

Review

Implementing Digital Respiratory Technologies for People With Respiratory Conditions: Scoping Review

Io Chi-Yan Hui¹, PhD, CEng; Kathleena Condon², MPH; Shailesh Kolekar³, MBBS, MD; Nicola J Roberts⁴, PhD; Katherina Bernadette Sreter⁵, MD, PhD; Sami O Simons⁶, MD, PhD; Carlos Figueiredo⁷, MD; Zoe McKeough⁸, BAppSc(Physio), PhD; Hani Salim⁹, PhD; Aleksandra Gawlik-Lipinski¹⁰, MSc; Apolline Gonsard¹¹, MD; Ayşe Önal Aral¹², MD; Anna Vanoverschelde¹³, PhD, PharmD; Matthew Armstrong¹⁴, PhD; Dario Kohlbrenner¹⁵, PhD; Cátia Paixão¹⁶, PhD; Patrick Staffler¹⁷, MD; Efthymia Papadopoulou¹⁸, MD; Adrian Paul Jaravata Rabe¹⁹, MD; Milan Mohammad²⁰, MD; Izolde Bouloukaki²¹, PhD; Shirley Quach²², PhD, RRT; Georgios Kaltsakas²³, PhD; Kate Loveys²⁴, PhD; Tonje Reier-Nilsen²⁵, MD, PhD; Anthony Paulo Sunjaya²⁶, MD, PhD; Paul Robinson², PhD; Michaela Senek²⁷, PhD, MPH; Amy Hai Yan Chan²⁸, BPharm(Hons), PhD; Hilary Pinnock¹, MBChB, MD

¹School of Population Health Sciences, Usher Institute, The University of Edinburgh, Edinburgh, United Kingdom

²Faculty of Health, Medicine and Behavioural Sciences, University of Queensland, Brisbane, Queensland, Australia

³Department of Medicine Helsingborg Hospital, Lund University, Region Skane, Sweden

⁴School of Health and Social Care, Edinburgh Napier University, Edinburgh, United Kingdom

⁵Department of Pulmonology, University Hospital Centre "Sestre Milosrdnice", Zagreb, Croatia

⁶NUTRIM Institute for Nutrition and Translational Research in Metabolism, Faculty of Health, Medicine and Life Sciences, Maastricht University Medical Center+, Maastricht, The Netherlands

⁷Hospital Santa Marta, ULS São José, Lisboa, Portugal

⁸Sydney School of Health Sciences, University of Sydney, Sydney, NSW, Australia

⁹Department of Family Medicine, Universiti Putra Malaysia, Serdang, Selangor, Malaysia

¹⁰Department of Respiratory Sciences, University of Leicester, Leicester, United Kingdom

¹¹University Hospital Necker-Enfants Malades, AP-HP, Paris, France

¹²Pulmonary Diseases Clinic, Ankara Gölbaşı State Hospital, Gölbaşı/Ankara, Turkey

¹³General Hospital Zeno, Knokke-Heist, Belgium

¹⁴Department of Sport and Exercise Sciences, University of Durham, Durham, United Kingdom

¹⁵Epidemiology, Biostatistics, and Prevention Institute, University of Zurich, Zurich, Switzerland

¹⁶Respiratory Research and Rehabilitation Laboratory (Lab3R), School of Health Sciences (ESSUA) and Institute of Biomedicine (iBiMED), University of Aveiro, Aveiro, Portugal

¹⁷Schneider Children's Medical Center of Israel and Gray Faculty of Life Sciences, Tel Aviv University, Petah Tikva, Israel

¹⁸Department of Respiratory Failure, G. Papanikolaou General Hospital of Thessaloniki, Thessaloniki, Greece

¹⁹School of Public Health, Imperial College London, London, United Kingdom

²⁰Centre for Physical Activity Research, Copenhagen University Hospital, Copenhagen, Hovedstaden, Denmark

²¹Department of Social Medicine, School of Medicine, University of Crete, Heraklion, Crete, Greece

²²School of Rehabilitation Sciences, Faculty of Health Sciences, McMaster University, Hamilton, ON, Canada

²³Centre for Human & Applied Physiological Sciences, King's College London, London, United Kingdom

²⁴Department of Paediatrics: Child and Youth Health, School of Medicine, the University of Auckland, Auckland, New Zealand

²⁵Oslo Sports Trauma Research Center, Institute of Sports Medicine, Norwegian School of Sport Sciences, Oslo, Norway

²⁶School of Population Health, University of New South Wales, Sydney, NSW, Australia

²⁷School of Medicine & Population Health, University of Sheffield, Sheffield, United Kingdom

²⁸School of Pharmacy, The University of Auckland, Auckland, New Zealand

Corresponding Author:

Hilary Pinnock, MBChB, MD

School of Population Health Sciences

Usher Institute, The University of Edinburgh

5 Little France Rd

Edinburgh EH16 4UX

United Kingdom

Phone: 44 0131 651 7869

Email: hilary.pinnock@ed.ac.uk

Abstract

Background: Digital health offers opportunities for safe, equitable, and accessible care, and its integration into respiratory care is a strategic priority for the European Respiratory Society. However, sustainable implementation remains complex, and guidance for health care systems is limited.

Objective: This study aimed to undertake a scoping review of the published initiatives that have implemented digital respiratory technologies into real-world routine clinical practice over the past decade, identify the technologies used, implementation strategies used, the challenges and supports they encountered, and the lessons they reported for making care more equitable, strengthening patient-professional relationships, improving the patient journey, and reducing environmental impact.

Methods: Following Arksey and O'Malley's methodology, we searched ten databases (December 2013-2023 [updated April 2025 and February 2026]): MEDLINE, Embase, CINAHL, PsycINFO, Cochrane Library, Web of Science, Scopus, IEEE Xplore, CABI Global Health, and WHO Medicus; and used key domains in the commonly used implementation frameworks such as the Consolidated Framework for Implementation Research (CFIR), Nonadaptation, Abandonment, and Challenges to the Scale-up, Spread, and Sustainability of Health and Care Technologies (NASSS), and the Reach, Effectiveness, Adoption, Implementation, and Maintenance (RE-AIM) framework to categorize results and understand methodologies used. As a scoping review, we mapped the available evidence, rather than synthesizing outcomes, appraising study quality, or estimating effectiveness. To broaden coverage and strengthen interpretation, we crowdsourced additional studies and sought feedback on our preliminary findings from a network of respiratory experts across 17 countries.

Results: Overall, 24,672 studies were identified; after deduplication, 14,811 were screened; 84 studies from 31 countries were included in the final review. The digital respiratory technologies comprised apps, platforms, chatbots, and smart devices. Reported technological functionalities encompassed remote consultation, clinician monitoring, video directly observed therapy, remote rehabilitation training, self-management support, education, monitoring medication adherence, and a school-based remote clinic. CFIR, RE-AIM, and the plan-do-study-act (PDSA) cycle were the most widely used frameworks. Successful implementation used simple technologies that fitted existing workflows and avoided additional workload. Co-development and trust-building with end-users influenced motivation and adoption, while leadership, team cohesion, and communication facilitated success. Barriers included insufficient resources, poor interoperability, lack of funding and reimbursement, and limited technical support.

Conclusions: This scoping review provides a cross-condition review of digital respiratory technologies implemented in routine clinical practice. Unlike previous disease-specific or experimental-focused reviews, our innovative approach used established implementation Theories, Models, and Frameworks (TMFs) to identify shared barriers and enablers across diverse populations and health care systems. We summarize key implementation domains in state-of-the-art digital respiratory care and identify major gaps related to health equity, patient-clinician trust, continuity of support, and environmental sustainability. These findings emphasize the value of using implementation TMFs for scaling effective, patient-centered digital respiratory care in real-world settings.

International Registered Report Identifier (IRRID): RR2-10.1371/journal.pone.0314914

J Med Internet Res 2026;28:e88325; doi: [10.2196/88325](https://doi.org/10.2196/88325)

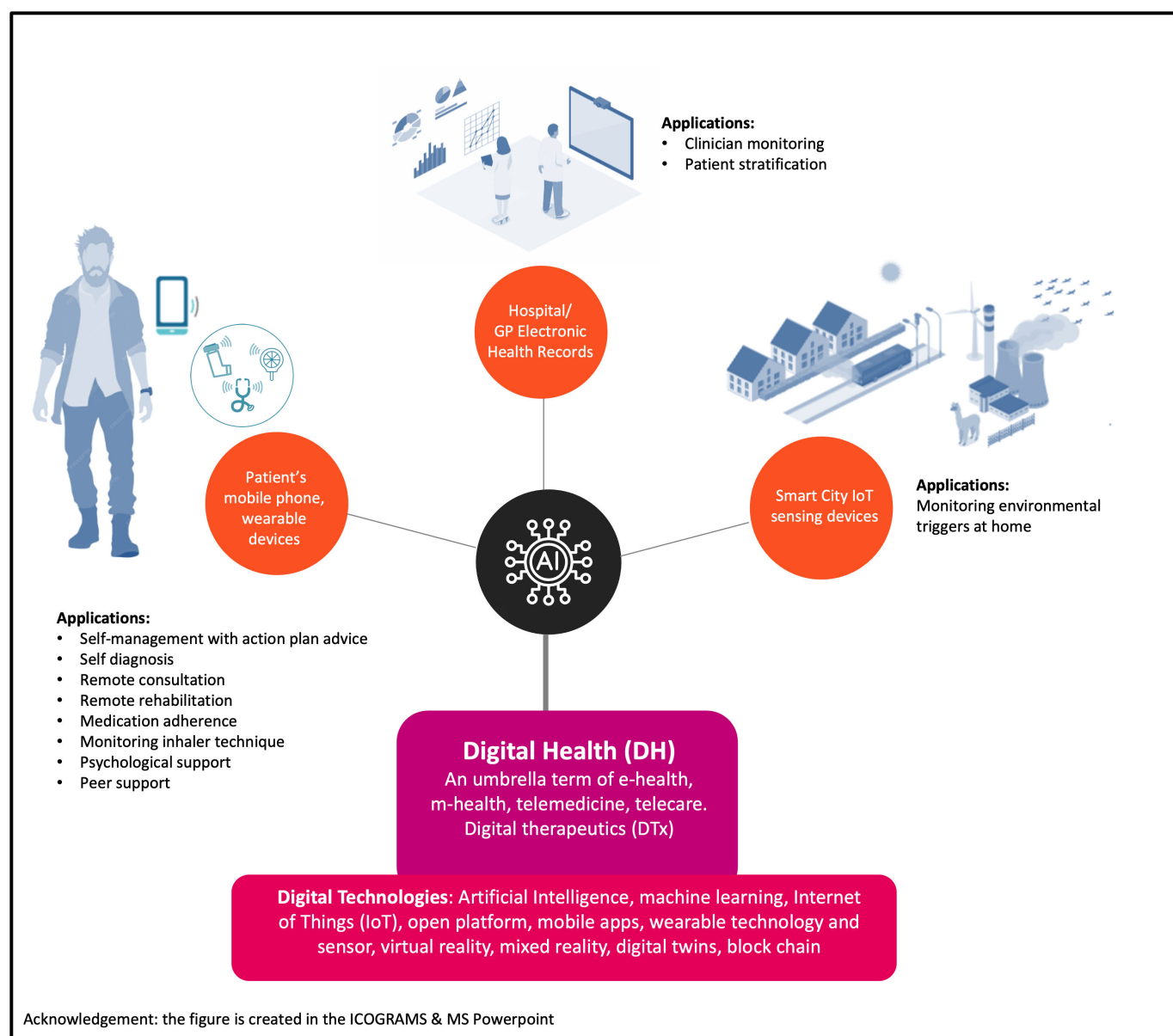
Keywords: digital health; respiratory; artificial intelligence; implementation; review

Introduction

Chronic respiratory diseases affect more than 545 million people worldwide, have a significant impact on individuals' quality of life, and are a major burden to health care systems [1]. Digital health tools that can contribute to regular monitoring of respiratory conditions are prone to exacerbation and support better health outcomes by enabling timely interventions. Conventionally, telemedicine, telecare, e-health, and mobile health have been defined as the use of electronic means, such as information and communication technologies, or mobile devices and remote sensors, to deliver health services [2,3]. Digital therapeutics are "interventions that are driven by high-quality software programs to treat, manage, or prevent a disease or disorder" [4]. Digital respiratory health is an umbrella term for all

these modalities, potentially incorporating artificial intelligence (AI), to support routine respiratory care [5] (Figure 1). Apps, platforms, and smart wearable or portable devices can be interconnected to support diagnosis, underpin personalized medicine, and enable self-management. Real-time video facilitates clinician-supervised remote rehabilitation by enabling health care professionals to guide patients through prescribed exercises within their homes [6]. It also allows clinicians to directly observe patients' medication adherence and inhaler technique, thereby supporting more accurate assessment and timely intervention. By integrating environmental data and using AI as the "brain," the system can advise on actions to prevent exacerbations and hospitalizations. Routine data collected from these tools aids interpretation of medical images and public health decisions [7].

Figure 1. Digital respiratory health landscape. Image created using ICOGRAMS EDUCATION, under CC-BY license [8,9]. AI: artificial intelligence; GP: general practitioner.



The global COVID-19 pandemic accelerated adoption of digital health technologies, enabling rapid deployment potential [5-7]. However, integrating digital health technologies into routine care is complex. Short-term success does not guarantee long-term sustainability. To address this challenge, implementation Theories, Models, and Frameworks (TMFs) were developed. They provide considerations (“domains”) and a systematic approach to guide planning and evaluation of the digitization process, helping organizations to identify barriers and facilitators for successful implementation. They also share similar descriptions of the domains, but terminologies vary. Widely used TMFs are Consolidated Framework for Implementation Research (CFIR), Nonadaptation, Abandonment, and Challenges to the Scale-up, Spread, and Sustainability of Health and Care Technologies (NASSS), Reach, Effectiveness, Adoption, Implementation, and Maintenance (RE-AIM), Exploration, Preparation, Implementation, and Sustainment (EPIS), Unified Theory

of Acceptance and Use of Technology (UTAUT), Technology Acceptance Model (TAM), and Theoretical Domains Framework [10]. CFIR and NASSS framework are determinant frameworks that delineate categories and specific domains that function as either barriers or facilitators, thereby influencing the outcomes of implementation processes [11, 12]. RE-AIM is an evaluation framework that provides specific aspects of domains that can be evaluated to determine the success of an implementation [13]. EPIS is a process model and determinant framework that outlines the domains and sequential steps involved in translating interventions into routine practice [14]. UTAUT and TAM are technology-focused models. They conceptualize technology adoption as domains of perceived usefulness and perceived ease of use [15,16]. The UTAUT extends this foundation by integrating 8 prior acceptance frameworks and identifying 4 primary determinants—performance expectancy, effort expectancy, social influence, and facilitating conditions—moderated by

user characteristics such as age and experience. Theoretical domains framework is a classic theory that can be applied to enhance understanding and/or explanation of various aspects of implementation [17]. Of these well-known implementation TMFs, CFIR is the most frequently used TMF. CFIR, NASSS, and RE-AIM are more widely used TMFs as they are relatively comprehensive, covering at least 2 phases of implementation (planning, early implementation, and late implementation) [18]. Despite the similarity in the coverage of the domains, the language and glossary are not standardized. Lack of harmonization of domains across borders and sectors [19] obstructs the digital transformation of health care, preventing it from providing safe, fair, and accessible care for everyone [20].

