

# Assessing the Major Aspects and Implications of Telerehabilitation Services: A Bibliometric Analysis

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## INDEXING

### Keywords:

Telerehabilitation services;  
Healthcare delivery;  
Treatment;  
Quality;  
Outcomes

## ABSTRACT

Telerehabilitation has emerged as a promising option for delivering rehabilitation services to individuals with physical impairments, but its effectiveness, efficiency, and economic implications are not yet fully understood. This study explores the relationship between telerehabilitation services and various aspects of healthcare delivery, including treatment, quality, outcome, and delivery of telerehabilitation. The Scopus database (<https://www.scopus.com>) with the term "Telerehabilitation Services" from 2012 to 2021 was used to gather the most recent evidence for this type of research: qualitative research on telerehabilitation services. Studies reporting on clinical outcomes and delivery of healthcare topics were included in the selected publications. VOSviewer, MAXQDA Analytic Plus, and Nvivo 12 Plus analytical tools assisted data analysis and extraction procedures. The findings indicated that telerehabilitation directly impacts health, with a very strong correlation value of 0.962644. Therapy, Aged, Stroke, Telemedicine, COVID-19, Treatment, Quality, Outcome, and Delivery also showed a strong correlation ranging from 0.851146 to 0.921129. Telerehabilitation services had a significant relationship with technology, physiotherapy, and feasibility, with a correlation ranging from 0.427715 to 0.572538. Challenges include the need for appropriate technology and infrastructure, data privacy and security concerns, and the potential for technology-related errors. Telerehabilitation significantly influenced healthcare delivery, including stroke, COVID-19, treatment, quality, outcome, delivery, technology, physiotherapy, and feasibility. Challenges remain, and further research is needed to evaluate cost-effectiveness in different settings and populations. Technology can enhance patient outcomes with proper planning, training, and support.

### Kata kunci:

Layanan  
telerehabilitasi;  
Pengiriman layanan  
kesehatan;  
Perlakuan;  
Kualitas;  
Hasil

Telerehabilitasi telah muncul sebagai pilihan yang menjanjikan untuk memberikan layanan rehabilitasi kepada individu dengan gangguan fisik, namun efektivitas, efisiensi, dan implikasi ekonominya belum sepenuhnya dipahami. **Tujuan:** Untuk mengeksplorasi hubungan antara layanan telerehabilitasi dan berbagai aspek pemberian layanan kesehatan, termasuk pengobatan, kualitas, hasil, dan pengiriman telerehabilitasi. Database Scopus (<https://www.scopus.com>) dengan istilah "Layanan Telerehabilitasi" dengan rentang tahun dari 2012 hingga 2021 digunakan untuk mengumpulkan bukti terbaru untuk jenis penelitian ini adalah penelitian kualitatif tentang telerehabilitasi jasa. Studi melaporkan hasil klinis, penyampaian topik perawatan kesehatan termasuk dalam publikasi yang dipilih. Prosedur analisis dan ekstraksi data dibantu oleh alat analisis VOSviewer, MAXQDA Analytic Plus, dan Nvivo 12 Plus. Telerehabilitasi berdampak langsung terhadap kesehatan, dengan nilai korelasi yang sangat kuat sebesar 0,962644. Terapi, Usia, Stroke, Telemedicine, Covid-19, Pengobatan, Kualitas, Hasil, dan Persalinan juga menunjukkan korelasi yang kuat mulai dari 0,851146 hingga 0,921129. Layanan telerehabilitasi juga memiliki hubungan yang signifikan dengan teknologi, fisioterapi, dan kelayakan, dengan korelasi berkisar antara 0,427715 hingga 0,572538. Tantangan dapat berupa kebutuhan akan teknologi dan infrastruktur yang tepat, masalah privasi dan keamanan data, dan potensi kesalahan terkait teknologi. Telerehabilitasi berdampak signifikan terhadap pemberian layanan kesehatan, termasuk stroke, Covid-19, pengobatan, kualitas, hasil, pengiriman, teknologi, fisioterapi, dan kelayakan. Tantangan tetap ada, dan penelitian lebih lanjut diperlukan untuk mengevaluasi efektivitas biaya dalam pengaturan dan populasi yang berbeda. Dengan perencanaan, pelatihan, dan dukungan yang tepat, teknologi dapat meningkatkan hasil pasien.

