoring methods.[47] Widespread misconceptions regarding the safety and efficacy of oxygen persist, with numerous individuals linking it to mortality due to its application in critically ill patients.[48] A deficient understanding of the advantages of oxygen therapy and apprehension regarding its appearance lead to refusal.[49] Community-based educational techniques are advised to enhance understanding and acceptance in response to these problems.[49] Additionally, poor patient adherence constitutes a substantial obstacle to the effective implementation of LTOT. Patients' attitudes and psychological obstacles significantly influence the beginning and utilization of LTOT, with apprehensions regarding prolonged use, unwelcome scrutiny, and absence of symptoms being pivotal factors.[50] Inadequate patient education and insufficient medical guidance worsen adherence problems.31 Patients frequently encounter difficulties in reconciling oxygen utilization with lifestyle disruptions and physical limitations, resulting in the rationalization and negotiation of their treatment.[51] To enhance adherence, interventions including peer counseling, incentives, and culturally tailored case management have been utilized; nonetheless, problems remain.[52] The COVID-19 pandemic has shown the acute deficiency of oxygen in SSA healthcare facilities, stressing the necessity to prioritise oxygen supply in conjunction with personal protective equipment for frontline personnel.[36] Overcoming these obstacles necessitates a comprehensive strategy, encompassing infrastructure enhancement, equipment allocation, and healthcare professional education.[35]

Integrating Long-Term Oxygen Therapy into Public Health Policies

Integrating LTOT care management into public health education programs is essential to meet the requirements of an increasingly aging population. Integrating LTOT into public health policies requires a multi-faceted approach to ensure accessibility, affordability, and optimal utilization. Key considerations:

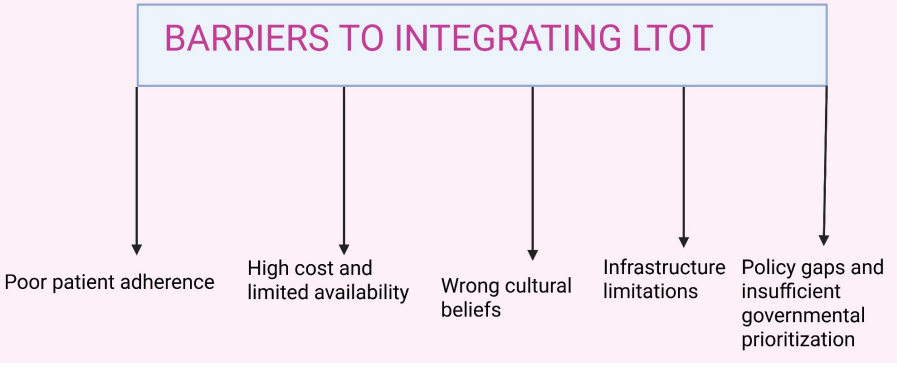

Figure 2 | **Barriers to integrating LTOT in SSA regions**
Created with BioRender.com. LTOT: Long-term oxygen therapy; SSA: Sub-Saharan Africa.

i. Healthcare system strengthening: Establishing robust supply chains and infrastructure for oxygen delivery, especially in low-resource settings, is vital. This includes portable oxygen systems and home-based services. Furthermore, developing training programs for healthcare providers on LTOT delivery and the establishment of oxygen production hubs and decentralized distribution networks would solve the problem of limited access, especially for those in rural areas. Slat et al.[53] identified limitations in incorporating LTOT into public health policy, such as infrastructure and access difficulties, patient-related obstacles, and restricted availability of multimodal treatments.