The World Health Organization (WHO) considers digital transformation to be essential for achieving universal health coverage, the EU (European Union) endorses implementation of technological advances to improve patient outcomes and promote patient-centered care, and adoption of digital health is a strategic priority for the European Respiratory Society (ERS) [21,22]. However, only a minority of digital health studies progress beyond the pilot or local intervention stage [23], and harmonization across borders and sectors is rare [19], with the welcome exception of the European Health Data Space, which has been greeted by the ERS as an opportunity to push forward health care, research, and policymaking [24,25].

Digital respiratory technologies are increasingly being adopted across a wide range of respiratory conditions and in diverse health systems. Exploring and adapting to clinical and socioeconomic context is crucial for successful local implementation, though shared barriers and enablers can provide useful learnings that help shape the feasibility and uptake of digital interventions [1,4]. Adopting a global perspective enables the learnings from successful implementation efforts to inform less developed technological initiatives. Using TMFs can support this process by ensuring the challenges are comprehensively considered; this is the underlying rationale for this global scoping review.

The CONNECT Clinical Research Collaboration (CRC) was launched by the ERS in 2023 with the goal of addressing the overarching challenges of whole systems implementation of respiratory digital health care. The core, overarching objective of CONNECT is to bridge the gap between existing disease- or location-focused digital respiratory health initiatives and sustainable, equitable, connected implementation into clinical respiratory practice in diverse health care systems [26]. CONNECT has 5 objectives, one of which focuses on systematically reviewing existing digital respiratory health care embedded in routine clinical practice. In this scoping review (WPIII), we explored published initiatives that integrated and implemented digital respiratory technologies into routine clinical workflows. Our objectives were to scope and describe:

1. Characteristics of respiratory digital health initiatives implemented in routine clinical practice in the last 10 years.

2. TMFs are used to develop and evaluate the implementation strategies.
3. Barriers and enablers to implementation.

Insights relevant to reducing inequity, enhancing patient and professional relationships, supporting the patient journey, and reducing adverse environmental impact.

Methods

Overview

We followed Arksey and O'Malley's methodology for scoping reviews [27] and used Covidence software to manage the review process, including to de-duplicate the studies [28]. We used the PRISMA-ScR (Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews) to guide reporting [29] and PRISMA-S to report the review methodologies and findings [30].

Published Protocol

Detailed methodology is described below with additional details available in our published protocol [31]. There were no deviations from the protocol.

Information Sources

We included ten databases (MEDLINE, Embase, CINAHL, PsycINFO, Cochrane Library, Web of Science, Scopus, IEEE Xplore, CABI Global Health, and WHO Medicus). We browsed reference lists manually with forward searches on included studies using the International Statistical Institute Proceedings. To ensure robust representation of research from low- and middle-income countries, we incorporated the low- and middle-income country (LMIC)-focused databases CABI Global Health and WHO Medicus. In addition, we consulted 28 colleagues in the CONNECT group to identify the missing studies in their networks (see Peer Review and consultation exercise section below for details).

Search Strategy

The search strategy was newly developed for this review to reflect its defined scope and objectives. We developed this search strategy with the Academic Support Librarian at the University of Edinburgh, used the key search terms of “respiratory condition” AND “digital technology” AND “implementation” to search ten databases over a 10-year period from December 12, 2013, to December 12, 2023 (update search performed on April 4, 2025, and February 7, 2026). Given the substantial number of studies, we applied a time limit filter to capture only those falling within the defined search window. In the update searches, we re-ran the same search terms and methods during the update search to identify the newly published studies. See [Multimedia Appendix 1](#) for detailed search strategy.

Eligibility Criteria

We included any digital health intervention implemented to support routine patient care. Patient care included but was not limited to digital support for diagnosis, self-management,

monitoring, medication adherence and compliance, education, psychological support, social support, remote consultation, or health professional-facing interventions. For example, a decision support system that was designed to support delivery of care was included, but an administrative system for scheduling appointments would be excluded.

Implementation studies are not always accurately indexed, so we defined the key features of “implementation” to guide the selection process.

The inclusion and exclusion criteria are outlined in [Table 1](#). See [Multimedia Appendix 2](#) and our published protocol [24] for further details of the criteria and definitions.

Table 1. Inclusion and exclusion criteria.

Criterion	Definition	Operationalization and examples
Inclusion criteria		
Population	Patients with any respiratory conditions (short or long-term) of all ages	Where there was doubt about whether a condition was “respiratory,” we included those conditions covered by the Assemblies and Groups of the ERS ^a
Intervention	The intervention should be delivered within the existing service and available to all clinically-eligible individuals (specifically not only to people who consent to the research)	Existing staff may be upskilled for the purpose, but interventions that require additional staff or resources for day-to-day delivery are unlikely to be sustained beyond the end of the project and were therefore excluded
Setting	Any health care setting was eligible	— ^b
Comparator	Typically usual care	Many studies used before-and-after observational designs
Outcomes	Outcomes should reflect the uptake and impact of the intervention within the population	for example, using routine data
Duration:	Any duration	We did not specify a duration for the evaluation, but only included studies in which the intervention was (or was intended to be) embedded for the long term in routine care
Study design	All study types	No geographical or language restrictions
Location	Any location	We did not exclude by language. CONNECT is a global network with members fluent in most major languages
Exclusion criteria		
Administrative only	Digital health interventions that did not directly involve patient care	for example, interventions such as workflow management, appointments, or triage systems with exclusively administrative purposes
Education	Health professional education	for example, online conferences and online courses
Pandemic management	Population-level COVID-19 initiatives, such as contact tracing or vaccination programs	COVID-19 was considered as a respiratory condition when studies focused on individual-level care, such as hospital-at-home programs or management of COVID-19 in people with chronic respiratory disease
Effectiveness research	Randomized controlled trials conducted to test the effectiveness of the intervention	for example, those requiring participant consent process to individual randomization) were excluded as our interest is in implementation in routine clinical care
Research types		
Conference abstracts	Potentially relevant abstracts were tagged and monitored for subsequent publications.	—
Review articles	Reviews and other relevant papers that did not meet inclusion criteria were retained for background reading and reference checking	—
Gray literature	We did not search for gray literature	—

^aERS: European Respiratory Society.

^bNot applicable.

Selection Process

This review was conducted by twenty-seven volunteers from the ERS CONNECT CRC, with a few hours funded by CONNECT for a post-doctoral researcher (ICYH) to provide training, oversight, and ensure quality control. Independent duplicate screening was carried out by the trained volunteers, with disagreements resolved by ICYH, AHYC, and HP in discussion with the 6 volunteers (ZM, AOA, NJR, KBS, SOS, and CF) who reviewed most studies (see protocol for further description of this process [31]). Divergent interpretations (eg, of implementation-related concepts, and which exclusion criterion took precedence) were clarified in discussion, and we subsequently achieved 100% agreement.

Data Charting, Extraction, and Data Items

Using a similar model of selected volunteers (AOA, SOS, SK, and CF) overseen by the lead author (ICYH, with AC and HP), data extraction was conducted in duplicate, with a final check on accuracy by ICYH. Data extraction was completed using a piloted, refined data extraction sheet with headings reflecting the four objectives (see [Multimedia Appendix 3](#) for the full data extraction table).

Collating, Summarising and Reporting the Results

We used a PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) diagram to report the selection process [29,30] and collated a narrative summary of qualitative data with charted results from the quantitative data to address the review objectives:

- Objective 1: we used a bubble plot of the technology components and their associated respiratory conditions to visualize the features integrated into digital health initiatives across various respiratory conditions.
- Objective 2: we identified the commonly used frameworks (see description in the introduction) and their usage in different countries and income groups. Initially, we used NASSS domains (Condition Complexities, Technology, Value Proposition, Adopters, Organization, Wider System, Embedding, and Adaptation Over Time) to categorize reporting, subsequently integrating features from CFIR and RE-AIM to develop an enriched model that comprehensively captures the complex dynamics influencing the implementation of digital technology within routine clinical practice.
- Objectives 3 and 4: we used narrative synthesis to categorize the implementation barriers and enablers identified by the authors, and their insights related to health inequities, patient–professional relationships, patient care pathways, and environmental impacts.

Peer Review and Consultation Exercise

We engaged with colleagues from the CONNECT CRC collaboration from the outset and maintained ongoing interaction throughout the review process. This group includes academic researchers, clinicians with experience in implementing digital respiratory health technologies, and

collaborators with technological expertise. Representing 17 countries across both high-income and low- and middle-income settings, 28 colleagues provided diverse perspectives on the review process. We conducted online workshops at key stages of the review.

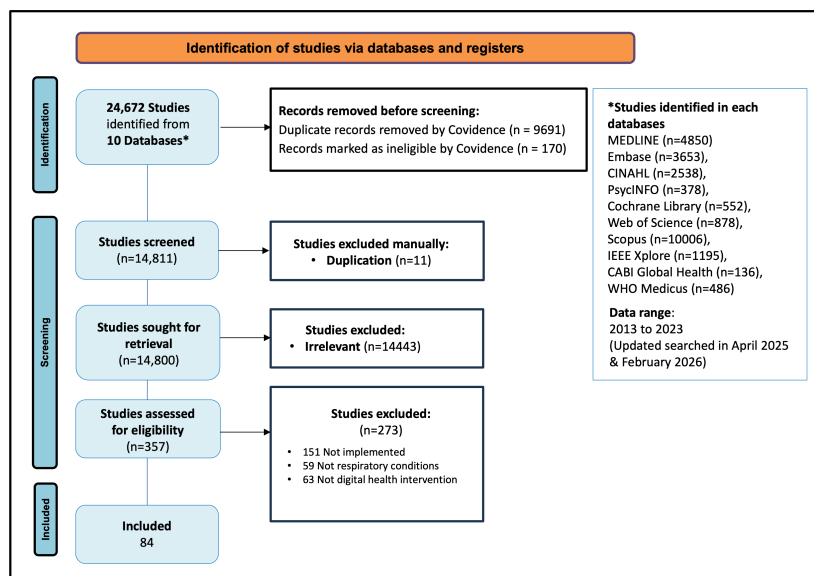
- Beginning of the review: to explore topical themes and practical challenges and refine research questions.
- Title and abstract, full text screening stages: to fine-tune the inclusion criteria, exclusion criteria, and discuss selection conflicts, crowdsourced potential studies to identify gaps in the included studies and suggest additional papers for consideration.
- Data charting and collation stages: we recorded a short video summarizing preliminary findings and used an online memo board to gather asynchronous feedback, facilitating engagement across different time zones. The feedback was collected in parallel with the discussions after our abstract presentation at the ERS Congress to finalize the findings and the practical interpretation.

Results

Overview

Figure 2 is the PRISMA-ScR flow diagram. A total of 24,672 records were identified. After removal of duplicates, the titles and abstracts of 14,800 records were screened. Of these, 14,443 records were excluded, primarily because they focused exclusively on COVID-19 without examining an underlying respiratory condition (eg, chronic obstructive pulmonary disease [COPD] or asthma), or because they were conference abstracts, systematic reviews, or scoping reviews. Reviews were retained at the search stage rather than filtered automatically to ensure that conclusions of relevant reviews could be considered when interpreting and comparing results.

Figure 2. PRISMA-ScR (Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for scoping reviews) flow diagram.



A total of 357 full-text articles were assessed for eligibility. Following full-text screening, 273 articles were excluded. The most common reasons for exclusion of full-text papers were lack of implementation in routine care (n=151; 55%),

no inclusion of respiratory patients (n=59, 22%), or initiatives focused on administrative systems for management, or clinicians rather than providing patient care (n=63, 23%). A total of 84 studies [32-115] met the eligibility criteria and were included in the review.

Study Characteristics (Objective 1)

Characteristics of the 84 included digital respiratory initiatives are described below, summarized in Table 2, and detailed in Multimedia Appendix 3 [32-115].

Table 2. Characteristics of the included studies.

Characteristics of the Included Program (n=84)	
Conditions	No of program (n=84), n (%)
Asthma, asthma, and AR ^a	18 (21)
COPD ^b , COPD and ILD ^c , COPD and HF ^d	23 (27)
Cystic fibrosis	6 (7)
Lung cancer	8 (10)
Lung transplant	3 (4)
Sleep-related breathing disorders	3 (4)
Tuberculosis (TB)/HIV	10 (12)
Multiple respiratory conditions	13 (15)
Year	
Pre-COVID-19	47 (56)
During COVID-19	32 (38)
Post-COVID-19	5 (6)
Participant age	
Adult (16 years or older)	61 (73)
Pediatric (younger than 16 years)	14 (17)
All ages	9 (11)
Countries	
High-income countries (IHCs)	71 (85)
Low and middle-income countries (LMICs)	7 (8)
Rural, low-resourced regions	6 (7)
Implementation scale	
Country	20 (24)
Regional	33 (39)
Service	31 (37)

^aAR: allergic rhinitis.

^bCOPD: chronic obstructive pulmonary disease.

^cILD: interstitial lung disease.

^dHF: heart failure.

Participants

The initiatives provided care services for pediatric (n=14; 17%) and adult (n=61; 73%) patients, or both (n=9; 11%). They mostly targeted specific respiratory conditions, but 15% (13/84) included multiple conditions. Age ranges reflected different disease profiles, with interventions for asthma [32-49] and cystic fibrosis including children [73-78]; while COPD [50-72], lung cancer [79-86], lung transplant [87-89], and sleep-related breathing disorders targeted older adults [90-92]. Tuberculosis or multiple respiratory conditions involved all age groups [93-115].