## INTRODUCTION

Rehabilitation is an essential component of healthcare that aims to assist individuals who are experiencing or are at risk of experiencing disabilities, according to the World Report on Disability (World Health Organization. & World Bank., 2011). It involves a comprehensive set of measures designed to help people achieve and maintain their optimal level of functioning in their interactions with the environment. Rehabilitation focuses on a person-centered approach, which means that the individual receiving rehabilitation services is at the center of the process, and their unique needs and preferences are considered (Gutenbrunner et al., 2015).

Telerehabilitation, defined as the delivery of rehabilitation services remotely using information and communication technology, has emerged as a promising alternative to traditional in-person rehabilitation, especially in remote or underserved areas where access to healthcare services is limited (Laver et al., 2020). Telerehabilitation has been demonstrated to deliver a high level of satisfaction for patients in various settings and populations utilizing telehealth services, with the satisfaction of patients being impacted by factors such as convenience, accessibility, quality of care, communication, privacy, and technical aspects. Additionally, telehealth services were discovered to be as effective and efficient as traditional face-to-face care or even better (Kruse et al., 2017a). Moreover, telerehabilitation is an attractive option for patients living in rural or distant places where access to rehab services may be restricted or for those with mobility challenges or other health conditions that make travel difficult (Gagnon, 2015; van der Meer et al., 2017).

Studies have demonstrated the effectiveness of telerehabilitation in managing various medical conditions, such as stroke, spinal cord injury, and traumatic brain injury (Laver et al., 2020). For instance, a randomized controlled trial discovered that telerehabilitation helped those with traumatic brain injury improve their upper limb function (Karshmer & Garland, 2017). Another study found that telerehabilitation helped people with Multiple Sclerosis disease balance and walk more naturally (Souza, 2021). With the increasing availability of telehealth technologies, telerehabilitation has emerged as a promising alternative to traditional in-person rehabilitation, especially in remote or underserved areas with limited access to healthcare services.

In response to the evolving medical landscape, the World Confederation for Physical Therapy has issued a position statement on telerehabilitation, also known as virtual rehabilitation, to enhance access to care (Turolla et al., n.d.). This innovative approach has opened new opportunities for physical therapists to provide care using an alternative delivery model, making it possible to provide rehabilitation services to patients who might otherwise not receive them due to geographic or financial barriers. Therefore, exploring the clinical outcomes, process, and economic implications of telerehabilitation services is crucial in advancing the use of this technology in rehabilitation.

Telerehabilitation has several advantages but has certain drawbacks and challenges that must be addressed to ensure its effectiveness and safety. One of the major concerns is assuring the caliber and dependability of telerehabilitation services (Karshmer & Garland, 2017). In addition, it is essential to manage issues concerning data security and privacy, ensure reliable technology and internet connectivity, and establish interprofessional collaboration among healthcare professionals such as physical therapists, occupational