ii. Policy framework recommendations: The effective implementation of LTOT in Japan is attributed to the collaboration of academic institutions, policymakers, and industry, alongside public health insurance coverage established in 1985.[54] Recent studies on the incorporation of LTOT into public health strategies underscore several critical domains. Policy frameworks aimed at enhancing acute care in low- and middle-income nations highlight the necessity for emergency medical services, neuroimaging, and the advancement of expert workforce development.[55] The health policy triangle paradigm has been utilized to examine several public health challenges, especially at national and worldwide scales.[56] Although not explicitly focused on LTOT, studies regarding long-term opioid therapy in cancer survivors highlight the necessity of including biopsychosocial aspects in chronic care programs.[57] These studies collectively indicate that complete policy frameworks for LTOT must encompass infrastructure, workforce, guidelines, and patient-specific attributes to enhance treatment delivery and outcomes. International partnerships to support oxygen access and funding as well as subsidies or financial aid programs for oxygen therapy are critical to the success of integrating LTOT into public health.[58]

iii. Community engagement: Community engagement has become an essential instrument for the integration of public health strategies and the mitigation of inequities. Recent studies have reported the effectiveness of community involvement especially the use of religious leaders as advocates for the promotion of healthy attitudes.[59,60] Collaboration with community leaders could address cultural barriers. Recent studies underscore its efficacy in empowering marginalized groups and tackling environmental health concerns.[61] Community engagement has garnered international focus, with the United States spearheading research initiatives, succeeded by developing nations such as South Africa and India.[62] Optimal methodologies in community engagement encompass critical service-learning, community-based participatory research, and collective impact strategies.[63] A conceptual framework for community engagement interventions delineates various elements, encompassing community definition, motives, modalities of participation, and factors affecting impact.[64] Three principal methods of effective engagement have been recognized: peer-led delivery, a partnership between communities and health systems, and empowerment-based strategies.[64] The active involvement of public health professionals as community coaches is essential for effective community engagement implementation.[61]

iv. Monitoring and evaluation: Regular patient monitoring and adherence to clinical guidelines can improve outcomes. Public health systems should ensure quality standards for oxygen devices and services. Implementation of tracking systems to monitor LTOT usage, adherence, and patient outcomes, is crucial. Mexico's experience illustrates the vital role of monitoring and evaluation in policy-making, as seen by programs such as Prospera and Seguro Popular, which effectively tackle social determinants of health.[65] A systematic methodology for monitoring and evaluation of integrated health care is essential, incorporating country-specific policies, logic models, and enhanced health information systems.[66] Significant political commitments and investments are essential for the effective monitoring of national health policy.[67] These findings underscore the necessity for comprehensive monitoring and evaluation frameworks to assess the efficacy of integrated health policies, guide decision-making, and ultimately enhance public health outcomes.

v. Integration with telemedicine: Leveraging telemedicine to monitor LTOT usage and patient health can enhance access and adherence, particularly in remote areas. Recent studies underscore the use of telemedicine in public health initiatives, especially in reaction to the COVID-19 pandemic.[68] Telemedicine has been advocated to mitigate transmission hazards and enhance healthcare accessibility. It has demonstrated potential in decreasing healthcare expenses, mitigating environmental effects, and promoting innovation in civic engagement and education.[69] Nonetheless, obstacles persist in the global implementation of telemedicine, notably the absence of legislative frameworks in some countries.[70] The amalgamation of telemedicine with LTOT has surfaced as a notable focus, with telemonitoring recognized as an important category in contemporary LTOT research.[71] Policymakers and healthcare systems must rectify discrepancies in access to telemedicine resources, especially for marginalized communities, to prevent the exacerbation of health result disparities.

Comparative Analysis and Case Studies

LTOT is a cornerstone in managing chronic respiratory conditions like COPD and interstitial lung diseases. However, implementing LTOT in LMICs faces significant challenges, including infrastructure limitations, resource constraints, and low awareness. Despite these barriers, certain LMICs have successfully established models of LTOT delivery that can serve as blueprints for other regions. **Table 1** highlights some examples of such success stories, emphasizing strategies, outcomes, and lessons learned.[72-81] Additionally, the utilization of LTOT varies in diverse populations with barriers including high cost, personnel shortages, regulatory issues, and cultural beliefs impeding patient adherence. **Table 2** is a comparison of LTOT utilization in high-income regions and healthcare systems within SSA.[35,82-84]

Recommendations

COPD presents a growing health challenge in aging populations across SSA, driven by indoor air pollution, tobacco use, occupational hazards, and limited healthcare access. Effective short-term and long-term strategies are essential to mitigate its burden. **Table 3** shows some actionable steps for improving COPD management and LTOT implementation in SSA. The under-listed steps, when implemented cohesively, can significantly reduce the burden of COPD in SSA's aging populations and enhance the quality of life for its aging populations.

