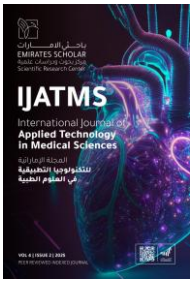

International Journal of Applied Technology in Medical Sciences
Vol 4 Issue 2 (2025)
Pages (4 - 25)

Available at
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Pneumonia and COPD in Middle Eastern Older Adults: Current Burden and Future Opportunities

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ARTICLE HISTORY

Received: 14 October 2025.
Accepted: 26 November 2025.
Published: 29 December 2025.

PEER - REVIEW STATEMENT:

This article was reviewed under a double-blind process by three independent reviewers.

HOW TO CITE

Sulthan, N. ., Saito, R. S., Amer, S. ., Aslam, A. ., Malik, M. ., Sreekumar, G. ., May, G. ., Dharmi, S., Daryanani, A. ., & Ahmed, I. . (2025). Pneumonia and COPD in Middle Eastern Older Adults: Current Burden and Future Opportunities. *International Journal of Applied Technology in Medical Sciences*, *4*(2), 4-25. https://doi.org/10.54878/44jjb542

ABSTRACT

Background: The Middle East is undergoing a demographic transformation marked by a rapidly expanding population of older adults, reshaping healthcare priorities and intensifying the burden of chronic and respiratory diseases. Among adults aged 60 years and above, pneumonia and chronic obstructive pulmonary disease (COPD) remain leading causes of morbidity, hospitalisation and mortality. These conditions frequently coexist, driven by high smoking rates and deteriorating air quality, both major regional risk factors. Objective: This paper adopts a health-systems perspective to analyse the burden of pneumonia and COPD among older adults in the Middle East and to evaluate the role and investment potential of digital health technologies in respiratory care management. Discussion The projected demographic shift is expected to place growing pressure on health infrastructures, with recurrent admissions, extended hospital stays and post-acute care needs contributing to rising cost burden. In response, governments across the region have begun prioritising ageing and chronic disease management within national health strategies, supported by advances in telemedicine, AI-assisted diagnostics and remote patient monitoring. These developments highlight increasing readiness to integrate digital tools into respiratory care pathways. Conclusions: The COVID-19 pandemic acted as a catalyst, accelerating digital transformation across the region. Sustained innovation, regulatory facilitation and public-private collaboration, will position the Middle East to meet global standards in digital respiratory health and deliver more inclusive, connected care for its ageing population.

Keywords: *Ageing population, Respiratory diseases, Digital health innovation, Chronic obstructive pulmonary disease (COPD), Pneumonia in older adults, Middle East healthcare, Health system resilience*

Introduction

The Middle East is experiencing a demographic transition, marked by a steadily ageing population which is driving significant shifts in health priorities (ESCWA, 2022). The population of the UAE, for example, included just 3% seniors, (defined as 60 and above according to the United Nations) in 2020, yet projections show that seniors will form approximately 20% of the population by 2050 (Figure 1), a more than six-fold increase (UNFPA, 2024). Against this backdrop, the burden of disease is undergoing a parallel shift. While infectious diseases such as pneumonia remain a leading cause of acute illness and mortality among older adults, the region faces a rising burden of non-communicable diseases (NCDs) such as chronic obstructive pulmonary disease (COPD), cardiovascular disease and diabetes. Recent Global Burden of Disease data show that COPD prevalence in the Middle East and North Africa (MENA) region increased by 30.6% between 1990 and 2019 and chronic respiratory diseases (CRDs) advanced from the 12th to the 6th leading cause of death in the region over the same period (Feizi *et al.*, 2022). Both COPD and pneumonia increase in severity and frequency with increasing age (Bailey, Kukrety and Parekh, 2018). For older adults, the coexistence of acute infections like pneumonia and chronic conditions such as COPD exacerbates morbidity and mortality, compounding the strain on individuals, families and healthcare systems (Yu *et al.* 2021, Zheng and Wang, 2024).

Responding to these challenges is further hindered by persistent healthcare system constraints. Delivering healthcare to older adults in the region remains limited due to inadequate geriatric infrastructure, shortages of specialised healthcare professionals and fragmented social support systems, as documented in recent evaluations of MENA health systems (Mate *et al.*, 2016). In Egypt, for example, geriatric care institutions are scarce and often lack specialisation, creating significant quality gaps in the care of older adults (Porcel-Gálvez *et al.*, 2024), while broader analyses show that many nursing homes across MENA remain under-resourced and frequently rely on non-specialists (Abyad. A, 2022). These issues are further exacerbated in settings affected by conflict or economic instability, where the dual burden of infectious and chronic disease stretches already limited resources and deepens inequities in care access and quality. Amid these pressures and demographic shifts, the region is turning increasingly to rapid digital innovation as a strategic lever for health-system reform. Investments in telemedicine, artificial intelligence (AI), remote patient monitoring (RPM) and interoperable electronic health records (EHR) are modernising care delivery and improving disease management (Grand View Research, 2024; Welch, 2024).

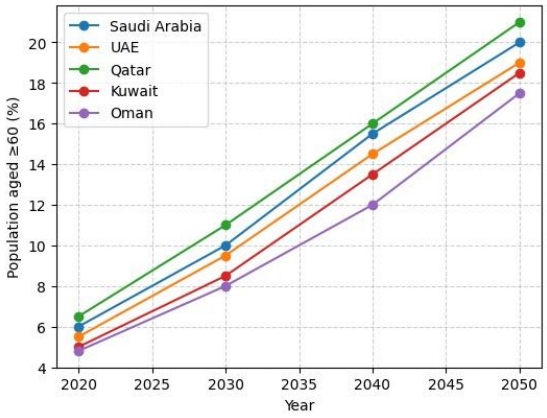

Figure 1: Projected Growth of the Older Adult Population (≥60 years) in GCC Countries, 2020-2050. *In 2020, the share of the population aged 60 and above ranged from just under 5% in Oman to around 8% in the UAE. By 2050, all GCC countries are projected to see significant increases: Oman (~19%), Saudi Arabia (~20%), Kuwait (~20.5%), Qatar (~21%), and both the UAE and Bahrain exceeding 22%. The UAE and Bahrain show the steepest growth, while Oman consistently records the lowest proportion throughout the period. (Source: United Nations,2022)*

This report examines the prevalence and burden of pneumonia and COPD among older adults in the Middle East, analysing patterns of disease, key risk factors and the emerging role of digital health technologies in respiratory care. It further evaluates current market size, development forecasts and funding opportunities for respiratory-focused digital health solutions. By

providing a comprehensive overview of these trends, these findings aim to inform clinicians, policymakers and investors seeking to strengthen service delivery and innovation capacity across the region. Viewed through a health-systems lens, this analysis highlights opportunities to integrate preventive and digital innovations across the respiratory-care continuum.

