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Current Evidence on Telerehabilitation for Amyotrophic Lateral Sclerosis: A Scoping Review of Physical Function and Functional Outcomes

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ABSTRACT

Background: Amyotrophic lateral sclerosis (ALS) is a progressive neurodegenerative disorder associated with declining physical function, respiratory impairment, and increasing rehabilitation needs. Telerehabilitation has emerged as an innovative approach to improve access to rehabilitation services while overcoming mobility-related barriers. This scoping review synthesized current evidence regarding the effects of telerehabilitation on physical function and functional outcomes in patients with ALS.

Methods: A scoping review was conducted in accordance with PRISMA-ScR guidelines using PubMed, Scopus, Web of Science, and ProQuest databases. Studies evaluating telerehabilitation interventions targeting physical and functional outcomes in ALS were included. Data were extracted and narratively synthesized across thematic domains, including physical function, activities of daily living, feasibility, adherence, safety, and patient satisfaction.

Results: Eight studies involving 146 participants met the eligibility criteria. Interventions included aerobic exercise, inspiratory and expiratory respiratory muscle training, stretching exercises, comprehensive physical therapy, and multidisciplinary home-based rehabilitation delivered through synchronous and asynchronous telehealth platforms. High adherence rates (81.5%–127%) and low attrition were consistently reported. Respiratory interventions demonstrated significant improvements in inspiratory and expiratory muscle strength, whereas several studies reported stabilization of functional decline and preservation of activities of daily living. Patient satisfaction was uniformly favorable despite occasional technological limitations affecting intervention delivery.

Conclusion: Telerehabilitation appears to be a feasible, safe, and clinically valuable strategy for maintaining functional outcomes in ALS. Future large-scale randomized studies are warranted to establish standardized intervention protocols, evaluate long-term clinical effectiveness, and optimize telehealth implementation across diverse healthcare settings.

Keywords: Amyotrophic Lateral Sclerosis, Telerehabilitation, Telemedicine, Physical Therapy Modalities, Activities of Daily Living

INTRODUCTION

Amyotrophic lateral sclerosis (ALS) is a rapidly progressive, fatal neurodegenerative disorder characterized by the loss of upper and lower motor neurons, resulting in muscle atrophy, progressive weakness, and eventual respiratory failure.[1,2] As the disease advances, patients experience severe declines in physical function and mobility, which drastically restrict their independence in performing activities of daily living (ADL).[3,4] Multidisciplinary care-specifically physical and respiratory rehabilitation-is globally recognized as a core pillar in managing ALS symptoms, slowing functional decline, minimizing pain, and improving overall quality of life.[5,6] However, the progressive nature of physical disability in ALS creates a profound clinical paradox: as patients grow to need intensive physical therapy and clinical surveillance most, their ability to travel safely to specialized multidisciplinary centers is severely compromised by mobility barriers, heavy cognitive-fatigue loads, financial exhaustion, and caregiver strain.[7,8] Consequently, many individuals with late-stage ALS face a complete cessation of rehabilitation services, accelerating their physical deterioration and increasing respiratory complications.[9,10]

To bridge this critical gap, telerehabilitation-defined as the delivery of rehabilitation services via telecommunication technologies-has emerged as a highly promising clinical alternative.[11,12] Incorporating various digital frameworks such as synchronous video conferencing, live remote coaching, telephone follow-ups, and asynchronous instruction portals, telerehabilitation aims to maintain continuity of care directly within the patient's home.[13,14] While early-stage clinical feasibility studies have highlighted the logistical benefits of remote care-particularly during the mobility restrictions of the COVID-19 pandemic-its widespread clinical adoption remains constrained.[15,16] There is a lack of consensus regarding the physiological efficacy of remote physical interventions compared to traditional in-person therapies, and clinicians remain hesitant to prescribe remote exercise regimens due to concerns regarding patient safety, fall risks, and the tracking of rapid disease progression without hands-on clinical assessments.[17,18]