Limitations

Although this study offers a thorough examination of the challenges and potential for using LTOT in SSA, the review still has some limitations:

i. Potential bias in article selection: This study mostly comprised English-published papers between 2014 and 2025, hence it could have missed pertinent research produced in other languages or before this period. Publication bias could also have affected the availability of papers documenting effective interventions over less successful ones.

ii. Limited data on LTOT implementation in SSA: Region-specific studies on LTOT accessibility, adherence, and outcomes in SSA are few. The dearth of strong epidemiological data makes it difficult to reach clear conclusions regarding the viability and influence of LTOT in many SSA healthcare settings.

iii. Heterogeneity in SSA healthcare systems: SSA consists of several healthcare systems with varying degrees of resources and policy consistency. Although general recommendations are included in this review, successful application will depend on country-specific adjustments.

iv. Lack of longitudinal studies on LTOT in SSA: While this review compiled cross-sectional and observational data, longitudinal studies evaluating long-term patient adherence, cost-effectiveness, and health effects of LTOT in SSA remain few. Generation of region-specific longitudinal data to guide policy decisions should be the main focus of future studies.

Despite these limitations, this paper offers an insightful analysis of the necessity of more proficient COPD control and LTOT integration in SSA. By means of additional research and focused actions, filling in these gaps will assist to close current healthcare inequalities.

Conclusion

Medical gases, particularly LTOT, play a critical role in managing COPD by alleviating symptoms, improving oxygenation, and enhancing the quality of life for patients with severe hypoxemia. Despite the proven efficacy of LTOT in high-income

Table 1 | Demographic and clinical data of all subjects

S/N	Country	Background	Model	Success Factors	*Outcome*	Lessons	Reference
1	Peru	Peru faces a high burden of COPD, especially in rural Andean regions where access to care is limited.	Peru's Ministry of Health initiated an integrated LTOT program that trained primary healthcare workers to administer and monitor LTOT. Portable oxygen concentrators were provided, supported by teleconsultations with specialists.	Decentralization of oxygen delivery through rural health centers. Use of cost-effective, solar-powered concentrators for remote areas. Strong government and community support.	Improved adherence to LTOT and reduced hospital admissions due to respiratory complications.	Decentralization and delivering LTOT through primary healthcare networks ensures access in remote areas.	72,73
2	India	High prevalence of respiratory diseases in urban slums and rural areas prompted the need for affordable LTOT.	A public-private partnership model was implemented in states like Tamil Nadu. Government-funded subsidies covered the cost of oxygen concentrators, while private partners ensured supply chain efficiency.	Low-cost manufacturing of concentrators locally. Community-based awareness campaigns to improve LTOT acceptance. Integration with existing health insurance schemes like Ayushman Bharat.	Significant expansion of LTOT services to underserved populations and enhanced quality of life for patients.	Government support and partnerships with NGOs or private sectors are critical for sustainability.	74,75
3	Kenya	In rural Kenya, respiratory conditions are exacerbated by high rates of biomass fuel use.	A CHW network was trained to deliver LTOT services. CHWs assessed patients, ensured proper oxygen usage, and conducted regular follow-ups.	Use of solar-powered oxygen concentrators to address power outages. Regular training programs for CHWs and caregivers. Partnerships with NGOs for funding and technical support.	High patient compliance and reduced mortality rates from chronic respiratory conditions.	Involving CHWs and conducting awareness campaigns improve adherence and acceptance. Use of solar-powered concentrators and telehealth minimizes infrastructure constraints.	76,77
4	Brazil	Brazil's universal healthcare system has successfully integrated LTOT into respiratory care frameworks	Public hospitals provided LTOT through home delivery programs, supported by multidisciplinary teams. Focus was placed on urban favelas and rural Amazon regions.	Telehealth services to monitor LTOT remotely. Collaboration with international agencies to procure affordable concentrators. Implementation of quality assurance protocols for oxygen delivery.	Reduction in COPD-related hospitalizations and increased survival rates.	Decreased hospitalizations associated with COPD and enhanced survival rates. Consistent follow-ups and the incorporation of telemedicine enhance outcomes and cost efficiency. Government assistance and collaborations with NGOs or the corporate sector are essential for sustainability.	78,79
5	South Africa	Respiratory diseases are prevalent due to mining-related occupational exposures and high smoking rates.	A centralized model where hospitals served as hubs for LTOT education, equipment distribution, and follow-ups.	Government-supported oxygen plants to reduce supply bottlenecks. Subsidized LTOT for low-income patients through national health programs. Collaboration with academic institutions for research and training.	Enhanced patient outcomes and scalability to neighboring regions.	Hospital-based LTOT expansion through primary healthcare networks ensures access in remote areas.	80,81