Regional Epidemiology & Disease Burden

Pneumonia

In the Middle East, adult pneumonia remains a major health concern, with incidence rates estimated between 1 and 14 cases per 1,000 persons annually. Research from Saudi Arabia shows community-acquired pneumonia (CAP) affected 13.4% of hospitalised patients over the age of 50 in a point-prevalence study (Oreibi *et al.*, 2023). Rates increase during the Hajj season, where older adults with comorbidities face the highest risk (Al-Tawfiq and Memish, 2014; Benkouiten *et al.*, 2018). In Iran, the severity of the issue is highlighted by a study in Tehran, which found that pneumonia was responsible for 15.9% of all respiratory-related deaths in individuals aged 65 and over, establishing it as a leading cause of mortality in this demographic (Pishgar *et al.*, 2020). Similarly, a hospital-based study on CAP in Egypt revealed that 28% of cases involved patients aged 60 and older, with *S. pneumoniae* being a common pathogen (Khalil *et al.*, 2013). The challenge is compounded by rising antimicrobial resistance (AMR) (Parkinson, 2024), underscoring the critical need for antibiotic stewardship and thorough surveillance.

Country-specific data further illustrates the disease burden on older populations. In the UAE, the annual hospital admission rate for pneumonia across all adults was reported at 760 per million in 2002 (Al-Muhairi *et al.*, 2016). While specific data for those over 60 are scarce, rates are presumed to be higher in this group due to age and comorbidities. A surveillance study in Lebanon found that 33.1% of invasive pneumococcal disease cases occurred in adults over 60, with risk factors including chronic lung disease, heart disease and diabetes (Bizri *et al.*, 2022). In Turkey, pneumonia remains the most frequent infection among the elderly, occurring at a rate 10 times higher than in younger adults and often necessitating hospitalisation, which leads to high morbidity and costs (Arslan *et al.*, 2013). In Syria, direct prevalence statistics for older adults are not available, but the risk is considered high, particularly for displaced individuals and those with chronic illnesses (Sahloul *et al.*, 2016). In Jordan, while specific figures are lacking, *Pneumococcus* is a primary cause of pneumonia, and vaccine uptake among older adults is low (Abu-Rish and Barakat, 2020). For other Gulf and Levant nations, the same cohort-specific data remains scarce. Global estimates however, place adult CAP incidence at 1-14 per 1,000 person-years, with older adults most likely at the upper end of this range (Cillóniz, Cardozo and García-Vidal, 2018)

COPD

The prevalence of COPD among older adults varies across Middle Eastern nations, but the burden is consistently high. In Saudi Arabia, the age standardised prevalence of COPD in 2019 was 3.65% with a higher prevalence in men (4.2%) than in women (3.1%) (Alqahtani, 2022). A population-wide survey conducted in 2011 had indicated that 2.4% of adults have COPD, but specific studies revealed this rate increases to 14.2% in older male smokers, with even higher rates among long-term smokers who also face biomass smoke exposure (Al Ghobain, Al-Hajjaj and Wali, 2011). A 2009 survey in Abu Dhabi revealed a 3.7% prevalence among adults aged 40-80 years (Al Zaabi *et al.*, 2011). Jordan's general population has a COPD prevalence of 5.4%, but this figure rises to 8.2% in older smokers (Al Omari *et al.*, 2014). In Lebanon, a spirometry-based study reported a 9.7% prevalence using GOLD criteria (Global Initiative for Chronic Obstructive Lung Disease, 2025), with 80% of cases undiagnosed - far higher than the 5.3% prevalence identified in the questionnaire-based BREATHE study. This gap highlights underdiagnosis and the importance of objective testing (Waked, Khayat and Salameh, 2011; Tageldin, *et al.*, 2012). The Syrian population has one of the highest regional rates at 6.1% among all adults, which is likely higher among older adults

due to extensive smoking and environmental pollutants (Mahboub *et al.*, 2017). The same study reports a prevalence of 3.5% in Egypt, however, research with high-risk groups, including smokers, construction workers and women exposed to biomass fuel, has shown COPD rates of approximately 9.6% using GOLD criteria, with biomass fuel exposure being a significant risk factor (Said *et al.*, 2015). A cross sectional study from Iran determined that COPD occurs in 4.9% of adults aged 40 and above, with prevalence increasing as age and exposure risks accumulate (Pishgar *et al.*, 2020). Older Turkish adults face a severe burden, with research showing that more than 10% of this demographic suffers from the condition due to historical tobacco use and environmental contamination; one industrial city reported 13.3% of its population aged 40 and above had COPD, with a 24% prevalence among men aged 60 to 69 (Arslan *et al.*, 2013). In Kuwait, Oman, Qatar, Bahrain, Yemen and Iraq, direct data are lacking, but prevalence is likely moderate, mirroring neighboring countries with similar risk exposures (Mahboub *et al.*, 2017). Both pneumonia and COPD impose a heavy health burden on the older populations in the Middle East (Figure 2): pneumonia is a leading infectious cause of death and hospitalisation, while COPD is a major cause of chronic disability. Their frequent overlap compounds both clinical and economic impact, underscoring the need for innovative solutions such as digital health interventions.