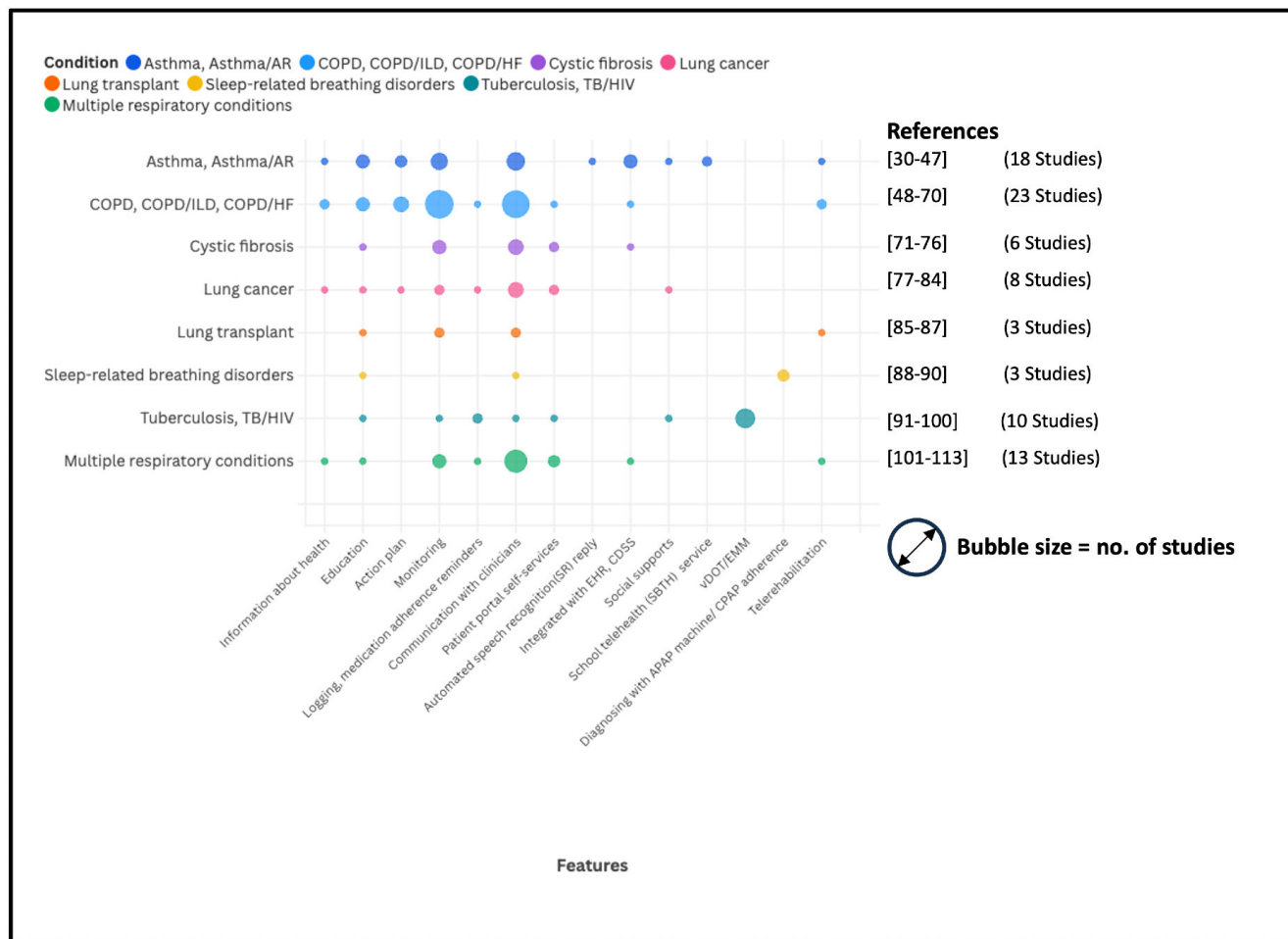
Interventions

Features of the mobile apps, digital platforms, and monitoring devices are shown in Figure 3.

Most commonly, clinicians used an app, either alone or connected with multiple monitoring devices (n=36; 42%), videoconference, SMS, phone communication features for health coaching, follow-up consultations, discussing action plans, triage, and escalating care to other providers (n=48; 57%). Four specific categories of applications were identified:

1. Video directly observed therapy for remote monitoring of adherence to tuberculosis medication [93,95-98,101,102].
2. Diagnosis of sleep apnea and home monitoring of continuous positive airway pressure therapy [90-92].
3. Virtual rehabilitation is used to provide remote exercise training for respiratory conditions at home or community settings [46,50,68,89,111].
4. School-based telemedicine services to provide care for children with asthma in rural areas [37,41].

Figure 3. Bubble plot of the technology features and their associated respiratory conditions [32-115]. APAP: automatic positive airway pressure; AR: allergic rhinitis; CDSS: clinical decision support system; COPD: chronic obstructive pulmonary disease; CPAP: continuous positive airway pressure; EHR: electronic health record; HF: heart failure; ILD: interstitial lung disease; EMM: electronic medication monitor; vDOT: video directly observed therapy.



Setting for the Technology Service

Most initiatives (n=64; 76%) were implemented within individual services (hospitals, GP clinics, and community centers) or regional clusters. Country-wide initiatives (n=20; 24%) included one application that was deployed in 22 countries. Of the 84 initiatives, most were deployed outside the EU region, including 36% (n=30) from the United States and 32% (n=27) from other countries such as Australia, Japan, Canada, China, India, Russia, South Africa, South Korea, and Singapore. Only 32% (n=27) originated from the EU.

Methodology

Of the 84 studies, 81% (n=68) [33,34,36-39,41-46,49,50,52,54,56-72,80,81,84-91,93-107,111-115] were service evaluations using pre- and poststudy designs, longitudinal observational, interrupted time-series, participatory action, or case study methodology, 19% (n=16) [32,35,40,47,48,51,53,55,73,79,82,83,92,108-110] studies were a narrative summary of their implementation experiences and learning. Overall, 38% (n=32) [37,42,43,46,47,51,56-60,64,67-71,73,75-77,84-86,91,94-97,99,100,105] used interviews with patient and professional stakeholders to explore the implementation process.

Outcomes

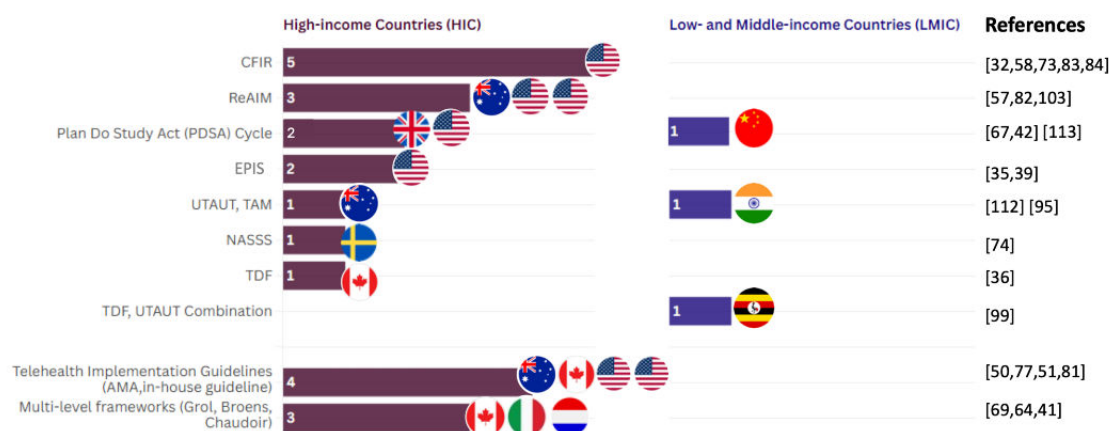
We did not synthesize outcomes or summarize effectiveness, as scoping review methodology is designed to map the available evidence rather than evaluate study quality or determine effectiveness. Overall, 50 studies reported clinical outcomes [32-34,36,39,45-54,56,57,59,61-65,71,72,74,77,78,81,87,89-96,98,99,101-106,109-111,113-115], with each study assessing between one and four outcomes. Of these, health care service quality-related outcomes were reported in more than half of the initiatives (n=35; 42%), followed by prescribing or treatment adherence (n=18; 21%), and health-related outcomes, including respiratory-specific outcomes such as disease control and exacerbations, quality of life, and the mental health benefits (n=6; 7%).

Two initiatives used real-world observational data from an app to explore correlations between treatment usage and asthma control [49] or risk of needing care escalation [52].

Use of Implementation Theories, Models, and Frameworks (TMFs; Objective 2)

Of the 84 initiatives, 30% (n=25; and all the 18 country-level evaluations) used one or more TMF to guide development or evaluation (Figure 4).

Figure 4. Implementation theories, models, and frameworks (TMFs) used by the high-income and low middle-income countries [34,37,38,41,43,44,52,53,59,60,66,69,71,75,76,79,83-86,97,101,105,114,115]. AMA: American Medical Association; CFIR: Consolidated Framework for Implementation Research; EPIS: Exploration, Preparation, Implementation, and Sustainment framework; NASSS: Nonadoption, abandonment, scale-up, spread, and sustainability framework; ReAIM: Reach, Effectiveness, Adoption, Implementation, and Maintenance framework; TAM: Technology Acceptance Model; TDF: Theoretical Domains Framework; TMF: Theories, Models, and Framework; UTAUT: Unified Theory of Acceptance and Use of Technology.



The remaining 70% (n=59) of studies did not report using an implementation framework or describe their approach to initiative development. The most commonly used frameworks were CFIR (n=5; 20%) [34,60,75,85,86], RE-AIM (n=3; 12%) [59,84,105], and the plan-do-study-act (PDSA) cycle (n=3; 12%) [44,69,115]. Of the initiatives that used TMF, three were from the LMICs (China, India, Uganda). Seven service- and regional-level initiatives used a range of guidelines and multilevel models [43,52,53,66,71,79,83] to observe the digitization process. Typically, they focused on the benefits of an agile approach that incorporated feedback from patients and clinical staff.

Common Implementation Domains

Of the 7 interconnected implementation domains from the NASSS, 6 were addressed frequently; they were “condition complexities,” “technology,” “value proposition,” “adopters,” “organization,” and “wider system” (Table 3). Only “embedding and adoption over time” was not explicitly reported in the included studies, though the need to incorporate long-term monitoring was mentioned.

Table 3. Common implementation domains.

Commonly reported implementation domains (n=84)	n (%)
Technology	
Integration (vendor partnerships, use of existing infrastructure, and interoperability)	36 (42.9)
System accuracy and reliability, security and privacy, confidentiality	11 (13.4)
User-friendly interface and features	6 (7.1)
Development supported by evidence	2 (2.4)
Value proposition	
Values to end users (cost, COVID-19 emergency, and service advancement)	29 (35.4)
Adopters	
Acceptability and satisfaction	38 (45.2)
Adoption, usability, and adherence rate	39 (47.6)
Co-develop with end users	13 (15.9)
Motivation, perceptions from end users	12 (14.6)
Technical support and devices to patients	11 (13.4)
Self-efficacy, knowledge	5 (6.1)
Identify early adopters	4 (4.9)
Staff willingness and organizational readiness to change	4 (4.9)
Trust from end users	2 (2.4)
Organization	
Staff training, supports, and extra workload due to implementation	26 (31)
Develop interprofessional team and workflow	26 (31)

Commonly reported implementation domains (n=84)	n (%)
Use opinion leaders, subject matter expertise, advisory boards, workgroups	10 (12.2)
Procurement processes, supply chain, device logistics	3 (3.7)
Wider system	
Reimbursement, insurance, and funding	16 (19)
Policy, social benefits, guideline compliance, "tech push" as driver for implementation	14 (17.1)

Within the widely reported domain of "condition complexities," examples were both organizational (the rapid transition and unprecedented strain on health care systems of the COVID-19 pandemic [87] as well as incomplete registries in lung cancer [82,84]). Features of specific clinical contexts included multimorbidity in COPD [68], poor adherence in asthma [33,34,42], tuberculosis [93-102], and obstructive sleep apnea [90-92], as well as the high degree of disciplined self-care required in cystic fibrosis [76]. Technology domains such as choosing in-house development or a proprietary solution, or integration with the electronic health record were mostly considered in the development phases. Value proposition domains were described as the incentive for launching the initiative. Adoption and organizational factors were influenced by inter-relationships,

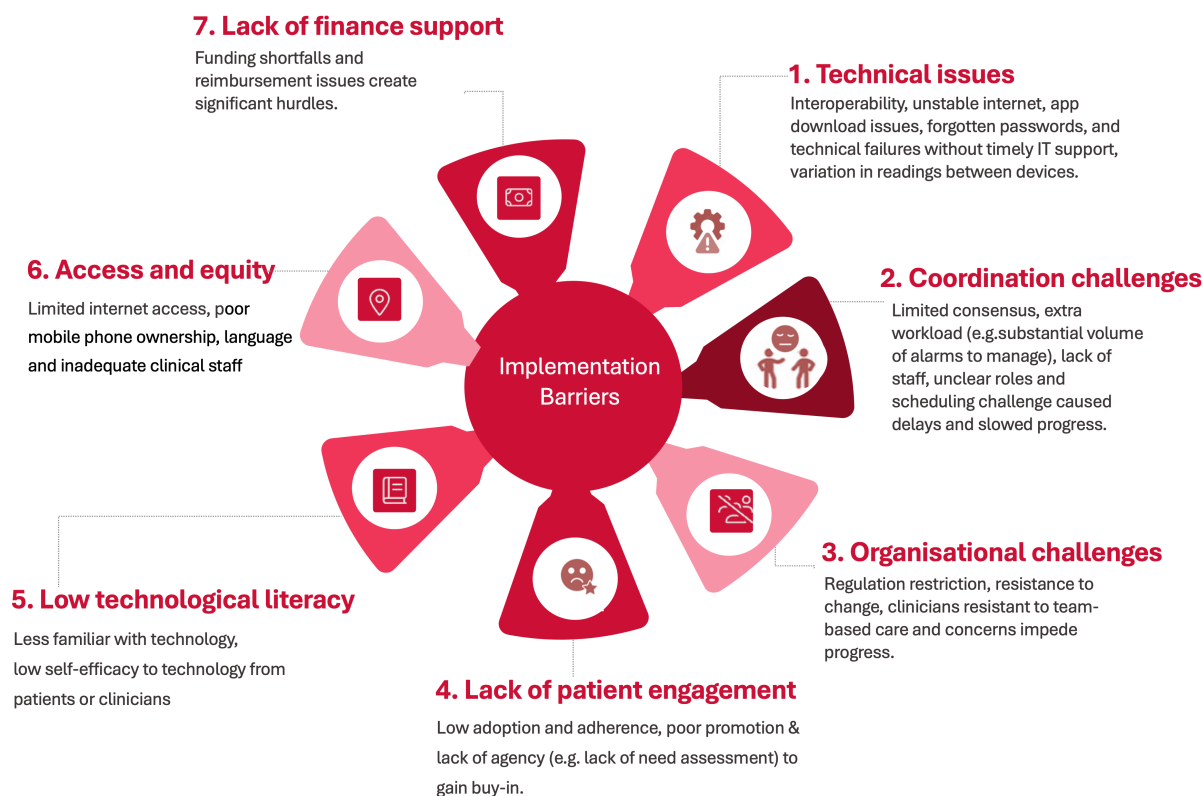
communication, and culture. Opinion leaders and subject expertise could drive implementation. Wider system domains included both internal and external service goals, political or policy aims, intervention costs (money; time), and funding (grants; reimbursement).

Implementation Barriers and Facilitators (Objective 3)

More than half (n=54; 64%) of the studies reported barriers and/or enablers to implementing digital health initiatives in routine care [33-43,46,47,50-52,55,57-60,64-69,71,73,75,76,79,80,82,84-89,92,93,95-97,100-102,106-108,110,113,114]. These are summarized in Figures 5 and 6; with details in Multimedia Appendix 3.

Figure 5. Facilitators for effective implementation.



Figure 6. Barriers for effective implementation.**Key issues included:**

1. Technical barriers (poor integration with existing technology; software installation problems; password barriers) could be reduced by error-free, user-friendly interfaces, tailored to the needs of the target population and offering easy access to timely IT support.
2. Coordination challenges (implementation teams with unclear roles; difficulty scheduling meetings) could be mitigated by facilitating co-development from the outset (common goals; clear expectations) and allowing sufficient committed staff time.
3. Streamlining processes and integrating into existing workflow to avoid additional workload (eg, duplicate data entry) reduced resistance to adopting new ways of working.
4. Engaged leadership and local champions helped convince staff of the value of the innovation and overcome reservations (eg, about third-party providers of systems; or risk to valued interpersonal contact).
5. Optimizing patient engagement by raising awareness, promoting buy-in, and improving technological literacy by using co-design, developing innovations that were patient-friendly, multilingual, addressed actual needs, and used data-secured technology.
6. Removing structural barriers by minimizing cost to the patient (free devices and internet access), thereby reducing unaffordability and the risk of increasing inequities.
7. Funding models that did not reimburse the full costs of a technology-based service (eg, required upgrades of existing legacy systems to maintain compatibility,

necessitated multidisciplinary support staff costs) created significant hurdles for clinicians to adopt and sustain the initiative.