CHW: Community health worker; COPD: chronic obstructive pulmonary disease; LTOT: long-term oxygen; NGOs: non-governmental organizations.

Table 2 | A comparison of LTOT utilization in high-income regions and healthcare systems within SSA

Factor	Experimental studies (high-income settings)	Applicability to SSA	Key considerations for SSA	Reference
Study population	Mostly older adults with COPD, well-diagnosed cases	Younger COPD patients, often undiagnosed due to limited access	Need for improved screening programs	82
Healthcare system	Well-established LTOT programs, reimbursement schemes	Limited LTOT availability, lack of funding	Policy development and funding support needed	83
Socioeconomic factors	LTOT covered by insurance, patient education programs in place	High out-of-pocket costs, limited awareness	Need for government subsidies, public awareness campaigns	35
Cultural and Behavioral Aspects	High patient adherence due to structured monitoring	Stigma around oxygen therapy, fear of dependence	Community engagement and education programs required	84
Policy & infrastructure	National LTOT guidelines, oxygen readily available	Poor infrastructure, oxygen shortages in rural areas	Investment in local production and supply chain efficiency	83

COPD: Chronic obstructive pulmonary disease; LTOT: long-term oxygen; SSA: Sub-Saharan Africa.

Table 3 | Actionable steps for improving COPD management and LTOT implementation in SSA

Increase awareness & education	Launch national COPD awareness campaigns via radio, TV, and community outreach	Ministries of Health, NGOs, community leaders	Short-term (1–2 yr)	Improved COPD recognition and earlier diagnosis
Expand LTOT access	Develop government-subsidized LTOT programs and incentivize private suppliers	Health policymakers, private sector, insurance companies	Medium-term (3–5 yr)	Increased LTOT availability and affordability
Strengthen healthcare infrastructure	Invest in local oxygen production plants and establish distribution networks in rural areas	Government, global health partners (WHO)	Long-term (5+ yr)	Stable oxygen supply and accessibility for COPD patients
Improve training for healthcare workers	Integrate COPD & LTOT management into medical and nursing school curricula	Medical schools, professional associations	Medium-term (3–5 yr)	More skilled healthcare providers managing COPD effectively
Enhance patient adherence & monitoring	Implement CHW programs for home-based LTOT monitoring	Ministries of Health, local governments	Short-term (1–2 yr)	Better patient adherence and fewer complications
Research and data collection	Supporting research on COPD prevalence, risk factors, and effective interventions specific to the SSA. Additional randomized controlled trials are required to assess COPD management methods in SSA	Ministries of Health, global health partners, researchers	Long-term (5+ yr)	Improved COPD recognition, earlier diagnosis, and better management culminating in enhanced patient outcome.

CHW: Community health worker; COPD: chronic obstructive pulmonary disease; LTOT: long-term oxygen; NGOs: non-governmental organizations; SSA: Sub-Saharan Africa; TV WHO: World Health Organization.

countries, its integration into healthcare systems in SSA remains limited due to infrastructure challenges, cost barriers, and inadequate awareness. Addressing these gaps requires urgent and coordinated efforts, including strengthening healthcare infrastructure, implementing supportive policy frameworks, fostering community engagement, and leveraging global and regional collaborations. By prioritizing the integration of LTOT and related interventions into public health systems, SSA can significantly reduce the COPD burden, improve patient outcomes, and meet the growing healthcare demands of its aging populations.

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