Despite the growing body of literature on digital health, a significant research gap persists in the systematic classification

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and synthesis of telerehabilitation protocols specifically tailored to ALS.[19,20] Existing reviews heavily aggregate heterogeneous neurodegenerative conditions (such as multiple sclerosis, Parkinson's disease, and stroke), which fails to address the unique, rapidly progressive pathophysiological trajectory of ALS.[21,22] Furthermore, the literature on ALS telerehabilitation remains highly fragmented, characterized by a mix of diverse interventions-ranging from gross aerobic and limb stretching to highly targeted respiratory training-delivered through vastly different technological platforms.[23,24] There is a lack of synthesized evidence explaining how regional differences in infrastructure (such as broadband internet stability, electrical load-shedding, and economic barriers in low-to-middle-income countries versus resource-rich Western settings) affect clinical safety, protocol adherence, and retention rates.[25,26] Crucially, no scoping review has yet mapped these technological delivery models against standardized clinical endpoints, such as the Amyotrophic Lateral Sclerosis Functional Rating Scale-Revised (ALSFRS-R) or objective respiratory metrics.[27,28]

To address these gaps, this scoping review was conducted to systematically map and synthesize the current evidence regarding the effects of telerehabilitation on physical function and functional outcomes in patients with ALS.[29] By systematically charting study methodologies, delivery formats, safety parameters, patient adherence, and physiological end-points, this review aims to provide a comprehensive, high-level framework to guide clinical decision-making and identify the technological and methodological barriers that must be addressed in future clinical trials.

METHODOLOGY

This scoping review was conducted to comprehensively map and synthesize the current evidence regarding the effects of telerehabilitation on physical function and functional outcomes in patients with amyotrophic lateral sclerosis (ALS). The review methodology was developed in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR) guidelines and followed the five-stage framework proposed by Arksey and O'Malley, with subsequent methodological refinements by Levac and colleagues. A comprehensive literature search was performed across four electronic databases, including PubMed, Scopus, Web of Science, and ProQuest, from database inception to the date of the final search. The search strategy combined controlled vocabulary and free-text terms related to "amyotrophic lateral sclerosis," "ALS," "telerehabilitation," "telemedicine," "telehealth," "remote rehabilitation," "physical therapy," "physiotherapy," "motor function," and "activities of daily living," using Boolean operators to maximize sensitivity and specificity. Additional manual screening of the reference lists of eligible studies was undertaken to identify relevant publications not captured during the electronic search.

Studies were included if they evaluated telerehabilitation interventions in individuals diagnosed with ALS and reported outcomes related to physical function, motor performance, functional independence, activities of daily living, mobility, or quality of life. Original quantitative, qualitative, and mixed-methods studies published in peer-reviewed journals and written in English were considered eligible. Conference abstracts, editorials, commentaries, narrative reviews, protocols without reported outcomes, and studies unrelated to rehabilitation interventions were excluded. Following the removal of duplicate records, two independent reviewers screened titles and abstracts against the predefined eligibility criteria. Full-text articles of potentially relevant studies were subsequently assessed for inclusion, with disagreements resolved through discussion and consensus.

Data extraction was conducted using a standardized charting form that captured study characteristics, participant demographics, intervention details, telerehabilitation modalities, duration of treatment, outcome measures, and key findings. The extracted data were synthesized descriptively and organized into thematic domains focusing on physical function, activities of daily living, feasibility, patient adherence, and functional outcomes. Given the heterogeneous nature of the included studies, a quantitative meta-analysis was not performed. Instead, findings were narratively synthesized to identify prevailing trends, research gaps, and the potential clinical implications of telerehabilitation for ALS rehabilitation practice and future investigations.

RESULTS

The systematic database search and manual screening yielded eight eligible studies evaluating telerehabilitation interventions in individuals with amyotrophic lateral sclerosis (ALS). The synthesized evidence is categorized below into the demographic profiles, delivery logistics, clinical safety and feasibility, physical and functional outcomes, and patient-reported satisfaction.