Studies reported that the COVID-19 pandemic was a key facilitator in eliminating some previous barriers (eg, additional funding streams and coordination support) as the traditional care model was changed rapidly to digital. Attitudes shifted as both patients and providers recognized the need for social distancing and remote care delivery overriding preferences for valued direct patient interactions.

Insights (Objective 4)**Health Inequity**

Digital health initiatives that incorporated remote monitoring and brought services closer to the point of need such as providing remote consultations within schools for students with respiratory conditions would be an effective strategy for improving access to care, but initiatives from LMICs [82,93-97,100,101,113,115], rural regions, and low-income populations [37,41,52,58,85,112] faced significant barriers such as poor transportation, no insurance, poor mobile phone coverage, and health care provider shortage. Tailored interventions and language support facilitated the needs of diverse subpopulations.

Patient and Professional Relationships

Remote consulting could reduce clinicians' workloads but raises concerns about dehumanization and reduced patient engagement compared to face-to-face interactions [34]. Remote pediatric consultations struggled to involve the

child (though easier if the child already knew the clinician), and even parents were less active than in face-to-face appointments [44,46]. Building rapport was hindered by clinicians' difficulty sensing body language and responding to emotional cues [43,58,64,86]. Initiatives with 2-way messaging improved access, but ensuring timely responses was difficult [43]. Practical challenges included difficulty checking objective signs [70,73,75,88]. Retaining the option of in-person consultations was deemed safe and respectful for individual preferences [46,68].

Patient Journey

Digital initiatives allowed patients to receive support in their own homes and could improve continuity of care [47,53,107], empower self-care, and ensure that care plans reflected individual needs and preferences [55,81], while reducing barriers of travel time and costs [34,67,91,108,






111]. Connected care models, such as a platform connecting multiple monitoring devices or enabling data sharing with specialists across departments, helped to coordinate support, simplify the patient journey, and improve access to multiple specialists [73,77].

Environmental Impact

Remote monitoring and consultation minimized travel [42, 58,95,112], especially in rural areas, potentially improving attendance at pulmonary rehabilitation [111]. By decreasing reliance on carbon-intensive travel for health care appointments, digital approaches supported both environmental sustainability and economic efficiency.

We have summarized the do's and don'ts for implementation in Figure 7.

Figure 7. Do's and don'ts for implementation. UI: user interface; UX: user experience.

	Do's	Don'ts
Patient 	<ul style="list-style-type: none"> • Co-design implementation strategies with patients to align with their needs, preferences, and daily lives. • Ensure support (such as tutorials, devices, family involvement, and reminders) to boost engagement and adherence. 	<ul style="list-style-type: none"> • Don't assume all patients have smartphones, internet, or technological experience. • Don't implement without addressing privacy and security concerns.
Clinician 	<ul style="list-style-type: none"> • Integrate technology into existing workflows and electronic health records to avoid duplication. • Assign clear roles and ensure clinician input into decisions about technological rollout. • Provide training for clinicians on platform use, skills for virtual communication and patient engagement. 	<ul style="list-style-type: none"> • Don't add technology that increases time burden or duplicates tasks. • Don't implement without clinician buy-in and feedback mechanisms. • Don't underestimate the need for support, especially for less technologically-savvy staff.
Organisation 	<ul style="list-style-type: none"> • Secure leadership and staff buy-in through early engagement and shared goals. • Identify 'champions' and develop dedicated teams, with sufficient administrative support. • Monitor progress with regular reports to provide dynamic feedback. 	<ul style="list-style-type: none"> • Avoid ambiguity about roles and responsibilities to prevent delays. • Don't neglect sustainability planning (e.g. funding, staffing, turnover mitigation).
Developer 	<ul style="list-style-type: none"> • Design with simplicity and inclusivity, multilingual, accounting for various age groups, literacy levels, and needs from different respiratory conditions. • Ensure interoperability with electronic medical records and other existing health systems. • Offer timely support, robust documentation, and usability testing with real users. 	<ul style="list-style-type: none"> • Don't sideline data privacy and ethical use in the rush for digitisation. • Don't build closed systems that require duplicate data entry or additional manual workarounds. • Don't overlook accessibility issues like poor UX/UI or language barriers.
Policy 	<ul style="list-style-type: none"> • Provide long-term investment for sustainability, including broad reimbursement policies for remote monitoring and hybrid care. • Support equity by bridging digital divides through infrastructure and device access. • Set clear standards for patient/clinician involvement in digital health, over and above data privacy policies. 	<ul style="list-style-type: none"> • Don't rely only on short-term grants or one-size-fits-all reimbursement rules. • Don't ignore structural barriers such as broadband gaps and data standardisation. • Don't rely solely on private sector rollout; ensure public sector alignment.

Discussion

Summary of Findings

This review provides an overview of evidence on the implementation of digital technologies from 84 digital respiratory care initiatives across diverse populations and settings. The most targeted population was adult patients with a range of respiratory conditions. The initiatives used apps, digital platforms, and smart devices to enable remote monitoring and facilitate communication with clinicians for care planning and management. Health care service quality, prescribing or treatment adherence, and respiratory-specific clinical outcomes were the most reported outcome measurements. Fewer than a third of initiatives, typically national initiatives in high-income countries, used TMFs such as CFIR, RE-AIM, and PDSA cycles to address condition complexities, technology, value proposition, adopters, organization, and wider system factors. Barriers to implementation included limited technical integration, low patient engagement, funding shortfalls, and organizational challenges, mitigated by early involvement of stakeholders, leadership and champions, user-friendly design, and providing training and support.

Interpretation and Implications in Relation to Published Literatures

Use of Implementation Frameworks

Fewer than a third of the studies used a TMF to guide the implementation and evaluation of their initiative—and those that did were typically country-level initiatives in high-income settings (Figure 4). The comprehensive approaches to development and evaluation embodied by the CFIR and the RE-AIM frameworks may be perceived as resource-intensive, or too complex for local initiatives, or not adapted to the specific policies, infrastructure, and social-cultural adjustments required in LMICs [116]. However, it is notable that the least reported domains (Table 3) are “organizational” and the “wider context;” they emerge as key barriers and enablers, suggesting that a structured approach to digital implementation could be helpful in adapting to diverse clinical, health care systems and socioeconomic contexts.

Complexities in Implementation

Clinical complexity challenged the implementation of digital health care for respiratory conditions. For example, multimorbidity is common in COPD, and initiatives required technology developers to integrate systems for multiple conditions in often deprived social contexts whilst providing error-free technology that is user-friendly and compliant with global data privacy regulations [117]. The organizational enablers and barriers resonated with those found in a recent survey of stakeholders who facilitated innovation adoption across 18 UK National Health Service sites [118]. Ensuring timely technical support and involving cross-functional teams and patients early in the design phase were critical (but complex) tasks requiring strong leadership to align stakeholders and manage resources effectively [119]. Additionally, the

challenges and enablers were dynamic; initial barriers like staff resistance due to perceived workload could evolve into facilitators as confidence in the intervention grew [120]. The COVID-19 pandemic accelerated adoption by easing regulations and reimbursement barriers, shifting preferences toward remote care [5].

Complexity in implementation reflects the multiple stakeholders involved in developing, using, and maintaining digital care and the need to align organizational change with existing workflows and routines [121,122].

Future Challenges for Implementation

Two key challenges that remain under-explored are avoiding increasing inequity and considering environmental impacts. Initiatives prioritized clinical outcomes and service outcomes over assessing differential access, usability, or benefits across diverse socioeconomic, geographic, and demographic groups.

Digital Divide

A substantial number of studies showed that, despite their promise, digital health technologies can inadvertently widen existing health inequities—“the digital divide”—particularly in LMICs, rural areas with poor infrastructure, or other resource-constrained settings [123]. About one in five studies in this review highlighted inequity as a concern [37,41,52,58,82,85,93-97,100,101,112,113,115]. Disparities in broadband availability, digital literacy, and culturally responsive technology design disproportionately burden underserved groups, increasing uneven uptake and consequently exacerbating differential health outcomes [124]. Digital-only interventions heighten vulnerability in these populations and may entrench, rather than alleviate, socioeconomic barriers to care [125]. In response, care-coordination models that provide structured, personalized support, encompassing routine screening for digital-health readiness, proactive patient navigation (eg, including community health workers), and coordinated cross-sector referrals, offer plausible countermeasures by embedding digital tools within human-facilitated, inclusive workflows [126]. However, realizing the benefits of these equity-first hybrid models requires explicit operational definitions and clear delineation of responsibilities between technological components and coordinating staff, alongside sustained solutions for root-cause constraints such as reliable access to devices (eg, mobile phones, wearables, and AI), affordable and stable connectivity [127].

Environmental Sustainability

Within the studies in this review, 5 considered environmental sustainability to be an important benefit of the technology initiative [42,58,95,111,112]. Remote care is often framed as a means of reducing carbon emissions and generating economic benefits [128]. However, the energy-intensive infrastructure required to develop and operate AI systems raises concerns about increased energy consumption, making the long-term net carbon impact on health care uncertain [129]. Training large-scale AI models, such as deep neural networks and generative models, demands substantial computational power [130]. In the meanwhile,

AI combined with internet of things and the things network smart-city sensors offers new ways to address environmental challenges, including disaster forecasting, climate modeling, and operational energy optimization. Examples include sentiment analysis to shape environmental messaging, reinforcement learning to optimize water and energy use, and AI simulations to evaluate conservation strategies under varied ecological conditions [131]. Furthermore, the emerging concept of “Green AI” calls for quantifying embodied carbon and operational energy use across the full lifecycle of AI infrastructure, from construction to decommissioning data centers, together with associated Scope 1-3 (direct and indirect) supply-chain emissions, to support meaningful carbon reduction efforts [132,133]. However, deploying AI in routine respiratory care by adding health care-specific supply chains (eg, inhaler recycling pathways) can contribute to an overall beneficial footprint [134]. Further research is needed to develop pragmatic key performance indicators and measurement frameworks that capture both carbon impacts and health benefits.

Trust

Reduced personal interaction in remote consultations raises trust concerns. Strong patient-clinician relationships require confidence in technology, clear motives, and empathetic responses [135]. Despite adoption being widely discussed, “trust from end users” was only mentioned in 2% of the included studies, suggesting the need to increase the focus on this core attribute (Table 3). As generative AI becomes increasingly integrated into daily life, evaluating its perceived empathy and trustworthiness in health care is increasingly crucial. Moreover, perceptions of algorithmic bias, data security, and transparency can significantly influence whether patients feel comfortable engaging with AI-supported care [136,137]. Establishing robust guidelines for how AI systems communicate with patients, who is responsible when things go wrong, and how humans supervise AI decisions could help reduce worries about trust, safety, and reliability [138,139]. Ultimately, systematically assessing how different populations experience trust in AI-enabled health care will be essential for equitable and sustainable implementation.

Strengths and Limitations

We used standard methodology PRISMA-ScR and PRISMA-S methodology, while considering the reporting items suggested by Arksey and O’Malley [27] to ensure a transparent and systematic approach to this mixed-methods scoping review [23]. The collaborative process enabled input throughout the review from a multidisciplinary global team with academic and clinical interest in digital respiratory health.

There were some limitations. Despite the use of broad search terms, poor indexing of implementation research may

have excluded relevant studies. Gray literature was omitted due to concerns regarding the methodological quality and limited resources. We set a 10-year search time limit to ensure our review reflected current technology and its implementation, but may have missed valuable lessons from older, well-established initiatives. We included studies from both LMICs and high-income countries to ensure global representation; however, the diverse health care contexts meant the included studies were heterogeneous. To facilitate contextual interpretation, we grouped the findings into low- and high-income countries based on the World Bank’s income classification. Most of the initiatives were deployed in non-EU countries, where barriers, such as regulatory requirements and funding structures, were substantially different from those in the EU or low-resource settings. Nevertheless, this broad geographical representation provided valuable insight into common barriers and facilitators at an international level, and our focus on TMFs is a strength, as a comprehensive framework can support the adaptation required to transfer ideas between diverse health care systems.

Our scoping review provides an overview of digital respiratory initiatives rather than evaluating their effectiveness. Our analysis is limited by reported data, and could not detect unreported factors, but key implementation challenges and facilitators were highlighted in most papers.

Conclusions

This scoping review provides insights into factors affecting the implementation of digital respiratory health care, summarizing 84 digital respiratory initiatives, the frameworks they used, and the barriers and facilitators to successful implementation in routine care. The findings provide a contemporary overview of the use of TMFs across LMICs and high-income countries, highlighting the value of structured implementation of TMFs in supporting adoption across diverse clinical settings, health care systems, and socioeconomic contexts. It offers an empirical basis to inform future policy statements and guidance on standardized approaches to the development, evaluation, and reporting of digital health care interventions. Meaningful engagement of multiple stakeholders throughout the project lifecycle is essential to ensure alignment with patient needs and organizational workflows, thereby minimizing additional workload and safeguarding time for direct patient care. Addressing persistent and emerging challenges, including the digital divide, environmental sustainability, and the establishment of trust between technologies such as AI, patients, and clinicians, will be essential to support effective and scalable delivery of digital respiratory health care services.

Acknowledgments

We gratefully acknowledge the advice from Dr Marshall Dozier, Academic Support Librarian, University of Edinburgh, for her help with developing the search strategy. No generative artificial intelligence tools were used in any portion of the manuscript.

Funding

The CONNECT Clinical Research Collaboration is funded by the European Respiratory Society Clinical Research Collaboration (ERS CRC) Fund. This scoping review had limited funding from CONNECT which was used to provide a small honorarium for one of the lead researchers (ICYH). All other work was undertaken by volunteers from the CONNECT collaboration. The CONNECT CRC funder had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

Data Availability

All data generated or analyzed during this study are included in this published article and its supplementary information files.

Authors' Contributions

HP and ICYH conceptualized this study. HP, ICYH, and AHYC led the development of the scoping review with the advice of all authors. ZM, AOA, NJR, KBS, SOS, and CF contributed to the conflict resolutions. AOA, SOS, SK, and CF contributed to data curation, with the final check on accuracy by ICYH. ICYH performed the formal analysis, managed the project, software (created and tested the search codes on the databases, managed Covidence), resources, validated the data, prepared the visualizations, drafted and edited the original paper, which was reviewed, validated, and revised by HP critically. All authors approved the final version, contributed to discussions or meetings.