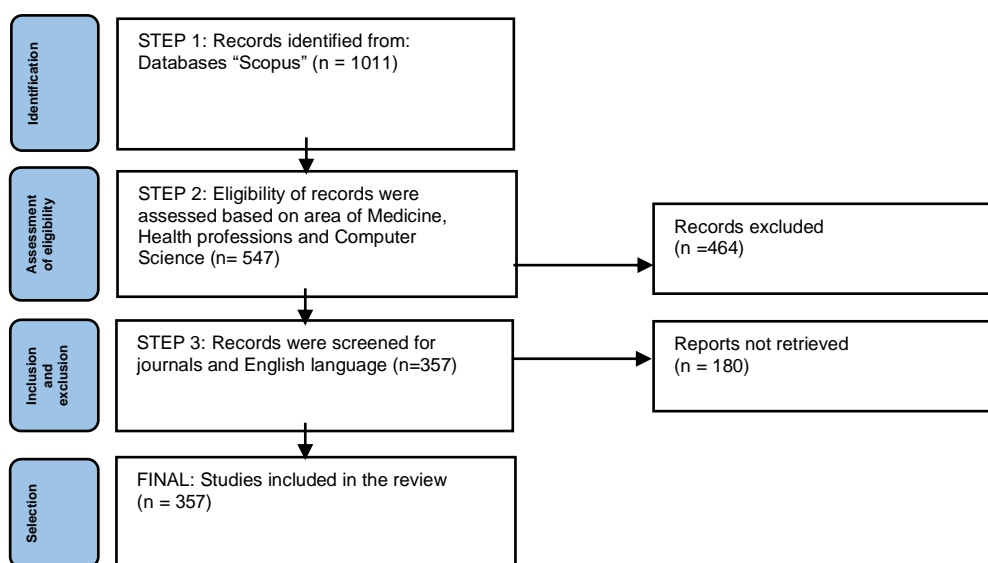
therapists, and speech therapists (Ortiz Gutiérrez et al., 2013). physical medicine and rehabilitation providers and patients face several difficulties when using telehealth. These are related to protecting privacy and security; having consistent and clear rules, standards, and payment methods; accessing the necessary devices and equipment; getting enough training and technical help; maintaining a personal connection and rapport; and resolving ethical issues (Tenforde et al., 2017).

As a result, this research provides a bibliometric review of the developments in telerehabilitation research. It aims to examine the clinical outcomes and clinical telerehabilitation process and its economic implications. Using the term "clinical outcomes" highlights the emphasis on patient outcomes and the potential impact of telerehabilitation on their health and well-being.

## RESEARCH METHOD

This study used a qualitative bibliometric review to investigate the impact of telerehabilitation on patient and provider satisfaction, clinical outcomes, delivery, and costs. The Scopus database searched for articles published between 2012 and 2021 using the keywords "telerehabilitation" and "services". Only English-language journal articles were included, resulting in 357 documents. The researchers used VOSviewer, Nvivo Plus 12, and MAXQDA Analytic 2022 to analyze original papers and conferences. All data were collected in March and December 2023 to minimize database expansion effects and prevent bias.

This study exported data in RIS format and used two types of analysis: Scopus menu search and VOSviewer/MAXQDA software. Scopus was used to analyze publication characteristics, while VOSviewer was used to determine bibliometric maps on "Medicine," "Health Professions," and "Computer Science." MAXQDA was used to test relationships between indicators and key phrases. The study aimed to promote future research on Telerehabilitation services and mapped frequently used terms using VOSviewer. Telerehabilitation Services were based on title or author keywords. More details on the analysis mechanism can be found in the analytical methods section.