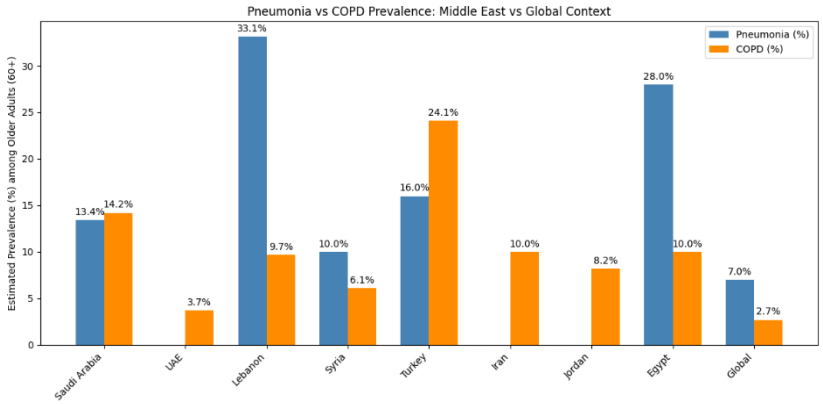

Figure 2: Prevalence of Pneumonia and COPD among older adults in Middle Eastern countries compared with the global average. *Estimates reflect the most recently published national or sub-national datasets, adjusted for elderly population proportion where available. (Source: Global Burden of Disease Study 2021).*

Risk Factors and Disease Drivers

Multiple risk factors contribute to the high burden of pneumonia and COPD in Middle Eastern older adults. These include traditional risk factors such as tobacco use, indoor and outdoor air pollution and occupational exposures, as well as region-specific factors like frequent mass gatherings and displacement due to conflict, explained diagrammatically in Figure 3.

Smoking and Air Pollution

The Global Burden of Disease 2019 identified smoking as the leading risk factor for chronic respiratory diseases in the MENA region, accounting for 31.6% of deaths, particularly among men (Fallahzadeh *et al.*, 2022). Previous research has indicated that smoking prevalence varied significantly across MENA countries (15.3% in Morocco to 53.9% in Lebanon), with overall rates of 31.2% for any tobacco use, including 28.8% cigarette smoking and 3.5% waterpipe use. The study concluded that smoking is a major health issue in the region with both cigarette and waterpipe smoking contributing to substantial COPD risk through high cumulative exposure levels (Khattab *et al.*, 2012).

Air quality is a critical concern across the region. Cities like Riyadh, Cairo, Tehran and Beirut experience severe air pollution from rapid urbanisation and rising traffic density (IQAir, 2021). Fine particulate matter impairs respiratory

defences, worsening chronic conditions and raising pneumonia risk. In rural and low-income areas, the use of biomass fuels such as wood or charcoal for cooking and heating creates sustained indoor air pollution, disproportionately affecting older women who have spent years cooking in poorly ventilated spaces (Mahboub *et al.*, 2017).

Climate and Social Drivers

Respiratory diseases follow specific seasonal patterns. Influenza and pneumococcal infections surge during colder months, likely due to viral co-infections that increase susceptibility to bacterial invasion, leading to spikes in pneumonia-related hospitalisations, (Weinberger *et al.*, 2013).

Climate change is an emerging driver but under-quantified in the Middle East. Rising temperatures and desertification contribute to frequent dust storms, which trigger respiratory irritation and hospital admissions among people with lung conditions (Geravandi, S. *et al.* 2017; Khaniabadi *et al.*, 2017), adding further risk for vulnerable older adults.

Mass gatherings, such as the major annual Hajj pilgrimage in Saudi Arabia attract more than two million pilgrims to Mecca and create environments conducive to respiratory pathogen transmission (Gautret and Benkouiten, 2016). Research indicates that pneumonia cases reach their peak during the Hajj period and older adults with existing medical conditions are most vulnerable. Saudi health authorities recommend vaccination for pilgrims and enforce infection control, yet Hajj remains a recurrent pneumonia risk for the region (Al-Tawfiq and Memish, 2014; Alzeer, 2009). Healthcare systems must therefore prepare for both seasonal surges and event-related spikes in respiratory cases among this group of adults.

Conflict and displacement in countries such as Syria and Yemen create additional vulnerabilities. Poor housing, overcrowding and limited access to affordable healthcare and medications contribute to higher rates of both acute and chronic respiratory disease (Sahloul *et al.*, 2016).

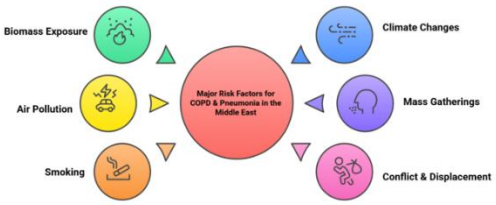

Figure 3. Major risk factors and disease drivers contributing to chronic obstructive pulmonary disease (COPD) and pneumonia in older adults across the Middle East. *These include tobacco use, indoor and outdoor air pollution, seasonal infection patterns, climate change-induced dust exposure, mass gatherings, and displacement due to conflict.*

Preventive and Early Detection Gaps

Vaccination and Preventive Care Gaps

Community-acquired pneumonia represents a significant health burden in the MENA region, with overall mortality from lower respiratory tract infections reaching 10% compared to only 4% in developed regions. *Streptococcus pneumoniae* is the leading pathogen, with concerning levels of AMR, particularly to penicillin (Shibl *et al.*, 2010). The growing AMR burden heightens the urgency of preventive strategies such as vaccination. Pneumococcal vaccination is not included in most national immunisation programs across the MENA region and inadequate surveillance limits understanding of both disease burden and vaccine uptake in this population (Bizri *et al.*, 2021). In Jordan coverage was only 0.5% among older adults prior to awareness campaigns, rising to 1.9% after targeted interventions, underscoring the opportunity for improvement (Abu-Rish and Barakat, 2020). Similar gaps persist elsewhere, in part due to limited adult immunisation registries, weak surveillance and low provider recommendation rates, which mask the true scale of under-vaccination.

Influenza vaccination rates are somewhat higher, though still below 50% in Saudi Arabia, UAE and Turkey, with pneumococcal coverage still less than 15% (Koksal *et al.*, 2024). Given that influenza infection frequently predisposes older adults to secondary bacterial pneumonia, more robust influenza vaccination programmes could indirectly reduce pneumococcal disease incidence. The recent inclusion of pneumococcal vaccine in the national programmes of Saudi Arabia and Qatar, is a promising step toward improving coverage.