Conflicts of Interest

Io Chi Yan Hui is an Honorary Fellow in the University of Edinburgh and a Senior Consultant at the PM Group. She receives the European Respiratory Society (ERS) Clinical Research Collaboration fund to develop this study. This study and her research with the University of Edinburgh are independent from, and not financially supported by the PM Group. Her views in this publication are her own, and not those of the PM Group. Neither she, nor PM Group, stand to gain financially from this work. She is the WPIII co-lead of the CONNECT working group and the Chair of the ERS Group 1.04 ehealth/mhealth. Aleksandra Gawlik-Lipinski has received honoraria for lectures from AstraZeneca, support to attend meetings from AstraZeneca and Chiesi. Kate Loveys is a former consultant to and employee of Soul Machines Ltd. Patrick Stafler has received consulting fees from TytoCare for freelance advisory work, outside the submitted work. Shirley Quach has received fellowship and research grants from the Canadian Lung Association, Lung Health Foundation, Asthma Canada, and Canadian Society of Respiratory Therapists, unrelated to the submitted work. Anthony Sunjaya reports research grants from Australia's Medical Research Future Fund and the National Health and Medical Research Council (NHMRC) outside of the submitted work and all paid to his institution, and reports consultancy fees from the Australian Commission on Safety and Quality in Health Care. AS is also co-founder of a digital health startup, BantingMed, unrelated to this submitted work. Amy Hai Yan Chan reports research grants from Health Research Council of New Zealand, Auckland Medical Research Foundation, Asthma UK, University of Auckland, Oakley Mental Health Foundation, World Health Organization, and Hong Kong University, outside the submitted work and all paid to her institution (the University of Auckland); previously was supported by the Robert Irwin Postdoctoral Fellowship; reports consultancy fees from AcademyX and Spoonful of Sugar Ltd. and travel support from AstraZeneca; advisory board fees from AstraZeneca, GSK, CSL. Amy Hai Yan Chan is the clinical director of Asthma NZ, and is a member of the Respiratory Effectiveness Group, the scientific advisory board for Asthma Respiratory Foundation NZ, and working group lead for the European Respiratory Society Clinical Research Collaboration "CONNECT." Tonje Reier-Nilsen has received honoraria from ALK, AstraZeneca, MediTuner, and Sanofi for lectures, travel fees, and advisory boards. SOS reports grants from Roche, Dutch Research Council (NWO), and Dutch Lung Foundation (Longfonds); consulting fees from AstraZeneca and Chiesi; honoraria from AstraZeneca, Chiesi, and Janssen-Cilag; support for attending meetings from AstraZeneca and Chiesi; all outside the scope of the submitted work and paid to his institution. SOS reports a patent pending (published 12 March 2026); SOS reports roles as board member of the P4O2 consortium, and national delegate and member of the management committee of the COST ACTION eVoiceNet (CA24128). Hilary Pinnock has research grants from multiple, noncommercial sources for conducting applied respiratory research, all paid to her university and outside of the submitted work. All other authors declare no conflicts of interest.

Multimedia Appendix 1

Detailed search strategy.

[\[DOCX File \(Microsoft Word File\), 52 KB-Multimedia Appendix 1\]](#)

Multimedia Appendix 2

Detailed criteria and definitions.

[\[DOCX File \(Microsoft Word File\), 36 KB-Multimedia Appendix 2\]](#)

Multimedia Appendix 3

Full data extraction table.

[\[XLSX File \(Microsoft Excel File\), 47 KB-Multimedia Appendix 3\]](#)

Checklist 1

PRISMA-ScR reporting checklist.

[\[DOCX File \(Microsoft Word File\), 115 KB-Checklist 1\]](#)**References**

1. Chronic respiratory diseases and health equity by 2050. World Health Organization (WHO) European Region, European Respiratory Society (ERS); 2025. URL: <https://www.knowledge-action-portal.com/sites/default/files/2025-06/WHO-EURO-2025-12340-52112-79990-eng.pdf> [Accessed 2026-05-29]
2. Pinnock H, Poberezhets V, Drummond D. Digital Respiratory Healthcare. European Respiratory Society; 2023. [doi: [10.1183/2312508X.erm10223](https://doi.org/10.1183/2312508X.erm10223)]
3. Labaki WW, Han MK. Chronic respiratory diseases: a global view. *Lancet Respir Med*. Jun 2020;8(6):531-533. [doi: [10.1016/S2213-2600\(20\)30157-0](https://doi.org/10.1016/S2213-2600(20)30157-0)] [Medline: [32526184](https://pubmed.ncbi.nlm.nih.gov/32526184/)]
4. Pinnock H, Hui CY, van Boven JFM. Implementation of digital home monitoring and management of respiratory disease. *Curr Opin Pulm Med*. Jul 1, 2023;29(4):302-312. [doi: [10.1097/MCP.0000000000000965](https://doi.org/10.1097/MCP.0000000000000965)] [Medline: [37132298](https://pubmed.ncbi.nlm.nih.gov/37132298/)]
5. Pinnock H, Murphie P, Vogiatzis I, Poberezhets V. Telemedicine and virtual respiratory care in the era of COVID-19. *ERJ Open Res*. Jul 2022;8(3):00111-02022. [doi: [10.1183/23120541.00111-2022](https://doi.org/10.1183/23120541.00111-2022)] [Medline: [35891622](https://pubmed.ncbi.nlm.nih.gov/35891622/)]
6. Cox NS, Dal Corso S, Hansen H, et al. Telerehabilitation for chronic respiratory disease. *Cochrane Database Syst Rev*. Jan 29, 2021;1(1):CD013040. [doi: [10.1002/14651858.CD013040.pub2](https://doi.org/10.1002/14651858.CD013040.pub2)] [Medline: [33511633](https://pubmed.ncbi.nlm.nih.gov/33511633/)]
7. Poberezhets V, Kasteleyn MJ, Aardoom JJ. The use of digital health solutions for COVID-19: pandemic surveillance, remote monitoring and big data. In: Hilary P, Vitalii P, David D, editors. *Digital Respiratory Health (ERS Monograph)*. European Respiratory Society; 2023:160-169. [doi: [10.1183/2312508X.10001623](https://doi.org/10.1183/2312508X.10001623)]
8. IcoGrams commercial license agreement. ICOGRAMS EDUCATION. URL: <https://education.icograms.com/license-agreement-commercial> [Accessed 2026-06-16]
9. CC BY 4.0 attribution 4.0 international deed. Creative Commons. URL: <https://creativecommons.org/licenses/by/4.0/deed.en> [Accessed 2026-06-16]
10. Atzmon O, Crowther ME, Bei B, O'Connor DA. The use of implementation science theoretical approaches in hybrid effectiveness-implementation type 1 randomised trials of healthcare interventions: a scoping review. *Implement Sci*. May 16, 2025;20(1):23. [doi: [10.1186/s13012-025-01435-6](https://doi.org/10.1186/s13012-025-01435-6)] [Medline: [40380198](https://pubmed.ncbi.nlm.nih.gov/40380198/)]
11. Damschroder LJ, Reardon CM, Widerquist MAO, Lowery J. The updated consolidated framework for implementation research based on user feedback. *Implement Sci*. Oct 29, 2022;17(1):75. [doi: [10.1186/s13012-022-01245-0](https://doi.org/10.1186/s13012-022-01245-0)] [Medline: [36309746](https://pubmed.ncbi.nlm.nih.gov/36309746/)]
12. Greenhalgh T, Wherton J, Papoutsi C, et al. Beyond adoption: a new framework for theorizing and evaluating nonadoption, abandonment, and challenges to the scale-up, spread, and sustainability of health and care technologies. *J Med Internet Res*. Nov 1, 2017;19(11):e367. [doi: [10.2196/jmir.8775](https://doi.org/10.2196/jmir.8775)] [Medline: [29092808](https://pubmed.ncbi.nlm.nih.gov/29092808/)]
13. Glasgow RE, Vogt TM, Boles SM. Evaluating the public health impact of health promotion interventions: the RE-AIM framework. *Am J Public Health*. Sep 1999;89(9):1322-1327. [doi: [10.2105/ajph.89.9.1322](https://doi.org/10.2105/ajph.89.9.1322)] [Medline: [10474547](https://pubmed.ncbi.nlm.nih.gov/10474547/)]
14. Aarons GA, Hurlburt M, Horwitz SM. Advancing a conceptual model of evidence-based practice implementation in public service sectors. *Adm Policy Ment Health*. Jan 2011;38(1):4-23. [doi: [10.1007/s10488-010-0327-7](https://doi.org/10.1007/s10488-010-0327-7)] [Medline: [21197565](https://pubmed.ncbi.nlm.nih.gov/21197565/)]
15. Venkatesh V, Morris MG, Davis GB, Davis FD. User acceptance of information technology: toward a unified view1. *MIS Q*. Sep 1, 2003;27(3):425-478. [doi: [10.2307/30036540](https://doi.org/10.2307/30036540)]
16. Davis FD. Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Q*. Sep 1, 1989;13(3):319-340. [doi: [10.2307/249008](https://doi.org/10.2307/249008)]
17. Richardson M, Khouja CL, Sutcliffe K, Thomas J. Using the theoretical domains framework and the behavioural change wheel in an overarching synthesis of systematic reviews. *BMJ Open*. Jun 22, 2019;9(6):e024950. [doi: [10.1136/bmjopen-2018-024950](https://doi.org/10.1136/bmjopen-2018-024950)] [Medline: [31229999](https://pubmed.ncbi.nlm.nih.gov/31229999/)]
18. Lukersmith S, Woods C, Sarma H, de Miquel C, Salvador-Carulla L. Determining the process components of impact assessment in health and social program implementation: a scoping review of theories, models and frameworks. *Public Health (Fairfax)*. Mar 2025;240:41-47. [doi: [10.1016/j.puhe.2024.12.056](https://doi.org/10.1016/j.puhe.2024.12.056)] [Medline: [39862623](https://pubmed.ncbi.nlm.nih.gov/39862623/)]
19. Istepanian RSH. Mobile health (m-Health) in retrospect: the known unknowns. *Int J Environ Res Public Health*. Mar 22, 2022;19(7):3747. [doi: [10.3390/ijerph19073747](https://doi.org/10.3390/ijerph19073747)] [Medline: [35409431](https://pubmed.ncbi.nlm.nih.gov/35409431/)]
20. Sunyer-Vidal JG, Rodes M, Lupiáñez-Villanueva F. Policy Context for Digital Transformation: Benefits and Challenges of Implementing EU Digital Health Regulation. *Digital respiratory healthcare*; 2023:132-141. [doi: [10.1183/2312508X.10001423](https://doi.org/10.1183/2312508X.10001423)]

21. World Health Organization. Exploring the Digital Health Landscape in the WHO European Region: Digital Health Country Profiles. World Health Organization; 2024. ISBN: 978-92-890-6099-8
22. Gappa M, Ryan S, Garcia-Aymerich J, et al. The future of the European Respiratory Society: strategy update 2025. *Eur Respir J*. Jan 2025;65(1):2402327. [doi: [10.1183/13993003.02327-2024](https://doi.org/10.1183/13993003.02327-2024)] [Medline: [39819825](https://pubmed.ncbi.nlm.nih.gov/39819825/)]
23. Perrin Franck C, Babington-Ashaye A, Dietrich D, et al. iCHECK-DH: guidelines and checklist for the reporting on digital health implementations. *J Med Internet Res*. May 10, 2023;25:e46694. [doi: [10.2196/46694](https://doi.org/10.2196/46694)] [Medline: [37163336](https://pubmed.ncbi.nlm.nih.gov/37163336/)]
24. European health data space. European Commission. URL: https://health.ec.europa.eu/ehealth-digital-health-and-care/european-health-data-space_en [Accessed 2026-04-12]
25. European Respiratory Society. ERS Submission to the European Commission's Proposal on the European Health Data Space [Internet]. European Respiratory Society; URL: <https://www.ersnet.org/wp-content/uploads/2022/08/ERS-submission-EHDS.pdf> [Accessed 2026-04-12]
26. van Boven JFM, Drummond D, Chan AHY, et al. ERS "CONNECT" clinical research collaboration - moving multiple digital innovations towards connected respiratory care: addressing the over-arching challenges of whole systems implementation. *Eur Respir J*. Nov 2023;62(5):2301680. [doi: [10.1183/13993003.01680-2023](https://doi.org/10.1183/13993003.01680-2023)] [Medline: [37945041](https://pubmed.ncbi.nlm.nih.gov/37945041/)]
27. Arksey H, O'Malley L. Scoping studies: towards a methodological framework. *Int J Soc Res Methodol*. Feb 2005;8(1):19-32. [doi: [10.1080/1364557032000119616](https://doi.org/10.1080/1364557032000119616)]
28. Covidence - better systematic review management. Veritas Health Innovation. 2023. URL: <https://www.covidence.org/> [Accessed 2026-04-12]
29. Tricco AC, Lillie E, Zarin W, et al. PRISMA extension for scoping reviews (PRISMA-ScR): checklist and explanation. *Ann Intern Med*. Oct 2, 2018;169(7):467-473. [doi: [10.7326/M18-0850](https://doi.org/10.7326/M18-0850)] [Medline: [30178033](https://pubmed.ncbi.nlm.nih.gov/30178033/)]
30. Rethlefsen ML, Kirtley S, Waffenschmidt S, et al. PRISMA-S: an extension to the PRISMA statement for reporting literature searches in systematic reviews. *Syst Rev*. Jan 26, 2021;10(1):39. [doi: [10.1186/s13643-020-01542-z](https://doi.org/10.1186/s13643-020-01542-z)] [Medline: [33499930](https://pubmed.ncbi.nlm.nih.gov/33499930/)]
31. Hui CY, Condon K, Kolekar S, et al. Implementing digital respiratory technologies for people with respiratory conditions: a protocol for a scoping review. *PLoS ONE*. 2024;19(12):e0314914. [doi: [10.1371/journal.pone.0314914](https://doi.org/10.1371/journal.pone.0314914)] [Medline: [39729438](https://pubmed.ncbi.nlm.nih.gov/39729438/)]
32. Benfante A, Principe S, Cicero MN, et al. Management of severe asthma during the first lockdown phase of SARS-CoV-2 pandemic: tips for facing the second wave. *Pulm Pharmacol Ther*. Jun 2022;73-74:102083. [doi: [10.1016/j.pupt.2021.102083](https://doi.org/10.1016/j.pupt.2021.102083)] [Medline: [34628048](https://pubmed.ncbi.nlm.nih.gov/34628048/)]
33. Bereznicki B, Peterson G, Jackson S, Walters EH, Gee P. The sustainability of a community pharmacy intervention to improve the quality use of asthma medication. *J Clin Pharm Ther*. Apr 2011;36(2):144-151. [doi: [10.1111/j.1365-2710.2010.01165.x](https://doi.org/10.1111/j.1365-2710.2010.01165.x)] [Medline: [21366642](https://pubmed.ncbi.nlm.nih.gov/21366642/)]
34. Cvietusa PJ, Goodrich GK, Shoup JA, et al. Implementing health care technology research into practice to improve adult asthma management. *J Allergy Clin Immunol Pract*. Mar 2019;7(3):908-914. [doi: [10.1016/j.jaip.2018.08.029](https://doi.org/10.1016/j.jaip.2018.08.029)] [Medline: [30201160](https://pubmed.ncbi.nlm.nih.gov/30201160/)]
35. Ainsworth B, Bruton A, Thomas M, Yardley L. One year later: highlighting the challenges and opportunities in disseminating a breathing-retraining digital behaviour change intervention. *Digit Health*. 2020;6:2055207620936441. [doi: [10.1177/2055207620936441](https://doi.org/10.1177/2055207620936441)] [Medline: [32728474](https://pubmed.ncbi.nlm.nih.gov/32728474/)]
36. Harada N, Harada S, Ito J, Atsuta R, Hori S, Takahashi K. Mobile health app for Japanese adult patients with asthma: clinical observational study. *J Med Internet Res*. Aug 14, 2020;22(8):e19006. [doi: [10.2196/19006](https://doi.org/10.2196/19006)] [Medline: [32795993](https://pubmed.ncbi.nlm.nih.gov/32795993/)]
37. Johnson EE, MacGeorge C, King KL, et al. Facilitators and barriers to implementation of school-based telehealth asthma care: program champion perspectives. *Acad Pediatr*. 2021;21(7):1262-1272. [doi: [10.1016/j.acap.2021.04.025](https://doi.org/10.1016/j.acap.2021.04.025)] [Medline: [33940203](https://pubmed.ncbi.nlm.nih.gov/33940203/)]
38. Kouri A, Yamada J, Sale JEM, Straus SE, Gupta S. Primary care pre-visit electronic patient questionnaire for asthma: uptake analysis and predictor modeling. *J Med Internet Res*. Sep 18, 2020;22(9):e19358. [doi: [10.2196/19358](https://doi.org/10.2196/19358)] [Medline: [32945779](https://pubmed.ncbi.nlm.nih.gov/32945779/)]
39. Kuhn L, Reeves K, Taylor Y, et al. Planning for action: the impact of an asthma action plan decision support tool integrated into an electronic health record (EHR) at a large health care system. *J Am Board Fam Med*. 2015;28(3):382-393. [doi: [10.3122/jabfm.2015.03.140248](https://doi.org/10.3122/jabfm.2015.03.140248)] [Medline: [25957371](https://pubmed.ncbi.nlm.nih.gov/25957371/)]
40. Lowery CL, Bronstein JM, Benton TL, Fletcher DA. Distributing medical expertise: the evolution and impact of telemedicine in Arkansas. *Health Aff*. Feb 2014;33(2):235-243. [doi: [10.1377/hlthaff.2013.1001](https://doi.org/10.1377/hlthaff.2013.1001)]
41. MacGeorge CA, King K, Andrews AL, et al. School nurse perception of asthma care in school-based telehealth. *J Asthma*. Jun 2022;59(6):1248-1255. [doi: [10.1080/02770903.2021.1904978](https://doi.org/10.1080/02770903.2021.1904978)] [Medline: [33730979](https://pubmed.ncbi.nlm.nih.gov/33730979/)]