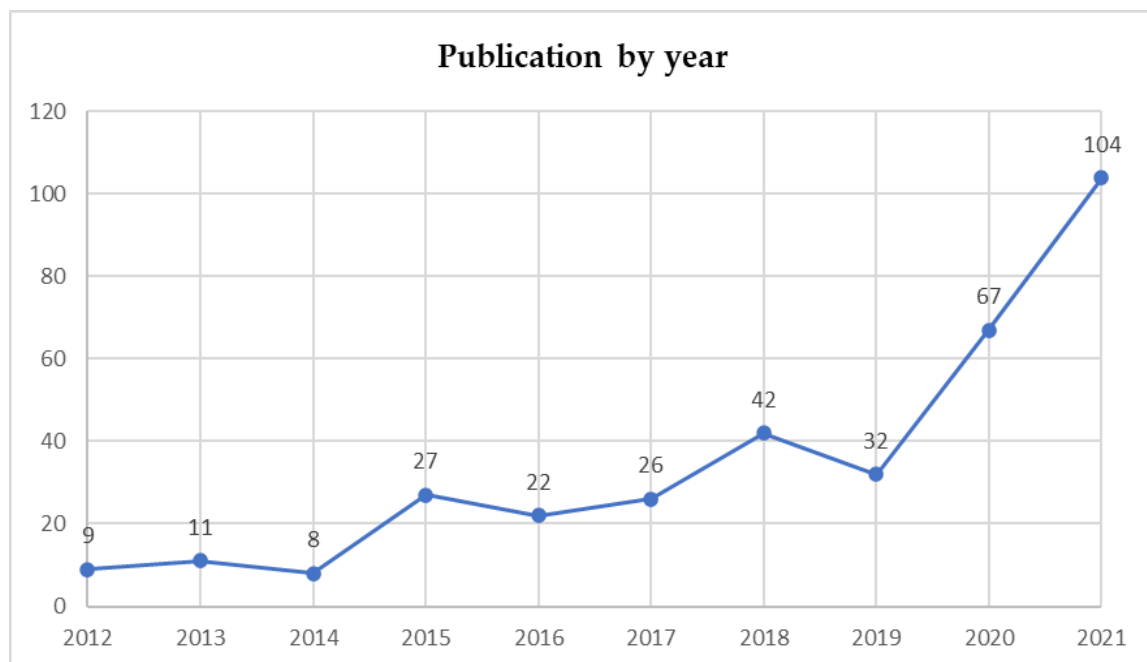
Picture 1. The Steps in Selecting Articles

Researchers used a combination of mixed citations and bibliometric searches to analyze the dimensions and units of their bibliometric investigation, including co-authorships, bibliographic coupling, and co-citations, which helped the researchers examine the social structure, document set patterns, and conceptual framework of the study's subject. To produce figures and data from cited papers, the researchers utilized co-occurrence analysis of keywords and co-citation reference network analysis of telerehabilitation services. This categorization of studies allowed for comparing results in programs with comparable features. More details are provided in the next section.

## RESULTS AND DISCUSSION

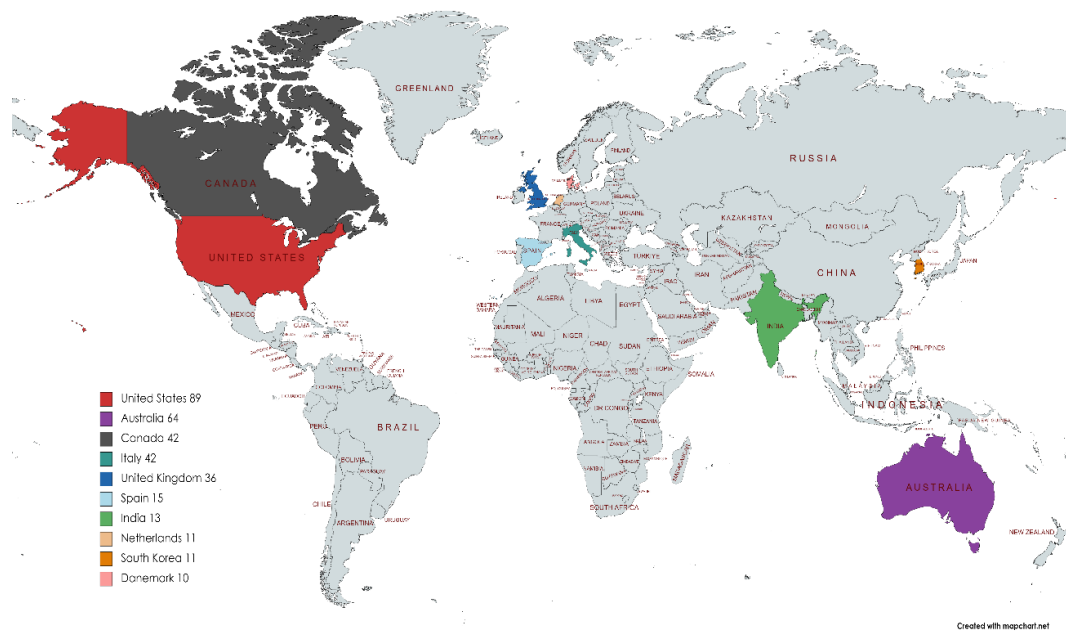
### *Development Trends in Telerehabilitation Services Research Studies*