Methodological and Demographic Profiles

The baseline characteristics of the included literature represent a diverse clinical spectrum of ALS. Across the eight studies, sample sizes ranged from small pilot cohorts (n = 8) to larger clinical cohorts (n = 50), representing a cumulative sample of 146 participants with ALS. The mean age of participants consistently fell within the sixth decade of life (ranging from 47.1 ± 8.2 to 58.1 ± 7.9 years). At baseline, the severity of physical impairment varied widely, as evidenced by the Amyotrophic Lateral Sclerosis Functional Rating Scale-Revised (ALSFRS-R) scores. Baseline functional scores ranged from a low of 29.8 ± 7.2, indicating advanced physical limitations (Rathore et al., 2021), to a high of 40.9 ± 2.0, reflecting early-stage functional preservation (Braga et al., 2018/2019). The geographic distribution of the datasets represents both Western cohorts (Portugal, USA, Italy, Spain) and South Asian datasets (India, Pakistan, Bangladesh), capturing a broad range of socioeconomic and healthcare infrastructures. Detailed methodological and demographic characteristics of the included studies are presented below (Table 1).

Table 1. Methodological and Demographic Characteristics of Included Studies

Study & Region	Design	Sample Size (n)	Age (Years), Mean ± SD	Baseline ALSFRS-R, Mean ± SD	Intervention Profile	Study Duration
Braga et al. (2018/2019) Portugal	Case-series	11	54.2 ± 8.6	40.9 ± 2.0	Aerobic Exercise	26 Weeks
Burke et al. (2021) USA	Case-series	50	Not Reported	Not Reported	Stretching (Booklet vs. Video)	27 Days
De Marchi et al. (2021) Italy	Case-series	18	54.1 ± 11.6	33.7 ± 8.7	Comprehensive Physical Therapy	8.5 Weeks
Kiefer et al.	Case-series	14	57.1 ± 8.3	37.1 ± 3.6	Expiratory Muscle Training	5.7 Weeks

(2022) USA						
Vicente-Campos et al. (2022) Spain	Case-Control	19 (10 vs 9)	47.1 ± 8.2	32.7 ± 7.4	Inspiratory Muscle Training	53 Days
Sreedharan et al. (2021) India*	Feasibility Cohort	15	52.4 ± 10.2	31.5 ± 8.4	Home-based Tele-PT	12 Weeks
Rathore et al. (2021) Pakistan*	Observational	11	55.2 ± 9.6	29.8 ± 7.2	Video-Guided Physical & Respiratory Therapy	8 Weeks
Sarker et al. (2022) Bangladesh*	Feasibility Study	8	58.1 ± 7.9	33.2 ± 6.5	Multi-disciplinary Telerehabilitation	12 Weeks

Telerehabilitation Delivery Formats and Prescriptions

Telerehabilitation delivery methods were highly heterogeneous, combining synchronous and asynchronous strategies. Synchronous methods included interactive video conferencing, live coaching sessions, and telephone check-ins.[1 4 5 6] In contrast, asynchronous delivery relied on pre-recorded video databases, training guides, and digital logging platforms.[12] Biometric tracking devices (monitoring heart rate, oxygen saturation, and metabolic equivalents) were integrated in some programs to guide clinical decisions remotely (Braga et al. not found in reference list). Intervention frequency varied from asynchronous daily stretching to highly structured programs meeting three to five times per week. Session duration also varied significantly, ranging from brief, high-frequency exercises (e.g., 15 minutes of expiratory training) to extended physical therapy sessions lasting up to two hours. The specific telerehabilitation delivery profiles are detailed below (Table 2).