42. Radhakrishnan D, Higginson A, Thipse M, Tessier M, Radhakrishnan A. Optimizing pediatric asthma education using virtual platforms during the COVID-19 pandemic. *Allergy Asthma Clin Immunol*. Aug 7, 2022;18(1):72. [doi: [10.1186/s13223-022-00713-y](https://doi.org/10.1186/s13223-022-00713-y)] [Medline: [35934694](https://pubmed.ncbi.nlm.nih.gov/35934694/)]
43. van den Wijngaart LS, Geense WW, Boehmer AL, et al. Barriers and facilitators when implementing web-based disease monitoring and management as a substitution for regular outpatient care in pediatric asthma: qualitative survey study. *J Med Internet Res*. Oct 30, 2018;20(10):e284. [doi: [10.2196/jmir.9245](https://doi.org/10.2196/jmir.9245)] [Medline: [30377147](https://pubmed.ncbi.nlm.nih.gov/30377147/)]
44. Van Houten L, Deegan K, Siemer M, Walsh S. A telehealth initiative to decrease no-show rates in a pediatric asthma mobile clinic. *J Pediatr Nurs*. 2021;59:143-150. [doi: [10.1016/j.pedn.2021.04.005](https://doi.org/10.1016/j.pedn.2021.04.005)] [Medline: [33887684](https://pubmed.ncbi.nlm.nih.gov/33887684/)]
45. Teresi RK, Hendricks AC, Moraveji N, Murray RK, Polsky M, Maselli DJ. Clinical interventions following escalations from a continuous respiratory monitoring service in patients with chronic obstructive pulmonary disease. *Chronic Obstr Pulm Dis*. Nov 22, 2024;11(6):558-568. [doi: [10.15326/jcopdf.2023.0475](https://doi.org/10.15326/jcopdf.2023.0475)] [Medline: [39357503](https://pubmed.ncbi.nlm.nih.gov/39357503/)]
46. Prior SJ, Bassett G, Van Beek E, et al. Evaluation of a telehealth paediatric asthma and allergy clinic patient follow-up during the COVID-19 pandemic. *Children (Basel)*. Dec 11, 2024;11(12):1507. [doi: [10.3390/children11121507](https://doi.org/10.3390/children11121507)] [Medline: [39767936](https://pubmed.ncbi.nlm.nih.gov/39767936/)]
47. Allenbrand R, DiDonna A, Marshall J, Kennedy K. Establishing a virtual home assessment program: from concept to implementation as a result of the COVID-19 pandemic. *Curr Allergy Asthma Rep*. Sep 2023;23(9):531-540. [doi: [10.1007/s11882-023-01099-6](https://doi.org/10.1007/s11882-023-01099-6)] [Medline: [37405680](https://pubmed.ncbi.nlm.nih.gov/37405680/)]
48. Joo KR, Brewer TL, Matcham WA. Implementation of text message reminder system in the pediatric urgent care to improve compliance with asthma care follow-up. *J Inform Nurs*. 2019;4(1):6-12. URL: <https://www.proquest.com/docview/2194527940?pq-origsite=gscholar&fromopenview=true&sourcetype=Scholarly%20Journals> [Accessed 2026-06-06]
49. Bédard A, Basagaña X, Anto JM, et al. Mobile technology offers novel insights into the control and treatment of allergic rhinitis: the MASK study. *J Allergy Clin Immunol*. Jul 2019;144(1):135-143. [doi: [10.1016/j.jaci.2019.01.053](https://doi.org/10.1016/j.jaci.2019.01.053)] [Medline: [30951790](https://pubmed.ncbi.nlm.nih.gov/30951790/)]
50. Alwakeel AJ, Sicondolfo A, Robitaille C, Bourbeau J, Saad N. The accessibility, feasibility, and safety of a standardized community-based tele-pulmonary rehab program for chronic obstructive pulmonary disease a 3-year real-world prospective study. *Ann Am Thorac Soc*. Jan 2022;19(1):39-47. [doi: [10.1513/AnnalsATS.202006-638OC](https://doi.org/10.1513/AnnalsATS.202006-638OC)] [Medline: [34170802](https://pubmed.ncbi.nlm.nih.gov/34170802/)]
51. Cheung NW, Crampton M, Nesire V, Hng TM, Chow CK, Western Sydney Integrated Care Program Investigators. Model for integrated care for chronic disease in the Australian context: Western Sydney Integrated Care Program. *Aust Health Rev*. Oct 2019;43(5):565-571. [doi: [10.1071/AH18152](https://doi.org/10.1071/AH18152)] [Medline: [30862349](https://pubmed.ncbi.nlm.nih.gov/30862349/)]
52. Chow JSF, Gonzalez-Arce V, Knight A, Kohler F. Retrospective analysis of telemonitoring in Wollondilly, Australia. *JICA*. Apr 16, 2018;26(2):150-157. [doi: [10.1108/JICA-10-2017-0032](https://doi.org/10.1108/JICA-10-2017-0032)]
53. Coffey JD, Christopherson LA, Williams RD, et al. Development and implementation of a nurse-based remote patient monitoring program for ambulatory disease management. *Front Digit Health*. 2022;4:1052408. [doi: [10.3389/fdgh.2022.1052408](https://doi.org/10.3389/fdgh.2022.1052408)] [Medline: [36588748](https://pubmed.ncbi.nlm.nih.gov/36588748/)]
54. Dyrvig AK, Gerke O, Kidholm K, Vondeling H. A cohort study following up on a randomised controlled trial of a telemedicine application in COPD patients. *J Telemed Telecare*. Oct 2015;21(7):377-384. [doi: [10.1177/1357633X15572202](https://doi.org/10.1177/1357633X15572202)] [Medline: [25761469](https://pubmed.ncbi.nlm.nih.gov/25761469/)]
55. Eeles J, Ellison S, Jones C, Huntington C. Early experiences of telehealth monitoring for patients with COPD and implementation of person-centred care plans. *Br J Community Nurs*. Apr 2, 2023;28(4):172-178. [doi: [10.12968/bjcn.2023.28.4.172](https://doi.org/10.12968/bjcn.2023.28.4.172)] [Medline: [36989197](https://pubmed.ncbi.nlm.nih.gov/36989197/)]
56. Hofer F, Schreyögg J, Stargardt T. Effectiveness of a home telemonitoring program for patients with chronic obstructive pulmonary disease in Germany: evidence from the first three years. *PLoS ONE*. 2022;17(5):e0267952. [doi: [10.1371/journal.pone.0267952](https://doi.org/10.1371/journal.pone.0267952)] [Medline: [35551546](https://pubmed.ncbi.nlm.nih.gov/35551546/)]
57. Howard O, Thomas A, Henry H, Wallace J. Impact of a pharmacist-led outpatient telemedicine clinic on chronic obstructive pulmonary disease in a veteran population. *J Am Pharm Assoc*. Nov 2022;62(6):1919-1924. [doi: [10.1016/j.japh.2022.06.011](https://doi.org/10.1016/j.japh.2022.06.011)]
58. Price-Haywood EG, Arnold C, Harden-Barrios J, Davis T. Stop the divide: facilitators and barriers to uptake of digital health interventions among socially disadvantaged populations. *Ochsner J*. 2023;23(1):34-42. [doi: [10.31486/toj.22.0101](https://doi.org/10.31486/toj.22.0101)] [Medline: [36936477](https://pubmed.ncbi.nlm.nih.gov/36936477/)]
59. Raeside R, Singleton AC, Todd A, et al. Lung support service: implementation of a nationwide text message support program for people with chronic respiratory disease during the COVID-19 pandemic. *Int J Environ Res Public Health*. Dec 19, 2022;19(24):24. [doi: [10.3390/ijerph192417073](https://doi.org/10.3390/ijerph192417073)] [Medline: [36554954](https://pubmed.ncbi.nlm.nih.gov/36554954/)]

60. Sibbald SL, Van Asseldonk R, Cao PL, Law B. Lessons learned from inadequate implementation planning of team-based chronic disease management: implementation evaluation. *BMC Health Serv Res*. Feb 12, 2021;21(1):134. [doi: [10.1186/s12913-021-06100-4](https://doi.org/10.1186/s12913-021-06100-4)] [Medline: [33579271](https://pubmed.ncbi.nlm.nih.gov/33579271/)]
61. van Berkel C, Almond P, Hughes C, Smith M, Horsfield D, Duckworth H. Retrospective observational study of the impact on emergency admission of telehealth at scale delivered in community care in Liverpool, UK. *BMJ Open*. Jul 31, 2019;9(7):e028981. [doi: [10.1136/bmjopen-2019-028981](https://doi.org/10.1136/bmjopen-2019-028981)] [Medline: [31371293](https://pubmed.ncbi.nlm.nih.gov/31371293/)]
62. van Buul AR, Derksen C, Hoedemaker O, van Dijk O, Chavannes NH, Kasteleyn MJ. eHealth program to reduce hospitalizations due to acute exacerbation of chronic obstructive pulmonary disease: retrospective study. *JMIR Form Res*. Mar 18, 2021;5(3):e24726. [doi: [10.2196/24726](https://doi.org/10.2196/24726)] [Medline: [33734091](https://pubmed.ncbi.nlm.nih.gov/33734091/)]
63. Cheung CY, Yam WS, Palmer MD, et al. Is videoconference pulmonary rehabilitation associated with improvements in knowledge in people living with COPD? A propensity-matched service-evaluation. *Chron Respir Dis*. 2025;22:14799731241310895. [doi: [10.1177/14799731241310895](https://doi.org/10.1177/14799731241310895)] [Medline: [39840462](https://pubmed.ncbi.nlm.nih.gov/39840462/)]
64. Schmidt CW, Borgnakke K, Frølich A, Kayser L. Preferences, needs, and values of patients with chronic obstructive pulmonary disease attending a telehealth service: qualitative interview study. *JMIR Hum Factors*. Jun 21, 2024;11:e53131. [doi: [10.2196/53131](https://doi.org/10.2196/53131)] [Medline: [38905629](https://pubmed.ncbi.nlm.nih.gov/38905629/)]
65. Taylor A, Cushing A, Dow M, et al. Long-term usage and improved clinical outcomes with adoption of a COPD digital support service: key findings from the RECEIVER trial. *Int J Chron Obstruct Pulmon Dis*. 2023;18:1301-1318. [doi: [10.2147/COPD.S409116](https://doi.org/10.2147/COPD.S409116)] [Medline: [37378275](https://pubmed.ncbi.nlm.nih.gov/37378275/)]
66. Segato F, Masella C. Telemedicine services: how to make them last over time. *Health Policy Technol*. Sep 2017;6(3):268-278. [doi: [10.1016/j.hlpt.2017.07.003](https://doi.org/10.1016/j.hlpt.2017.07.003)]
67. Odeh B, Kayyali R, Nabhani-Gebara S, Philip N. Implementing a telehealth service: nurses' perceptions and experiences. *Br J Nurs*. 2014;23(21):1133-1137. [doi: [10.12968/bjon.2014.23.21.1133](https://doi.org/10.12968/bjon.2014.23.21.1133)] [Medline: [25426527](https://pubmed.ncbi.nlm.nih.gov/25426527/)]
68. Verweel L, Packham T, Goldstein R, Brooks D, MacKay C. Implementation of virtual pulmonary rehabilitation during the COVID-19 pandemic: experiences and perceptions of patients and healthcare providers. *Respir Med*. 2024;225:107588. [doi: [10.1016/j.rmed.2024.107588](https://doi.org/10.1016/j.rmed.2024.107588)] [Medline: [38460709](https://pubmed.ncbi.nlm.nih.gov/38460709/)]
69. Taylor J, Coates E, Wessels B, Mountain G, Hawley MS. Implementing solutions to improve and expand telehealth adoption: participatory action research in four community healthcare settings. *BMC Health Serv Res*. Dec 1, 2015;15:529. [doi: [10.1186/s12913-015-1195-3](https://doi.org/10.1186/s12913-015-1195-3)] [Medline: [26626564](https://pubmed.ncbi.nlm.nih.gov/26626564/)]
70. Bond CS, Worswick L. Self management and telehealth: lessons learnt from the evaluation of a Dorset Telehealth Program. *Patient*. Aug 2015;8(4):311-316. [doi: [10.1007/s40271-014-0091-y](https://doi.org/10.1007/s40271-014-0091-y)] [Medline: [25315192](https://pubmed.ncbi.nlm.nih.gov/25315192/)]
71. Hunting G, Shahid N, Sahakyan Y, et al. A multi-level qualitative analysis of telehomecare in Ontario: challenges and opportunities. *BMC Health Serv Res*. Dec 9, 2015;15:544. [doi: [10.1186/s12913-015-1196-2](https://doi.org/10.1186/s12913-015-1196-2)] [Medline: [26645639](https://pubmed.ncbi.nlm.nih.gov/26645639/)]
72. Sánchez FM, Bommatty MS, Haro MQ, et al. Telemonitoring in patients with COPD: a prospective study with results from the AIRE project. *Respir Med*. Nov 2025;248:108307. [doi: [10.1016/j.rmed.2025.108307](https://doi.org/10.1016/j.rmed.2025.108307)] [Medline: [40849078](https://pubmed.ncbi.nlm.nih.gov/40849078/)]
73. Perkins R, Davis J, Bailey J, et al. Telehealth implementation in cystic fibrosis care during COVID-19: the clinician experience. *Pediatr Pulmonol*. 2020;55(S2):S359-S359.
74. Somerville L, List R, Compton M, et al. 110 Real-world outcomes in cystic fibrosis telehealth clinical care during the COVID-19 pandemic. *J Cyst Fibros*. Nov 2021;20(Supplement 2):S55-S56. [doi: [10.1016/S1569-1993\(21\)01535-6](https://doi.org/10.1016/S1569-1993(21)01535-6)]
75. Van Citters AD, Dieni O, Scalia P, et al. Barriers and facilitators to implementing telehealth services during the COVID-19 pandemic: a qualitative analysis of interviews with cystic fibrosis care team members. *J Cyst Fibros*. Dec 2021;20 Suppl 3(101128966):23-28. [doi: [10.1016/j.jcf.2021.09.004](https://doi.org/10.1016/j.jcf.2021.09.004)] [Medline: [34930537](https://pubmed.ncbi.nlm.nih.gov/34930537/)]
76. Mazzocato P, Luckhaus JL, Malmqvist Castillo M, et al. A patient-driven mobile health innovation in cystic fibrosis care: comparative cross-case study. *J Med Internet Res*. Jul 31, 2024;26:e50527. [doi: [10.2196/50527](https://doi.org/10.2196/50527)] [Medline: [39083342](https://pubmed.ncbi.nlm.nih.gov/39083342/)]
77. Nazareth D, Sumner C, Daniels J, Mathews J, Hyde G, Walshaw M. Managing an adult CF population in the COVID-19 pandemic - 1 year on. *QJM*. Aug 13, 2022;115(8):521-524. [doi: [10.1093/qjmed/hcab228](https://doi.org/10.1093/qjmed/hcab228)] [Medline: [34432060](https://pubmed.ncbi.nlm.nih.gov/34432060/)]
78. Opipari-Arrigan L, Kouril M, Connor J, et al. Evaluating feasibility, acceptability, and effectiveness of a digital behavioral nutrition intervention in cystic fibrosis care. *Clin Pract Pediatr Psychol*. Sep 2025;13(3):269-279. [doi: [10.1037/cpp0000543](https://doi.org/10.1037/cpp0000543)]
79. Ahmed S, LePage K, Benc R, et al. Lessons learned from the implementation of a person-centred digital health platform in cancer care. *Curr Oncol*. Sep 29, 2022;29(10):7171-7180. [doi: [10.3390/curroncol29100564](https://doi.org/10.3390/curroncol29100564)] [Medline: [36290841](https://pubmed.ncbi.nlm.nih.gov/36290841/)]
80. Darcourt JG, Aparicio K, Dorsey PM, et al. Analysis of the implementation of telehealth visits for care of patients with cancer in Houston during the COVID-19 pandemic. *JCO Oncol Pract*. Jan 2021;17(1):e36-e43. [doi: [10.1200/OP.20.00572](https://doi.org/10.1200/OP.20.00572)] [Medline: [33026951](https://pubmed.ncbi.nlm.nih.gov/33026951/)]