Screening and Early Detection Gaps

Screening and early detection of chronic lung disease remain limited across the region. Most smokers develop COPD symptoms only after the disease reaches advanced stages as early disease often goes undiagnosed. Routine spirometry for high-risk groups is rarely implemented in Middle Eastern health systems and there is no standardised screening pathway (Al-Moamary *et al.*, 2021). Patients typically seek medical attention only once lung function significantly deteriorates, leading to delayed diagnosis, higher morbidity and greater costs (Al Ghobain, Al-Hajjaj and Wali, 2011). Limited awareness among primary care physicians about COPD risk factors and early symptoms further compounds underdiagnosis. Expanding spirometry training in primary care, coupled with public education on COPD symptoms, could substantially improve case-finding and enable earlier intervention. Screening programmes could also integrate pulse oximetry or targeted chest imaging for long-term smokers and other high-risk groups, although these remain uncommon in routine practice. Strengthening preventive screening infrastructure therefore represents a critical opportunity to reduce the burden of advanced disease in older adults.

The interaction between demographic, environmental and clinical determinants of respiratory disease, together with the potential intervention points for digital health technologies, can be represented through an integrated pathway model (Figure 4).

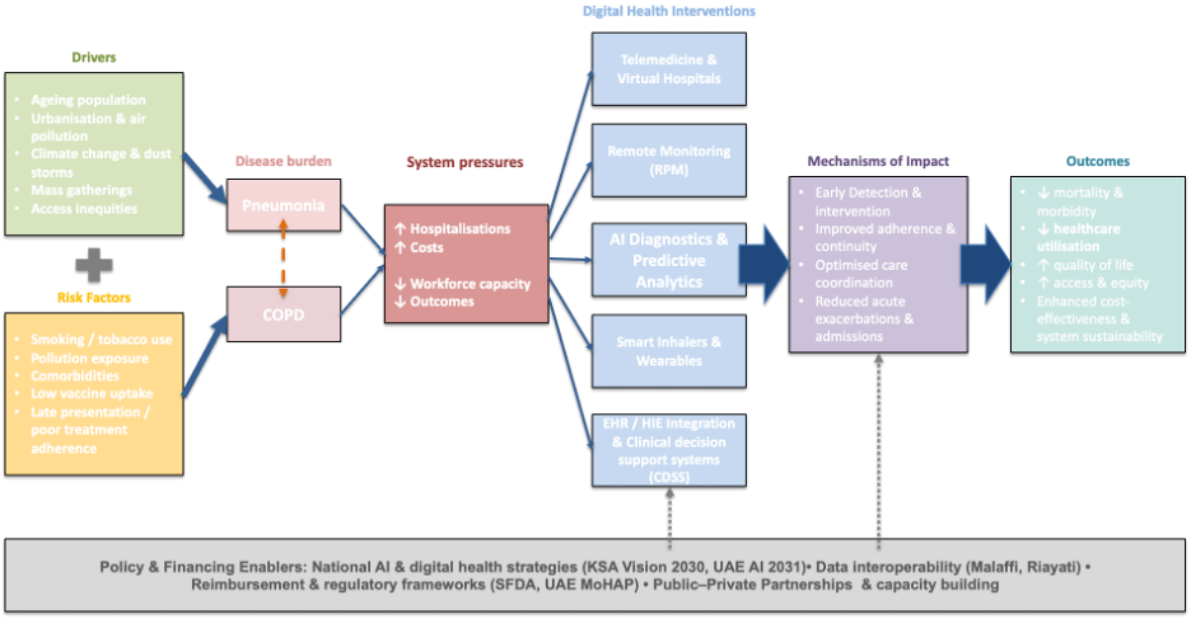

Figure 4. Integrated pathway of respiratory disease burden and digital health interventions in Middle Eastern older adults.

Digital Health Technologies in Respiratory Care Management

Telemedicine Platforms

Middle Eastern nations rapidly scaled up telehealth services during the COVID-19 pandemic to ensure continuity of care for older adults with pneumonia and COPD, reducing hospital exposure risk and maintaining follow-up treatment. In Saudi Arabia, the Ministry of Health's Vision 2030 reforms established the *Seha Virtual Hospital*, recognised by Guinness as the world's largest virtual hospital, connecting 224 hospitals and offering 44 specialties and 71 sub-specialties, including respiratory care, specialist consultations and remote diagnostics (Welch, 2025). In the UAE, the Dubai Health Authority's "*Doctor for Every Citizen*" service, launched in 2019 and scaled during the pandemic, supports real-time respiratory care, prescription management and lab coordination. Telemedicine utilisation in Dubai increased from 0.2% pre-pandemic to 14% during the pandemic, with most users having chronic conditions, including COPD (Swidan *et al.*, 2022). International programmes reinforce these benefits. NHS England's "Virtual Wards" programme has shown that home-based telemonitoring for COPD and pneumonia patients reduces hospital admissions by over 20% (GIRFT and NHS England Virtual Ward programme, 2024). Similarly, US Veterans Affairs telehealth initiatives reported improved quality of life scores and lower readmission rates among older COPD patients (Darkins *et al.*, 2008). These findings align with Middle Eastern experience, suggesting scalability and sustained impact (Alghamdi *et al.* 2023; Rezende *et al.*, 2023).

Remote Monitoring & Wearable Technologies

Remote patient monitoring is increasingly recognised as an essential complement to in-person care, offering real-time data that allows clinicians to intervene earlier. Devices such as pulse oximeters, smart inhalers and connected spirometers can provide continuous assessment of oxygen saturation, lung function and medication adherence. In the UAE, the Dubai Health Authority has piloted *BioIntelliSense BioButton and BioSticker* wearables for real-time monitoring, feeding data to care teams for proactive intervention (Mubadala Health, 2022). Recent studies increasingly demonstrate the clinical promise of wearable-based RPM in COPD. A prospective observational cohort study showed high patient adherence to biometric wearables continuously capturing physiological data predictive of exacerbations (Coutu, Iorio and Ross, 2023). Similarly, a retrospective study found significant reductions in hospitalisations among COPD patients monitored via wearable cardiorespiratory sensors, highlighting RPM's role in proactive disease management (Polsky *et al.*, 2023). Such models strengthen the case for Gulf Cooperation Council (GCC)-wide adoption.