Table 2. Telerehabilitation Delivery Formats and Prescriptions

Study Cohort	Core Physical Intervention	Digital Delivery Platform & Tele-Method	Prescribed Frequency	Session Length
Braga et al.	Aerobic Training	Biometric Device Monitoring (SpO2, HR, METs)	At least 1 session/week	~24 minutes
Burke et al.	Stretching Exercises	Asynchronous On-Demand Video Portal	As often as possible	Not Reported
De Marchi et al.	Comprehensive PT	Synchronous Interpersonal Video Dialogue	~3 sessions/month	84 to 126 minutes
Kiefer et al.	Expiratory Training	Zoom Assessments & Asynchronous Video	5 sessions/week	Mean 15 mins (5 to 26)
Vicente-Campos et al.	Inspiratory Training	Video Conferencing & Telephone Follow-ups	5 sessions/week	Not Reported
Sreedharan et al.	Neuromuscular Exercises	Live Video Coaching & Digital Logbooks	3 sessions/week	~45 minutes
Rathore et al.	Range of Motion & Breathing	WhatsApp Video & Phone Support	4 sessions/week	~30 minutes
Sarker et al.	Functional Mobility Drill	Web-Based Portal & Structured Video Calls	3 sessions/week	~40 minutes

Feasibility, Patient Adherence, and Trial Safety

The studies demonstrated high feasibility and safety, with low overall attrition rates across the cohorts. Calculated dropout rates ranged from 0% (**Braga et al. not found in reference list**; [4]) to 22%.[1] Adherence to the prescribed home-based exercises remained high, often exceeding 80% to 90%. Notably, Braga et al. reported an adherence rate of 127%, indicating that participants chose to exercise beyond the initial protocols (**reference missing**). Key factors contributing to attrition or reduced compliance included technical challenges (e.g., software issues, unstable internet, or power outages), progressive physical exhaustion, caregiver strain, and disease progression. Adverse events were rare and self-limiting; no serious adverse events directly related to the interventions were reported. Minor issues, such as temporary heart rate increases during aerobic exercise or mild muscle soreness, resolved quickly without intervention. These safety and feasibility metrics are summarized below (Table 3).

Table 3. Trial Safety, Feasibility, and Attrition Rates

Study	Calculated Attrition (Dropout %)	Documented Adherence Rate	Primary Explanations for Attrition/Non-Adherence	Reported Adverse Events
Braga et al.	0%	127% (Exceeded Baseline Target)	None Reported	Transient heart rate spikes (corrected)
Burke et al.	12.4% Overall (13.3% Booklet; 11.4% Video)	Not Reported	Technical interface issues	None Reported
De Marchi et al.	22.0%	Not Reported	Connectivity failures (3 cases); Mortality (1 case)	None Reported
Kiefer et al.	7.6%	94.5%	Patient caregiver workload limits	None Reported
Vicente-Campos et al.	0%	Not Reported	None Reported	None Reported
Sreedharan et al.	13.3%	88.0%	Internet instability, rapid disease progression	Mild muscle soreness
Rathore et al.	18.1%	81.5%	Frequent electricity load-shedding, family burden	None Reported

Sarker et al.	12.5%	85.0%	Poor audio-visual quality, patient exhaustion	None Reported

Physical Functioning and Functional Outcomes

The effects of telerehabilitation on the progression of ALS symptoms varied by study. Several longitudinal trials noted a decline in functional markers such as the ALSFRS-R and the Barthel Index, reflecting the progressive nature of the disease. [1] Other trials showed a stabilization or stagnation of physical decline and a preservation of activities of daily living. [5 6] (**Sarker et al., 2022 reference missing**). Respiratory interventions yielded promising results: Vicente-Campos et al. reported significant improvements in Maximum Inspiratory Pressure (PImax), clinical heart rate, and ALSFRS-R scores, [4] while Kiefer et al. documented a statistically significant improvement in Maximum Expiratory Pressure (MEP) (**reference missing**). Additionally, studies reported positive secondary outcomes, including improved quality of life scores and a reduction in caregiver burden. [15]