**Availability by Year.** Figure 2 shows the results of a comprehensive bibliometric analysis performed using the VOSviewer tool and Scopus. The 348 documents in this study's investigation covered the last ten years (2012 to 2021). Picture 2 also displays the yearly publishing pattern for telerehabilitation services. Data for this inquiry were collected from 2012 through 2021. Studies on the evaluation of telerehabilitation services over the previous ten years showed increased articles released, especially in 2021.



Picture 2. Number of Publications by Year

### Geographic Distribution



**Picture 3. Documents by Country**

Picture 3 shows the publication breakdown per nation, with the United States generating the most (89 documents) between 2012 and 2021, according to Scopus search results. The US has a strong education system, and many authors are graduates of top colleges, so this ranking is expected. Italy ranked third with 42 papers, Australia second with 64 documents, and India is the top-ranked nation in Asia with the most publications.

### Distribution of Documents Based on Citations

**Table 1. Number of Citations per Article Distribution**

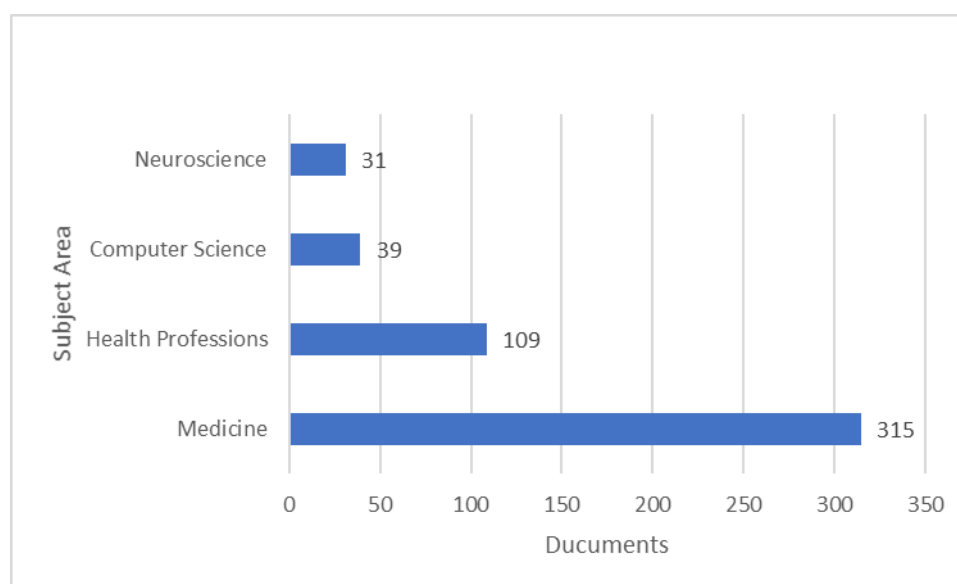
Title	Author and Year	Source	Citations
<i>Telerehabilitation Services for Stroke</i>	Laver, K.E., et al., 2013	Cochrane Database of Systematic Reviews	209
<i>In-Home Telerehabilitation Compared with Face-to-Face Rehabilitation After Total Knee Arthroplasty: A Non-Inferiority Randomized Controlled Trial</i>	Moffet, H., et al., 2015	Journal of Bone and Joint Surgery	150
<i>Home-Based Maintenance Telerehabilitation Reduces the Risk for Acute Exacerbations of COPD, Hospitalisations and Emergency Department Visits</i>	Vasilopoulou, M. et al., 2017	European Respiratory Journal	115
<i>Home-Based Telerehabilitation Is Not Inferior to A Center-Based Program in Patient with Chronic Failure: A Randomized Control Trial</i>	Hwang, R., et al., 2017	Journal of Physiotherapy	112
<i>Effects and Costs of Real-Time Cardiac Telerehabilitation: Randomised Controlled Non-Inferiority Trial</i>	Maddison, R., 2019	Heart	110