Artificial Intelligence and Predictive Analytics

AI is already being deployed internationally in respiratory care, demonstrating potential for GCC adaptation. AI-driven tools can analyse longitudinal health data, vital sign patterns and environmental variables to predict COPD or pneumonia exacerbations, thereby helping clinicians initiate timely treatment. For example, a machine learning model using electronic stethoscope and spirometry-derived features achieved excellent predictive accuracy for acute exacerbations, with CatBoost models reaching an area under the curve (AUC) of 0.97 (Yin *et al.*, 2024). Predictive performance improves further when models are trained on local epidemiological datasets, as shown in pilot work with Saudi health data (Kumar *et al.* 2025).

Clinical Decision Support Systems (CDSS)

Evidence-based CDSS integrated into EHRs are increasingly recognised for their ability to enhance chronic respiratory disease management by delivering guideline-driven treatment recommendations, issuing automated vaccination reminders and optimising medication reviews. A systematic review found that many CDSS implementations led to measurable improvements in care delivery for adults with chronic respiratory diseases, including COPD (O'Neil *et al.*, 2025). Randomised controlled trials have also shown positive effects of CDSS on

breathlessness related care in real-world clinical settings (Sunjaya *et al.*, 2022). Although Dubai's unified EMR supports coordinated clinical workflows across levels of care, public documentation confirming AI-enabled CDSS specifically for COPD or pneumonia management within the system remains unavailable. However, WHO-EMRO reports that broader regional efforts are underway to strengthen digital health governance, interoperability and health system coordination, creating a policy environment where disease-specific CDSS can be integrated in the near future (Regional Committee for the Eastern Mediterranean, 2022).

Emerging Smart Devices & Digital Biomarkers

Advances such as smart stethoscopes, connected nebulisers and digital biomarkers from wearable sensors are enabling non-invasive, continuous monitoring of respiratory patterns, cough frequency and oxygen consumption. AI-enhanced digital auscultation now detects lung crackles and wheezes with high precision, improving remote diagnostic accuracy (Karthika *et al.*, 2024). Clinical studies have demonstrated the feasibility of using intelligent stethoscopes for lung sound classification in telehealth contexts (Sueaseenak, 2025; Huang *et al.*, 2023). Pilots like the RESP Smart Sensor platform, which continuously captures lung sounds to detect early respiratory deterioration, have shown promise in reducing COPD-related readmissions (Carvalho, 2022). In Europe, smart inhalers integrated with adherence apps have increased inhaler compliance rates by 20-30%, directly improving COPD outcomes (Chan *et al.*, 2021) However, published Middle East-specific deployments remain scarce, representing a key gap for future research and documentation.

Health System and Policy Enablers for Digital Respiratory Care

Ethical Considerations in AI Deployment

The adoption of AI-driven tools in respiratory care requires robust safeguards to address patient data privacy, algorithmic bias and informed consent. WHO-EMRO's *Regional Digital Health Strategy 2023-2027* outlines priorities for digital health governance, including the development of legal frameworks, interoperability standards and regulatory oversight for AI deployment in healthcare (Regional Committee for the Eastern Mediterranean, 2022). Regional collaboration under WHO-EMRO seeks to harmonise digital health interoperability and regulatory approaches. At the country level, Saudi Arabia and the UAE have introduced broad digital health policies under their transformation agendas, yet comprehensive, disease-specific ethical frameworks for AI in respiratory care are still in development (Trigui *et al.*, 2024). Lessons from Europe's GDPR-compliant AI pilots suggest that aligning privacy safeguards with robust data-sharing agreements can accelerate adoption while maintaining patient trust.

Strategic National Plans and Funding Initiatives

GCC countries, including Saudi Arabia, the UAE and Qatar, have positioned digital health as a core pillar of their national transformation strategies. Saudi Arabia is advancing a national health information exchange system through Orion Health, enabling interoperability between public and private healthcare facilities (Cheriyan, 2024). This provides a foundation for building electronic patient registries for chronic respiratory conditions such as COPD and asthma, supporting surveillance, case-finding and care coordination for older adults. Similarly, the UAE launched the National Strategy for Artificial Intelligence 2031 in 2019, positioning the country as a global AI hub with healthcare as a core focus (Protocol Dubai, 2019). The UAE Ministry of Health and Prevention (MOHAP) has implemented virtual clinics for chronic disease management and is developing AI-powered digital health tools as part of its broader digital transformation initiative (Ministry of Health and Prevention, 2020; 2023). Qatar's National Health Strategy 2018-2022 also explicitly prioritised e-health expansion and chronic disease management, including COPD, through investment in integrated health information systems (World Health Organization, 2018).

While these reforms create a strong enabling environment, execution gaps persist: implementation often lags behind policy

ambitions, digital resources are unequally distributed between urban and rural areas, and measurable outcomes for respiratory disease management are still limited (Regional Committee for the Eastern Mediterranean, 2022; Alami *et al.*, 2020). Addressing these gaps will be essential to translate strategic intent into real population health gains for older people with COPD and pneumonia.

Digital Infrastructure and Data Integration

In Abu Dhabi, the Malaffi health information exchange system represents a flagship example of regional healthcare digitisation. Launched in 2019, Malaffi connects over 2,700 healthcare facilities across the Emirate, allowing physicians to access comprehensive patient records, including diagnostics, medications and discharge summaries after receiving patient consent (Department of Health-Abu Dhabi, 2025). This integration enables remote respiratory specialists to make informed clinical decisions during virtual consultations with older patients, supporting safer prescribing, fewer duplicated tests and more timely follow-up. Emirates Health Services (EHS) is pioneering advanced digital health tools in the UAE. In January 2023, EHS launched digital twin projects in partnership with Schneider Electric and Microsoft, creating virtual models of hospital environments to simulate responses to different interventions before implementing treatment. These digital twins aim to reduce energy consumption by up to 30% while simultaneously reducing breakdowns and maintenance work by up to 20% (Emirates Health Services, 2023). Although currently focused on infrastructure optimisation, there is growing interest in extending digital twin technologies to model patient pathways and predict outcomes in chronic disease management, including COPD.