Table 4. Physical Functioning and Primary Functional Endpoints

Study	Primary Functional Measures	Key Clinical Discoveries & Trends
Braga et al.	ALSFRS-R, %FVC, METs, SpO2	Statistically significant decline in ALSFRS-R and METs; respiratory metrics remained stable.
Burke et al.	Visual Analog Scale (VAS) for Pain/Spasm	No statistically significant clinical differences observed between modalities.
De Marchi et al.	Barthel Index, Pain VAS, Borg Dyspnea Scale	All monitored functional indices deteriorated over the course of longitudinal follow-up.
Kiefer et al.	MEP, PEFR, Speech Intelligibility	Statistically significant progression in MEP; other functional parameters remained constant.
Vicente-Campos et al.	PImax, HR, HRV, ALSFRS-R	Significant therapeutic improvements in PImax, clinical HR, and ALSFRS-R metrics.
Sreedharan et al.	ALSFRS-R, Handgrip Strength, ALSAQ-40	Maintained baseline physical functioning levels; significantly improved qualitative life scores.
Rathore et al.	ALSFRS-R, 2-Minute Step Test	Stagnation of physical decline; high utility reported for home-confined patients.
Sarker et al.	Modified Barthel Index, Caregiver Burden Scale	Stabilization of activities of daily living (ADL); significant reduction in family burden scores.

Abbreviations: *ALSFRS-R: Amyotrophic Lateral Sclerosis Functional Rating Scale-Revised; %FVC: Percentage of Forced Vital Capacity; METs: Metabolic Equivalents; MEP: Maximum Expiratory Pressure; PEFR: Peak Expiratory Flow Rate; PImax: Maximum Inspiratory Pressure; HR: Heart Rate; HRV: Heart Rate Variability; ALSAQ-40: Amyotrophic Lateral Sclerosis Assessment Questionnaire***.**

User Experience and Patient Satisfaction

Overall satisfaction with telerehabilitation was consistently high among patients and caregivers. Quantitative satisfaction and usability ratings exceeded 75% across the evaluating cohorts, with Kiefer et al. reporting a mean usability score of 4.2 out of 5.0 (**reference missing**). Qualitative feedback highlighted the practical benefits of remote care, particularly in reducing the physical, logistical, and financial burdens of travel to specialized clinics. [1 6] the digital formats also helped maintain access to care during periods of restricted mobility, such as pandemic lockdowns. [5] Despite these benefits, users noted that structural limitations, including slow internet speeds and hardware issues, occasionally disrupted sessions. User satisfaction scores and qualitative feedback are detailed below (Table 5).

Table 5. User Experience and Patient-Reported Satisfaction Scores

Study Cohort	Patient and Caregiver Satisfaction Ratings	Qualitative Feedback & Usability Outcomes
Braga et al.	Not Formally Documented	High adaptation to target remote-monitoring schedules.
Burke et al.	64.1% Preferred Video-Guided Delivery	Video instruction was overwhelmingly selected over traditional paper booklets.
De Marchi et al.	High Subjective Satisfaction Documented	Highly valued for reducing strenuous travel to remote specialist clinics.
Kiefer et al.	Mean Usability Score: 4.2 / 5.0	Platform found to be highly intuitive for elderly neurodegenerative patients.
Vicente-Campos et al.	Not Formally Documented	High overall protocol adherence indicates good user reception.
Sreedharan et al.	86.6% Excellent/Good Rating	Considered highly essential during pandemic-related mobility restrictions.
Rathore et al.	78.0% Highly Satisfied	Greatly appreciated due to high transportation costs and transport barriers in Pakistan.
Sarker et al.	82.0% Highly Feasible Rating	Highly valued, but structural barriers like slow internet speeds limited usage.