81. Demedts I, Himpe U, Bossuyt J, et al. Clinical implementation of value based healthcare: impact on outcomes for lung cancer patients. *Lung Cancer*. Dec 2021;162:90-95. [doi: [10.1016/j.lungcan.2021.10.010](https://doi.org/10.1016/j.lungcan.2021.10.010)] [Medline: [34763159](https://pubmed.ncbi.nlm.nih.gov/34763159/)]
82. Ye X, Wei J, Li Z, et al. Design and implementation of a mobile system for lung cancer patient follow-up in China and initial report of the ongoing patient registry. *Oncotarget*. Jan 17, 2017;8(3):5487-5497. [doi: [10.18632/oncotarget.13720](https://doi.org/10.18632/oncotarget.13720)]
83. Jaidar N, Thomas H, Nahm ES. Advancing telemedicine outreach within a comprehensive cancer center: lessons learned from rapid transformation of care practice and operational changes associated with the COVID-19 pandemic. *J Oncol Navig Surviv*. 2021;12(4):111-117. URL: <https://www.jons-online.com/issues/2021/april-2021-vol-12-no-4/advancing-telemedicine-outreach-within-a-comprehensive-cancer-center-lessons-learned-from-rapid-transformation-of-care-practice-and-operational-changes-associated-with-the-covid-19-pandemic> [Accessed 2026-06-06]
84. Lowery J, Fagerlin A, Larkin AR, Wiener RS, Skurla SE, Caverly TJ. Implementation of a web-based tool for shared decision-making in lung cancer screening: mixed methods quality improvement evaluation. *JMIR Hum Factors*. Apr 1, 2022;9(2):e32399. [doi: [10.2196/32399](https://doi.org/10.2196/32399)] [Medline: [35363144](https://pubmed.ncbi.nlm.nih.gov/35363144/)]
85. Mackwood M, Butcher R, Vaclavik D, et al. Adoption of telemedicine in a rural US cancer center amid the COVID-19 pandemic: qualitative study. *JMIR Cancer*. Aug 16, 2022;8(3):e33768. [doi: [10.2196/33768](https://doi.org/10.2196/33768)] [Medline: [35895904](https://pubmed.ncbi.nlm.nih.gov/35895904/)]
86. Turner K, Bobonis Babilonia M, Naso C, et al. Health care providers' and professionals' experiences with telehealth oncology implementation during the COVID-19 pandemic: a qualitative study. *J Med Internet Res*. Jan 19, 2022;24(1):e29635. [doi: [10.2196/29635](https://doi.org/10.2196/29635)] [Medline: [34907900](https://pubmed.ncbi.nlm.nih.gov/34907900/)]
87. Kayser MZ, Valtin C, Greer M, Karow B, Fuge J, Gottlieb J. Video consultation during the COVID-19 pandemic: a single center's experience with lung transplant recipients. *Telemed J E Health*. Jul 2021;27(7):807-815. [doi: [10.1089/tmj.2020.0170](https://doi.org/10.1089/tmj.2020.0170)] [Medline: [33054671](https://pubmed.ncbi.nlm.nih.gov/33054671/)]
88. Odisho AY, Liu AW, Maiorano AR, et al. Design and implementation of a digital health home spirometry intervention for remote monitoring of lung transplant function. *J Heart Lung Transplant*. Jun 2023;42(6):828-837. [doi: [10.1016/j.healun.2023.01.010](https://doi.org/10.1016/j.healun.2023.01.010)] [Medline: [37031033](https://pubmed.ncbi.nlm.nih.gov/37031033/)]
89. Wickerson L, Helm D, Gottesman C, et al. Telerehabilitation for lung transplant candidates and recipients during the COVID-19 pandemic: program evaluation. *JMIR Mhealth Uhealth*. Jun 17, 2021;9(6):e28708. [doi: [10.2196/28708](https://doi.org/10.2196/28708)] [Medline: [34048354](https://pubmed.ncbi.nlm.nih.gov/34048354/)]
90. Patel SR, Bakker JP, Stitt CJ, Hardy W, Aloia MS, Nouraie SM. Impact of an extended telemonitoring and coaching program on continuous positive airway pressure adherence. *Ann Am Thorac Soc*. Dec 2022;19(12):2070-2076. [doi: [10.1513/AnnalsATS.202204-310OC](https://doi.org/10.1513/AnnalsATS.202204-310OC)] [Medline: [35858100](https://pubmed.ncbi.nlm.nih.gov/35858100/)]
91. Kosky C, Madeira N, Boulton K, et al. Telemedicine compared to standard face-to-face care for continuous positive airway pressure treatment: real-world Australian experience. *Sleep*. Oct 10, 2022;45(10):1-11. [doi: [10.1093/sleep/zsac157](https://doi.org/10.1093/sleep/zsac157)] [Medline: [35830509](https://pubmed.ncbi.nlm.nih.gov/35830509/)]
92. Hirshkowitz M, Sharafkhaneh A. A telemedicine program for diagnosis and management of sleep-disordered breathing: the fast-track for sleep apnea tele-sleep program. *Semin Respir Crit Care Med*. Oct 2014;35(5):560-570. [doi: [10.1055/s-0034-1390069](https://doi.org/10.1055/s-0034-1390069)] [Medline: [25353101](https://pubmed.ncbi.nlm.nih.gov/25353101/)]
93. Kerschberger B, Daka M, Shongwe B, et al. The introduction of video-enabled directly observed therapy (video-DOT) for patients with drug-resistant TB disease in Eswatini amid the COVID-19 pandemic – a retrospective cohort study. *BMC Health Serv Res*. Jun 3, 2024;24(1):699. [doi: [10.1186/s12913-024-11151-4](https://doi.org/10.1186/s12913-024-11151-4)] [Medline: [38831356](https://pubmed.ncbi.nlm.nih.gov/38831356/)]
94. Hodges J, Zhdanova S, Koshkina O, et al. Implementation of a mobile health strategy to improve linkage to and engagement with HIV care for people living with HIV, tuberculosis, and substance use in Irkutsk, Siberia. *AIDS Patient Care STDS*. Mar 2021;35(3):84-91. [doi: [10.1089/apc.2020.0233](https://doi.org/10.1089/apc.2020.0233)] [Medline: [33538649](https://pubmed.ncbi.nlm.nih.gov/33538649/)]
95. Prabhu A, Agarwal U, Tripathy JP, et al. "99DOTS" techno-supervision for tuberculosis treatment - a boon or a bane? Exploring challenges in its implementation at a tertiary centre in Delhi, India. *Indian J Tuberc*. Jan 2020;67(1):46-53. [doi: [10.1016/j.ijtb.2019.08.010](https://doi.org/10.1016/j.ijtb.2019.08.010)] [Medline: [32192617](https://pubmed.ncbi.nlm.nih.gov/32192617/)]
96. Thekkur P, Kumar AN, Chinnakali P, et al. Outcomes and implementation challenges of using daily treatment regimens with an innovative adherence support tool among HIV-infected tuberculosis patients in Karnataka, India: a mixed-methods study. *Glob Health Action*. 2019;12(1):1568826. [doi: [10.1080/16549716.2019.1568826](https://doi.org/10.1080/16549716.2019.1568826)] [Medline: [30712507](https://pubmed.ncbi.nlm.nih.gov/30712507/)]
97. Thomas BE, Kumar JV, Onongaya C, et al. Explaining differences in the acceptability of 99DOTS, a cell phone-based strategy for monitoring adherence to tuberculosis medications: qualitative study of patients and health care providers. *JMIR Mhealth Uhealth*. Jul 31, 2020;8(7):e16634. [doi: [10.2196/16634](https://doi.org/10.2196/16634)] [Medline: [32735220](https://pubmed.ncbi.nlm.nih.gov/32735220/)]
98. Bachina P, Lippincott CK, Perry A, et al. Programmatic adoption and implementation of video-observed therapy in Minnesota: prospective observational cohort study. *JMIR Form Res*. Aug 5, 2022;6(8):e38247. [doi: [10.2196/38247](https://doi.org/10.2196/38247)] [Medline: [35834671](https://pubmed.ncbi.nlm.nih.gov/35834671/)]
99. Ortiz Laza N, Lopez Aranaga I, Toral Andres J, et al. Latent tuberculosis infection treatment completion in Biscay: differences between regimens and monitoring approaches. *Front Med*. 2023;10. [doi: [10.3389/fmed.2023.1265057](https://doi.org/10.3389/fmed.2023.1265057)]