To ensure interoperability and data standardisation, Middle Eastern governments are investing in unified EHR systems and promoting adherence to international digital health standards. WHO's regional digital health programme provides technical support to Member States to develop and implement national digital health strategies to enhance interoperability between different systems and countries of the region (Mandil *et al.*, 2021). The UAE successfully integrated three major health information platforms - Riayati (National Unified Medical Record), Malaffi and Nabidh, creating a comprehensive national health data ecosystem (UAE Ministry of Health and Prevention, 2023). These efforts lay the foundation for scalable AI integration, RPM and decision support systems, though gaps remain in cross-border data sharing and alignment of privacy frameworks across GCC countries. Prioritising respiratory registries and device data feeds (e.g. spirometry, oximetry) would accelerate real-world analytics for COPD and pneumonia.

Public Health Campaigns

The Saudi government's healthcare programmes, working alongside the Saudi Thoracic Society, have improved respiratory disease management by establishing standardised treatment guidelines, implementing vaccination strategies for chronic respiratory disease patients and promoting public health awareness campaigns that support early diagnosis and evidence-based care (Al Jahdali *et al.*, 2024). Capacity building is also emerging as a critical priority across the region. Medical universities and health ministries are partnering to train physicians and nurses in digital health competencies, with professional development programs including modules on AI-based diagnostic tools, RPM device integration and telemedicine best practices (Albasri *et al.*, 2022). However, many initiatives remain pilot-scale and unevenly distributed, often excluding rural and low-resource areas.

Beyond training, public awareness campaigns have had mixed success. For example, influenza vaccination uptake improved in Saudi Arabia following targeted campaigns linked to the Hajj, yet pneumococcal vaccination rates across the region remain persistently low despite similar initiatives (Koksal *et al.*, 2024). This highlights the challenge of sustaining behavioural change and the need for multi-channel communication strategies tailored to older adults and caregivers. Embedding prompts within EMRs and telehealth platforms (e.g. standing orders, e-reminders)

could raise adult immunisation coverage at low marginal cost.

Public-Private Partnerships and Innovation Ecosystems

Private sector participation is robust in the region's digital health ecosystem. Many platforms partner with ministries of health to deliver subsidised chronic-care services. Established platforms like Altibbi and Vezeeta have scaled teleconsultation services significantly. Altibbi, serving over 20 million unique monthly visitors, has conducted more than 5 million telehealth consultations across 14 regional countries (Zawya, 2022). Vezeeta partnered with the Egyptian Ministry of Health and Population during COVID-19 to provide free telehealth consultations for millions of Egyptians (Jackson, 2021). Vezeeta operates across Egypt, Saudi Arabia, Jordan and Lebanon, serving over 4.5 million patients and connecting more than 20,000 healthcare providers. Similarly, global medtech companies are investing in Middle Eastern markets by deploying AI-powered diagnostic tools, portable medical devices and connected healthcare technologies that support patient-centric care (BioSpectrum Asia, 2025). Collaborative innovation hubs support health tech entrepreneurs focused on digital transformation. The Mohammed Bin Rashid Innovation Fund (MBRIF), an AED 2 billion initiative by the UAE Ministry of Finance, provides government-backed credit guarantees and mentorship programs for high-potential innovators, lowering financial risk for start-ups and accelerating commercialisation of digital health solutions (UAE Government, 2024). In Saudi Arabia, Dammam Biotech Valley, led by CEO Abdulrahman Alolayan, focuses on biotechnology innovation with a strong emphasis on vaccine production, biologics, and healthcare technology solutions (Mahdi & Salloum, 2021). These platforms foster research, pilot programs, and commercialisation of technologies adapted to local needs and demographics. However, most Furthermore, standardised coding and insurance coverage for telehealth services in the UAE and Saudi Arabia ensure that digital services can be reimbursed, which is vital for commercial viability. The UAE has adopted Current Procedural initiatives remain concentrated in urban hubs such as Dubai, Riyadh and Cairo, raising questions about scalability and equitable access for older adults in rural or underserved regions. Targeted procurement (e.g. RPM kits bundled with data plans) and payer pilots can help shift from urban pilots to equitable regional deployment in respiratory care.

Policy Development and Regulatory Reform

To keep pace with innovation, Middle Eastern governments are evolving regulatory frameworks to support telehealth, AI deployment and remote diagnostics. Saudi Arabia has established comprehensive telemedicine regulations requiring all healthcare professionals to complete accredited training before practicing telemedicine, with the creation of the Saudi Telemedicine Unit of Excellence to regulate and monitor services (Bugis, S. 2019). The UAE has updated its federal telehealth regulations, with authorities implementing specific controls for remote medical consultations and new federal health regulations establishing stricter licensing requirements for healthcare professionals (Tithecott, A. 2023). Bahrain has been exploring agreements to connect with Saudi Arabia's Seha Virtual Hospital network, demonstrating regional collaboration in digital health services (Cheriyan, 2024). Saudi Arabia's Food and Drug Authority (SFDA) has established specific guidance for AI and machine learning-based medical devices, creating clearer pathways for manufacturers to obtain Medical Device Marketing Authorisation for digital health technologies (Sochacki and O'Connell, n.d.). The SFDA has published comprehensive requirements for AI-based medical devices that demonstrate accuracy in diagnosing or predicting diseases through medical big data analysis (Emergo by UL, 2021). These measures reduce regulatory uncertainty for innovators and investors, creating one of the more structured approval environments in the region.

Terminology (CPT) codes in Dubai and Abu Dhabi to support telehealth delivery solutions and enable reimbursement for remote care services . Additionally, Abu Dhabi has mandated that telemedicine must be included as a benefit in all

insurance products, with no co-payment required from members. Saudi Arabia has developed the Saudi Billing System (SBS), based on Australian coding classification, to create standardised billing mechanisms for health services in the insurance sector (WHX Insights, 2021; Sochacki, 2020). These financing reforms make digital respiratory solutions more commercially viable and sustainable, particularly when aligned with national transformation agendas. Next steps should prioritise reimbursement pathways for validated RPM and home-based pulmonary rehabilitation to translate policy into measurable reductions in admissions and length of stay.