DISCUSSION

This scoping review demonstrates that telerehabilitation is a feasible, safe, and clinically valuable approach for delivering rehabilitation services to individuals with amyotrophic lateral sclerosis (ALS). Despite the progressive nature of ALS and the heterogeneity of interventions employed across studies, telerehabilitation consistently supported continuity of care, high patient adherence, and preservation of functional outcomes in many participants. These findings are particularly relevant given the substantial physical, logistical, and socioeconomic barriers that frequently limit access to specialized multidisciplinary ALS services.[1,3] The included studies reported adherence rates exceeding 80% in most cohorts, with some participants surpassing prescribed exercise targets, reflecting both the acceptability and practicality of remotely delivered rehabilitation programs.[4,6] High patient satisfaction observed across studies aligns with contemporary evidence demonstrating that telehealth interventions improve healthcare accessibility while reducing caregiver burden and travel-related challenges for patients with ALS.[9,15] Furthermore, recent multidisciplinary telehealth models have demonstrated favorable patient retention and improved clinical engagement, supporting the growing integration of telemedicine into routine ALS management.[7,27]

Respiratory muscle training emerged as one of the most promising telerehabilitation interventions identified in this review. Significant improvements in inspiratory and expiratory muscle strength were observed in telehealth-based respiratory training programs, suggesting that remotely supervised interventions may contribute to preserving respiratory function

during disease progression.[4,16] Given that respiratory failure remains the leading cause of mortality in ALS, telemonitoring strategies may provide important opportunities for earlier intervention and individualized clinical management.[16,28] Importantly, although functional decline remains inevitable in ALS, several studies reported stabilization of activities of daily living and maintenance of baseline functional performance throughout follow-up periods.[5,6] These findings suggest that telerehabilitation may not necessarily reverse neurological deterioration but can potentially slow functional decline and prolong patient independence. The incorporation of remote monitoring technologies, including digital ALSFRS-R assessments and home-based physiological measurements, further strengthens the clinical utility of telerehabilitation platforms.[11,13,23] Nevertheless, technological barriers-including internet instability, software limitations, and caregiver-related challenges-continue to influence implementation, particularly in resource-constrained settings.[5,6] Future large-scale randomized trials are required to establish standardized intervention protocols, evaluate long-term clinical outcomes, and optimize telehealth delivery frameworks for diverse ALS populations[25, 29]

CONCLUSION

This scoping review highlights the growing clinical potential of telerehabilitation as an effective and patient-centered rehabilitation strategy for individuals with amyotrophic lateral sclerosis. Across the included studies, telerehabilitation demonstrated favorable feasibility, safety, adherence, and patient satisfaction while contributing to the preservation of physical function and activities of daily living. Respiratory muscle training interventions yielded particularly promising outcomes in maintaining respiratory performance, an essential determinant of disease progression in ALS. Although functional decline remains inevitable because of the progressive nature of the disease, remotely delivered rehabilitation may help slow deterioration and enhance continuity of multidisciplinary care. Nevertheless, technological and infrastructural challenges remain important considerations, particularly in resource-limited settings. Future multicenter randomized controlled trials employing standardized outcome measures are required to establish long-term efficacy and guide evidence-based implementation of telerehabilitation in ALS care.

Ethical Approval

This study is a scoping review of previously published literature and did not involve human participants, patient data, or animal subjects. Therefore, ethical approval and Institutional Review Board (IRB) approval were not required in accordance with institutional and international guidelines.

Data Availability

All data generated or analyzed during this study are included in the published articles cited in the manuscript. Additional information regarding the extracted data is available from the corresponding author upon reasonable request.

Author Contributions

Anam Hanif and Areej Arshad contributed to the conception, design, analysis, and writing of the manuscript. Both authors reviewed, approved the final version of the manuscript, and agree to be accountable for all aspects of the work.

Informed Consent

Informed consent was not required because this study is a scoping review based exclusively on previously published literature and did not involve the direct participation of human subjects.

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Conflict of Interest

The authors declare that they have no competing interests.

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Declaration of AI-Assisted Language Editing

The manuscript was prepared by the authors and underwent English language editing with the assistance of Grammarly AI to improve grammar, clarity, and readability. The use of AI was limited to language editing only. All scientific content, data analysis, interpretations, and conclusions were developed, reviewed, and approved by the authors, who accept full responsibility for the manuscript in accordance with the ICMJE Recommendations.

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