100. Wang N, Shewade HD, Thekkur P, et al. Electronic medication monitor for people with tuberculosis: implementation experience from thirty counties in China. *PLoS ONE*. ;15(4):e0232337. [doi: [10.1371/journal.pone.0232337](https://doi.org/10.1371/journal.pone.0232337)]
101. Kiwanuka N, Kityamuwesi A, Crowder R, et al. Implementation, feasibility, and acceptability of 99DOTS-based supervision of treatment for drug-susceptible TB in Uganda. *PLOS Digit Health*. Jun 2023;2(6):e0000138. [doi: [10.1371/journal.pdig.0000138](https://doi.org/10.1371/journal.pdig.0000138)] [Medline: [37390077](https://pubmed.ncbi.nlm.nih.gov/37390077/)]
102. Perry A, Chitnis A, Chin A, et al. Real-world implementation of video-observed therapy in an urban TB program in the United States. *Int J Tuberc Lung Dis*. Aug 1, 2021;25(8):655-661. [doi: [10.5588/ijtld.21.0170](https://doi.org/10.5588/ijtld.21.0170)] [Medline: [34330351](https://pubmed.ncbi.nlm.nih.gov/34330351/)]
103. Heo S, Jung W, Hwang SY, et al. The Impact of Introducing a Temporary Telemedicine Policy on Primary Care Visits: An Analysis of National Claims Data in South Korea. *Telemed J E Health*. Jun 2025;31(6):726-736. [doi: [10.1089/tmj.2024.0511](https://doi.org/10.1089/tmj.2024.0511)] [Medline: [39982782](https://pubmed.ncbi.nlm.nih.gov/39982782/)]
104. Schnoor K, Versluis A, Bakema R, et al. A pharmacy-based eHealth intervention promoting correct use of medication in patients with asthma and COPD: nonrandomized pre-post study. *J Med Internet Res*. Jun 8, 2022;24(6):e32396. [doi: [10.2196/32396](https://doi.org/10.2196/32396)] [Medline: [35675120](https://pubmed.ncbi.nlm.nih.gov/35675120/)]
105. Steinman L, Chadwick K, Chavez Santos E, et al. Remote evidence-based programs for health promotion to support older adults during the COVID-19 pandemic and beyond: mixed methods outcome evaluation. *JMIR Aging*. Jun 13, 2024;7:e52069. [doi: [10.2196/52069](https://doi.org/10.2196/52069)] [Medline: [38869932](https://pubmed.ncbi.nlm.nih.gov/38869932/)]
106. Braun M, Schmidt O, Schultz T, Woehrle H, Sundrup MG, Schöbel C. Experiences with digital care of patients with chronic and acute lung diseases during the SARS-CoV-2 pandemic. *Internist (Berl)*. Mar 2022;63(3):255-265. [doi: [10.1007/s00108-022-01266-3](https://doi.org/10.1007/s00108-022-01266-3)] [Medline: [35181796](https://pubmed.ncbi.nlm.nih.gov/35181796/)]
107. Capusan KY, Fenster T. Patient satisfaction with telehealth during the COVID-19 pandemic in a pediatric pulmonary clinic. *J Pediatr Health Care*. 2021;35(6):587-591. [doi: [10.1016/j.pedhc.2021.07.014](https://doi.org/10.1016/j.pedhc.2021.07.014)] [Medline: [34417077](https://pubmed.ncbi.nlm.nih.gov/34417077/)]
108. Denker K, Dean M, Chapman D, Sump C. Using a centralized nursing team to implement multi-specialty pediatric remote patient monitoring programs. *J Pediatr Nurs*. 2023;69:10-17. [doi: [10.1016/j.pedn.2022.12.028](https://doi.org/10.1016/j.pedn.2022.12.028)] [Medline: [36592607](https://pubmed.ncbi.nlm.nih.gov/36592607/)]
109. Vilendrer S, Patel B, Chadwick W, et al. Rapid deployment of inpatient telemedicine in response to COVID-19 across three health systems. *J Am Med Inform Assoc*. Jul 1, 2020;27(7):1102-1109. [doi: [10.1093/jamia/ocaa077](https://doi.org/10.1093/jamia/ocaa077)] [Medline: [32495830](https://pubmed.ncbi.nlm.nih.gov/32495830/)]
110. Zhang JR, Chua QHA, Shen XM, Viseikumar JA, Teoh T, Tan NG. A systematic implementation of telemedicine in Singapore's COVID-19 community recovery facilities. *Telemedicine and E-Health*. Nov 2022;28(11):1587-1594. [doi: [10.1089/tmj.2021.0466](https://doi.org/10.1089/tmj.2021.0466)]
111. Knox L, Dunning M, Davies CA, et al. Safety, feasibility, and effectiveness of virtual pulmonary rehabilitation in the real world. *Int J Chron Obstruct Pulmon Dis*. 2019;14(101273481):775-780. [doi: [10.2147/COPD.S193827](https://doi.org/10.2147/COPD.S193827)] [Medline: [31040656](https://pubmed.ncbi.nlm.nih.gov/31040656/)]
112. Mashru J, Kirlaw M, Saginur R, Schreiber YS. Management of infectious diseases in remote northwestern Ontario with telemedicine videoconference consultations. *J Telemed Telecare*. Jan 2017;23(1):83-87. [doi: [10.1177/1357633X15625136](https://doi.org/10.1177/1357633X15625136)] [Medline: [26748393](https://pubmed.ncbi.nlm.nih.gov/26748393/)]
113. Severini R da S, Oliveira P de, Couto TB, et al. Fast, cheap and feasible: Implementation of pediatric telemedicine in a public hospital during the Covid-19 pandemic. *J Pediatr (Rio J)*. 2022;98(2):183-189. [doi: [10.1016/j.jpeds.2021.05.007](https://doi.org/10.1016/j.jpeds.2021.05.007)] [Medline: [34181889](https://pubmed.ncbi.nlm.nih.gov/34181889/)]
114. Tan SC, Cross A. Virtual visiting in the intensive care unit: implementation, utilisation and provider acceptance in an Australian metropolitan health service. *Aust Health Rev*. Jun 2022;46(3):284-288. [doi: [10.1071/AH22032](https://doi.org/10.1071/AH22032)] [Medline: [35546423](https://pubmed.ncbi.nlm.nih.gov/35546423/)]
115. Xiao YZ, Chen XJ, Sun XL, et al. Effect of implementing an informatization case management model on the management of chronic respiratory diseases in a general hospital: retrospective controlled study. *JMIR Med Inform*. Jun 19, 2024;12:e49978. [doi: [10.2196/49978](https://doi.org/10.2196/49978)] [Medline: [38904478](https://pubmed.ncbi.nlm.nih.gov/38904478/)]
116. Hui CY, Abdulla A, Ahmed Z, et al. Mapping national information and communication technology (ICT) infrastructure to the requirements of potential digital health interventions in low- and middle-income countries. *J Glob Health*. Dec 29, 2022;12:04094. [doi: [10.7189/jogh.12.04094](https://doi.org/10.7189/jogh.12.04094)] [Medline: [36579436](https://pubmed.ncbi.nlm.nih.gov/36579436/)]
117. Jawad LA. Security and privacy in digital healthcare systems: challenges and mitigation strategies. *Abhigyan*. Mar 2024;42(1):23-31. [doi: [10.1177/09702385241233073](https://doi.org/10.1177/09702385241233073)]
118. McKenzie F, Hewitt C, Holmes HL, Johnson MR, Clarke T. Facilitating innovation in healthcare: insights from the frontline of adoption. *BMJ Innov*. Jul 2025;11(3):126-132. [doi: [10.1136/bmjinnov-2025-001407](https://doi.org/10.1136/bmjinnov-2025-001407)]
119. Pfitzer E, Bitomsky L, Nißen M, Kausch C, Kowatsch T. Success factors of growth-stage digital health companies: systematic literature review. *J Med Internet Res*. Dec 11, 2024;26(1):e60473. [doi: [10.2196/60473](https://doi.org/10.2196/60473)] [Medline: [39661978](https://pubmed.ncbi.nlm.nih.gov/39661978/)]
120. Rouleau G, Wu K, Ramamoorthi K, et al. Mapping theories, models, and frameworks to evaluate digital health interventions: scoping review. *J Med Internet Res*. Feb 5, 2024;26:e51098. [doi: [10.2196/51098](https://doi.org/10.2196/51098)] [Medline: [38315515](https://pubmed.ncbi.nlm.nih.gov/38315515/)]
121. Greenhalgh T. Role of routines in collaborative work in healthcare organisations. *BMJ*. Nov 17, 2008;337(nov17 1):a2448. [doi: [10.1136/bmj.a2448](https://doi.org/10.1136/bmj.a2448)] [Medline: [19015186](https://pubmed.ncbi.nlm.nih.gov/19015186/)]

122. Katonai G, Arvai N, Mesko B. AI and primary care: scoping review. *J Med Internet Res*. Aug 15, 2025;27:e65950. [doi: [10.2196/65950](https://doi.org/10.2196/65950)] [Medline: [40836794](https://pubmed.ncbi.nlm.nih.gov/40836794/)]
123. Sylla B, Ismaila O, Diallo G. 25 Years of digital health toward universal health coverage in low- and middle-income countries: rapid systematic review. *J Med Internet Res*. May 29, 2025;27:e59042. [doi: [10.2196/59042](https://doi.org/10.2196/59042)] [Medline: [40440696](https://pubmed.ncbi.nlm.nih.gov/40440696/)]
124. Wilson S, Tolley C, Mc Ardle R, et al. Recommendations to advance digital health equity: a systematic review of qualitative studies. *NPJ Digit Med*. Jun 29, 2024;7(1):173. [doi: [10.1038/s41746-024-01177-7](https://doi.org/10.1038/s41746-024-01177-7)] [Medline: [38951666](https://pubmed.ncbi.nlm.nih.gov/38951666/)]
125. Beltrán V, Abarza L, Acuña-Mardones P, et al. Effectiveness of digital and remote health interventions in pediatric populations from underserved or rural areas: a systematic review of randomized controlled trials. *Int J Telemed Appl*. 2026;2026(1):5586850. [doi: [10.1155/ijta/5586850](https://doi.org/10.1155/ijta/5586850)] [Medline: [41705276](https://pubmed.ncbi.nlm.nih.gov/41705276/)]
126. Endalamaw A, Zewdie A, Wolka E, Assefa Y. A scoping review of digital health technologies in multimorbidity management: mechanisms, outcomes, challenges, and strategies. *BMC Health Serv Res*. Mar 15, 2025;25(1):382. [doi: [10.1186/s12913-025-12548-5](https://doi.org/10.1186/s12913-025-12548-5)] [Medline: [40089752](https://pubmed.ncbi.nlm.nih.gov/40089752/)]
127. Richardson S, Lawrence K, Schoenthaler AM, Mann D. A framework for digital health equity. *NPJ Digit Med*. Aug 18, 2022;5(1):119. [doi: [10.1038/s41746-022-00663-0](https://doi.org/10.1038/s41746-022-00663-0)] [Medline: [35982146](https://pubmed.ncbi.nlm.nih.gov/35982146/)]
128. Donald N, Irukulla S. Greenhouse gas emission savings in relation to telemedicine and associated patient benefits: a systematic review. *Telemed J E Health*. Apr 20, 2022;28(11):1555-1563. [doi: [10.1089/tmj.2022.0047](https://doi.org/10.1089/tmj.2022.0047)] [Medline: [35446668](https://pubmed.ncbi.nlm.nih.gov/35446668/)]
129. Ueda D, Walston SL, Fujita S, et al. Climate change and artificial intelligence in healthcare: review and recommendations towards a sustainable future. *Diagn Interv Imaging*. Nov 2024;105(11):453-459. [doi: [10.1016/j.diii.2024.06.002](https://doi.org/10.1016/j.diii.2024.06.002)] [Medline: [38918123](https://pubmed.ncbi.nlm.nih.gov/38918123/)]
130. Bouza L, Bugeau A, Lannelongue L. How to estimate carbon footprint when training deep learning models? A guide and review. *Environ Res Commun*. Nov 1, 2023;5(11):115014. [doi: [10.1088/2515-7620/acf81b](https://doi.org/10.1088/2515-7620/acf81b)] [Medline: [38022395](https://pubmed.ncbi.nlm.nih.gov/38022395/)]
131. Kan Y. AI for environmental sustainability: advances, challenges, and future directions. *IJAI4S*. Mar 17, 2025;1(1). [doi: [10.63619/ijais.v1i1.006](https://doi.org/10.63619/ijais.v1i1.006)]
132. Oliveira AP, Carraquico T, Martinez-Perez C. Beyond efficiency: a systematic review of energy consumption and carbon footprint across the AI lifecycle. *Sustainability*. Jan 29, 2026;18(3):1359. [doi: [10.3390/su18031359](https://doi.org/10.3390/su18031359)]
133. Hasan SM, Islam T, Saifuzzaman M, Ahmed KR, Huang CH, Shahid AR. Carbon emission quantification of machine learning: a review. *IEEE Trans Sustain Comput*. Jun 11, 2025;10(6):1085-1102. [doi: [10.1109/TSUSC.2025.3578834](https://doi.org/10.1109/TSUSC.2025.3578834)]
134. Onasanya AA, Haider Y, Peaston G, Ignatowicz A, Turner AM. Inhaler sustainability in asthma and COPD care: a systematic review. *BMJ Open*. Jul 25, 2025;15(7):e098052. [doi: [10.1136/bmjopen-2024-098052](https://doi.org/10.1136/bmjopen-2024-098052)] [Medline: [40713041](https://pubmed.ncbi.nlm.nih.gov/40713041/)]
135. Senek M, Drummond D, Pinnock H, et al. Impact of digital health on patient-provider relationships in respiratory secondary care based on qualitative and quantitative evidence: systematic review. *J Med Internet Res*. May 30, 2025;27:e70970. [doi: [10.2196/70970](https://doi.org/10.2196/70970)] [Medline: [40446293](https://pubmed.ncbi.nlm.nih.gov/40446293/)]
136. Moy S, Irannejad M, Manning SJ, et al. Patient perspectives on the use of artificial intelligence in health care: a scoping review. *J Patient Cent Res Rev*. 2024;11(1):51-62. [doi: [10.17294/2330-0698.2029](https://doi.org/10.17294/2330-0698.2029)] [Medline: [38596349](https://pubmed.ncbi.nlm.nih.gov/38596349/)]
137. Kim C, Gadgil SU, Lee SI. Transparency of medical artificial intelligence systems. *Nat Rev Bioeng*. Jan 2026;4(1):11-29. [doi: [10.1038/s44222-025-00363-w](https://doi.org/10.1038/s44222-025-00363-w)] [Medline: [42027791](https://pubmed.ncbi.nlm.nih.gov/42027791/)]
138. M Astobiza A, Alonso M, Ortega Lozano R. Trust and AI in healthcare: a systematic review. *Monash Bioeth Rev*. Nov 11, 2025;11:1-21. [doi: [10.1007/s40592-025-00272-z](https://doi.org/10.1007/s40592-025-00272-z)] [Medline: [41217688](https://pubmed.ncbi.nlm.nih.gov/41217688/)]
139. Palmieri S, Robertson CT, Cohen IG. New guidance on responsible use of AI. *JAMA*. Jan 20, 2026;335(3):207-208. [doi: [10.1001/jama.2025.23059](https://doi.org/10.1001/jama.2025.23059)] [Medline: [41335417](https://pubmed.ncbi.nlm.nih.gov/41335417/)]

Abbreviations

AI: artificial intelligence

CFIR: Consolidated Framework for Implementation Research

COPD: chronic obstructive pulmonary disease

CRC: Clinical Research Collaboration

EPIS: exploration, preparation, implementation, and sustainment

ERS: European Respiratory Society

EU: European Union

LMIC: low and middle income countries

NASSS: Nonadaptation, Abandonment, and Challenges to the Scale-up, Spread, and Sustainability of Health and Care Technologies

PDSA: plan-do-study-act

PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses

PRISMA-ScR: Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for scoping reviews

RE-AIM: reach, effectiveness, adoption, implementation, and maintenance

TAM: Technology Acceptance Model

TMF: Theories, Models, and Framework

UTAUT: Unified Theory of Acceptance and Use of Technology

WHO: World Health Organization

Edited by Stefano Brini; peer-reviewed by Susannah Mclean, Tamara Vagg; submitted 23.Nov.2025; final revised version received 09.May.2026; accepted 11.May.2026; published 16.Jun.2026

Please cite as:

Hui ICY, Condon K, Kolekar S, Roberts NJ, Sreter KB, Simons SO, Figueiredo C, McKeough Z, Salim H, Gawlik-Lipinski A, Gonsard A, Aral AÖ, Vanoverschelde A, Armstrong M, Kohlbrenner D, Paixão C, Stafler P, Papadopoulou E, Rabe APJ, Mohammad M, Bouloukaki I, Quach S, Kaltsakas G, Loveys K, Reier-Nilsen T, Sunjaya AP, Robinson P, Senek M, Chan AHY, Pinnock H

Implementing Digital Respiratory Technologies for People With Respiratory Conditions: Scoping Review

J Med Internet Res 2026;28:e88325

URL: <https://www.jmir.org/2026/1/e88325>

doi: [10.2196/88325](https://doi.org/10.2196/88325)

©Io Chi-Yan Hui, Kathleena Condon, Shailesh Kolekar, Nicola J Roberts, Katherina Bernadette Sreter, Sami O Simons, Carlos Figueiredo, Zoe McKeough, Hani Salim, Aleksandra Gawlik-Lipinski, Apolline Gonsard, Ayşe Önal Aral, Anna Vanoverschelde, Matthew Armstrong, Dario Kohlbrenner, Cátia Paixão, Patrick Stafler, Efthymia Papadopoulou, Adrian Paul Jaravata Rabe, Milan Mohammad, Izolde Bouloukaki, Shirley Quach, Georgios Kaltsakas, Kate Loveys, Tonje Reier-Nilsen, Anthony Paulo Sunjaya, Paul Robinson, Michaela Senek, Amy Hai Yan Chan, Hilary Pinnock. Originally published in the Journal of Medical Internet Research (<https://www.jmir.org>), 16.Jun.2026. This is an open-access article distributed under the terms of the Creative Commons Attribution License (<https://creativecommons.org/licenses/by/4.0/>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work, first published in the Journal of Medical Internet Research (ISSN 1438-8871), is properly cited. The complete bibliographic information, a link to the original publication on <https://www.jmir.org/>, as well as this copyright and license information must be included.