Table 1: summarises cross-sector opportunities and key mitigation strategies for digital-respiratory-care scale-up in the Middle East.

Opportunity	Example	Risk	Mitigation	Value
Telehealth Scaling	*Seha Virtual Hospital (KSA)*	Unequal rural access	Mobile-based, low-bandwidth platforms	Access ↑, admissions ↓
RPM Adoption	*BioButton/BioSticker pilots (UAE)*	Low senior tech literacy	Caregiver-assisted use; simple interfaces	Earlier intervention, QoL ↑
AI Diagnostics	*CatBoost exacerbation prediction*	Data privacy & bias	Regional AI regulation; transparent models	Faster diagnosis, workload ↓
Smart Inhalers	*EU smart inhaler studies (20–30% adherence ↑)*	High device cost	Insurance reimbursement; subscription models	Adherence ↑, exacerbations ↓
Regional scaling of innovations	*GCC health market expansion*	Fragmented regulations across countries	Pilot in harmonised GCC hubs (Saudi, UAE), then expand via GCC frameworks	Encourages cross-border replication and standardisation
Integration with Records	*Malaffi (Abu Dhabi HIE)*	Interoperability gaps	Align with HIEs (Malaffi, Riayati)	Continuity of care, duplication ↓
Reimbursement Models	*Telehealth reimbursement reforms (KSA/UAE)*	Uncertain payer coverage	Local cost-effectiveness pilots	Sustainability; adoption ↑

Table 1. Opportunities, risks and mitigation strategies for scaling digital respiratory care in the Middle East. *Examples drawn from Seha Virtual Hospital (KSA), BioButton pilots (UAE), AI predictive modelling studies (Yin et al., 2024), and European smart inhaler trials (Chan et al., 2021). Mitigation strategies are adapted from regional digital transformation policies and WHO-EMRO recommendations to enhance interoperability, equity and reimbursement readiness.*

Market Outlook and Investment Opportunities

The digital health industry in the Middle East is undergoing rapid expansion, with telehealth services, mobile applications and remote monitoring solutions sustaining strong growth since the COVID-19 pandemic. According to market research, the broader Middle East digital health market was valued at approximately USD 10.93 billion in 2024 and is projected to grow at a compound annual growth rate of around 22.9% to reach USD 69.00 billion by 2033 (Grand View Research, 2024). This trajectory positions the region among the fastest-growing digital health markets globally. Telehealth is a dominant segment, bolstered by investments in virtual care infrastructure, government support and integration into chronic disease management. This growth is underpinned by widespread smartphone adoption, with penetration rates

surpassing 90% and near-universal internet access in several Gulf states (GO-Globe, 2024; Kemp, 2024). Public investment is a major catalyst, with Middle Eastern governments increasing healthcare budgets for digital transformation and supporting healthcare AI startups with funding grants, particularly in Saudi Arabia and the UAE. Saudi Arabia allocated over $50 billion in 2023 for initiatives including digital health services, while PwC forecasts that AI could contribute $320 billion to Middle East economies by 2030, with healthcare offering significant gains (Cheriyan, 2024). This level of public expenditure provides strong market signalling, giving confidence to private investors seeking scalable opportunities in respiratory care.

The projected expansion and investment distribution across digital-health sectors in the Middle East are illustrated in Figure 5.

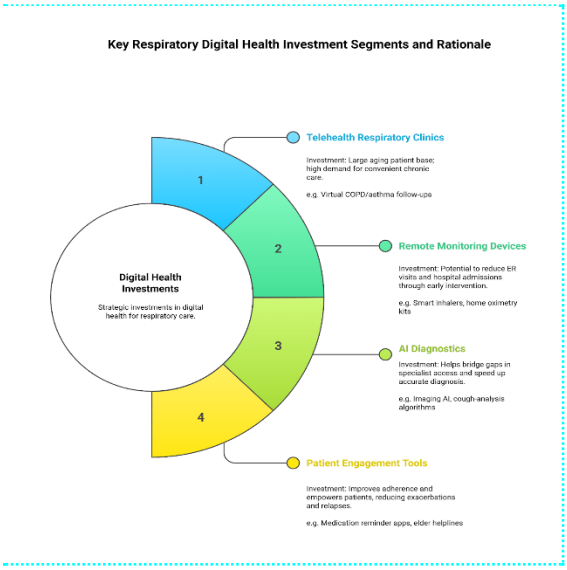

Figure 5. Strategic digital health investments for respiratory care. *The figure illustrates four priority areas: (1)* ***Telehealth respiratory clinics*** *to expand access for chronic care follow-ups; (2)* ***Remote monitoring devices*** *to enable early intervention and reduce hospital visits; (3)* ***AI diagnostics*** *to improve specialist access and diagnostic accuracy; and (4)* ***Patient engagement tools*** *to enhance adherence, empowerment, and relapse prevention.*

The healthcare system dedicates significant resources to managing chronic respiratory conditions, as older patients often require hospitalisation for conditions like COPD exacerbations and pneumonia. Consequently, paying entities, including governments and insurers are keen on innovative solutions that reduce admissions, shorten lengths of stay and improve disease management. Digital respiratory health solutions are particularly well placed to deliver these benefits. Evidence of cost savings at scale is encouraging payers to explore contracts with service providers, often based on enrolment fees or performance-linked outcomes. This creates promising opportunities in the smart respiratory device market, comprising connected inhalers, home ventilators with data transmission and advanced nebulizers, which is evolving from one-time hardware sales towards recurring subscription and service-based models.The region demonstrates strong investment potential, driven by rising healthcare expenditures and increasing capital inflows.

High Healthcare Expenditure

GCC countries have some of the highest per capita healthcare spending in the developing world. There is a strong willingness to pay for premium solutions, especially those that align with national visions for high-quality healthcare. Investors in respiratory healthtech can expect receptive government customers for pilot programs and large-scale deployments if outcomes are positive. According to Alpen Capital's 2025 report, current healthcare expenditure in the GCC is forecast to climb from $109.1 billion in 2024 to $159 billion by 2029, at a compound annual growth rate of 7.8%. This expansion is attributed to ongoing government investment, the growing and aging population, higher insurance coverage and sustained digital transformation, including AI and precision medicine (Alpen Capital, 2025). For respiratory care specifically, this upward expenditure trajectory creates sustained demand for cost-saving innovations.

Rising Venture Capital and Corporate Investments

Venture capital investment reached $2.6 billion in 2021, representing a 138% increase from 2020, with the healthtech sector emerging as the fourth most funded industry in the region (MAGNiTT, 2022). The MENA region raised $1.9 billion in funding during 2024, with investor confidence remaining strong as evidenced by a 20% increase in the number of active investors, signaling optimism for continued growth in 2025 (MAGNiTT, 2024). The healthtech sector has maintained its position as a key driver of this growth, benefiting from increased government support for digital health initiatives and rising demand for innovative healthcare solutions. Unlike many other emerging markets, MENA has defied global venture slowdown trends, sustained by sovereign wealth funds and renewed ecosystem momentum (MAGNiTT, 2025).

Corporate investments may include:

- Seed-stage startups developing digital respiratory tools, which hold significant promise for growth.
- Established pharmaceutical companies can also form partnerships with or acquire digital health solutions such as digital inhaler adherence platforms and patient education apps that support COPD medications. Integrating digital solutions enhances treatment results while providing additional value to their products.
- Insurance Providers and Government Payers represent a key market opportunity, since remote monitoring and AI-driven analytics solutions help lower hospital admissions and reduce healthcare costs for elderly populations. By integrating validated digital health interventions into pilot programs or reimbursement plans, these payers can realise significant cost savings while promoting healthier patient outcomes.
- Hospitals and clinics, which can benefit by adopting remote care models for respiratory conditions like COPD and pneumonia. These digital pathways would enable providers to broaden service offerings, improve patient care continuity, reduce readmissions and enhance emergency department efficiency using AI triage tools. Investors and stakeholders aligned with these trends can capitalise on a rapidly expanding digital respiratory care market in the Middle East, driven by increasing demand for affordable, accessible healthcare solutions.

Collectively, these dynamics position respiratory-focused digital health as one of the most attractive sub-segments for Middle Eastern health investment, reflecting a maturing ecosystem in which capital flows increasingly align with national health priorities and patient needs. This alignment sets the stage for analysing the economic returns and risk-mitigation strategies of implementing digital respiratory-care models.

Return on Investment and Risk Mitigation: Return on Investment (ROI) Potential

Digital respiratory health programs demonstrate compelling ROI potential through significant reductions in costly hospitalisations and improved patient outcomes. Clinical evidence shows that telemonitoring interventions can reduce COPD hospitalisations by over 20%, with systematic reviews reporting risk ratios of 0.72 across multiple randomised controlled trials (Ding *et al.* 2019). More targeted COPD-focused RPM interventions have reported reductions of up to 65% in unplanned hospitalisations per patient per year (Anderton, 2024), alongside improvements in health-related quality of life.

Economic analyses of RPM interventions demonstrate substantial cost savings, with studies showing up to 35% reductions in hospitalisation-related spending and per-patient costs dropping from $3,842 to $1,399 over three months (Isaranuwatchai *et al.*, 2018). Real-world deployments such as CareSignal's deviceless RPM programme reported 14x claims-based ROI and

$257 per member per month savings in COPD and heart failure patients (CareSignal, 2020).

For example, consider a hypothetical remote COPD monitoring initiative in Saudi Arabia:

- **Target population:** 1,000 senior COPD patients
- **Hospitalisation reduction:** 15% fewer admissions (due to early intervention via RPM)
- **Cost per admission:** ~SAR 12,000 (Saudi riyals) saved per avoided hospitalisation
- **Estimated annual savings:** ~SAR 1.8 million in hospital costs (from the 15% reduction)
- **Programme cost:** ~SAR 800,000 per year
- **Net ROI:** ~125% in the first year (cost savings vs. programme cost)

This scenario, informed by international COPD RPM evidence, highlights its potential relevance for Middle Eastern health systems. Beyond financial returns, remote monitoring and telehealth enable "ageing in place", fewer acute-care visits and better quality of life—critical priorities in the region's older population care agenda (Trualta, 2024). The alignment of economic and social benefits strengthens the case for adoption among policymakers, payers and investors. Ensuring that digital respiratory programmes are built on robust clinical evidence, integrated within existing health-system frameworks, and supported by active patient and caregiver engagement can help mitigate implementation risks.

Conclusion and Future Directions

The integration of digital health technologies is reshaping respiratory care in the Middle East, driven by the dual challenges of an ageing population and the increasing prevalence of COPD and pneumonia. Governments are spearheading this transformation with strategic initiatives such as Saudi Arabia's Vision 2030 and the UAE's National AI Strategy, which provide the policy foundation and infrastructure to scale these innovations. RPM and telemedicine have emerged as critical tools, enabling continuous patient oversight and remote consultations that enhance access to care while reducing hospitalisation rates. In parallel, AI and predictive analytics are being applied to refine diagnostics, forecast acute exacerbations and tailor treatment plans.

Notably, emerging AI-based solutions that analyse respiratory sounds and vocal biomarkers could support early detection and triage, offering non-invasive and scalable approaches.

Despite this progress, significant challenges remain. Data privacy and digital literacy barriers, particularly among older adults, must be addressed. Going forward, tackling the broader social determinants of health will be essential, alongside continued investment in digital infrastructure, robust regulatory frameworks, and focused research. The overarching goal is not only to improve clinical outcomes and system efficiency but also to empower older adults with greater autonomy and dignity in managing their conditions. With sustained innovation, the region is well positioned to meet global standards in digital respiratory health and deliver more inclusive, connected care for its growing ageing population. Future research should prioritise longitudinal evaluations of digital respiratory-care initiatives and assess their impact on health outcomes, equity and system sustainability across Middle Eastern ageing populations.

Acknowledgements

The authors would like to thank Julie Rieder and Harrison Kipper for their careful proofreading and valuable feedback. Their contributions helped enhance the clarity and precision of this work.

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