**Table 1. Number of Citations per Article Distribution (cont')**

Title	Author and Year	Source	Citations
<i>ESC e-Cardiology Working Group Position Paper: Overcoming Challenges in Digital Health Implementation in Cardiovascular Medicine</i>	Fredrix, I., 2019	Stroke	109
<i>Effects of Telerehabilitation on Physical Function and Disability for Stroke Patients: A Randomized, Controlled Trial</i>	Chumbler, N.R., 2012		109
<i>Outpatient Physical, Occupational, and Speech Therapy Synchronous Telemedicine; A Survey Study of Patient Satisfaction with Virtual Visits during the COVID-19 Pandemic</i>	Tenforde, AS, 2020	American Journal of Physical Medicine and Rehabilitation	108
<i>Recommendations for the Implementation of Telehealth in Cardiovascular and Stroke Care: A Policy Statement from the American Heart Association</i>	Schwamm, L.H., 2017	Circulation	106
<i>Telehealth for Musculoskeletal Physiotherapy</i>	Cottrell, MA, 2020	Musculoskeletal Science and Practice	105

Table 1 classifies articles based on their number of citations between 2012 and 2021, identifying the top ten most relevant research publications on Telerehabilitation Services. These publications usually relate to effectiveness, cost-efficiency, and delivery, and the citation numbers have been standardized through Scopus.

#### Trending Topics by Subject Area

**Picture 4. Documents by Subject Area**

Picture 4 displays the study topics related to Telerehabilitation Services, with medicine, health professions, computer science, and neuroscience being the most examined fields.

Researchers often select a specific subject area to focus their search for relevant publications. In this case, the areas of medicine, health professions, and computer science are most directly related to the research goal.

*Distribution of Documents by Keyword*

**Table 2. Trending Topics from Keywords**

Word	Word length	Frequency	Weight Percentage%
rehabilitation	14	1630	1.56
health	6	1520	1.45
telerehabilitation	18	1471	1.40
care	4	1058	1.01
study	5	876	0.84
patients	8	784	0.75
therapy	7	695	0.66
department	10	666	0.64
patient	7	614	0.59
services	8	596	0.57
clinical	8	565	0.54
aged	4	539	0.51
exercise	8	518	0.49
physical	8	511	0.49
stroke	6	491	0.47
medicine	8	462	0.44
disease	7	428	0.41
telemedicine	12	420	0.40
home	4	406	0.39
hospital	8	403	0.38
trial	5	388	0.37
group	5	386	0.37
states	6	381	0.36
covid-19	8	373	0.36
medical	7	371	0.35
treatment	9	359	0.34
controlled	10	354	0.34
quality	7	353	0.34
sciences	8	349	0.33
service	7	347	0.33
address	7	342	0.33
human	5	339	0.32
intervention	12	335	0.32
system	6	330	0.32
results	7	326	0.31
life	4	324	0.31



Table 2. Trending Topics from Keywords (cont')

Word	Word length	Frequency	Weight Percentage%
program	7	318	0.30
correspondence	14	313	0.30
participants	12	310	0.30
school	6	308	0.29
adult	5	297	0.28
outcome	7	294	0.28
delivery	8	289	0.28
analysis	8	285	0.27
technology	10	279	0.27
telehealth	10	275	0.26
humans	6	254	0.24
physiotherapy	13	253	0.24
middle	6	252	0.24
feasibility	11	251	0.24

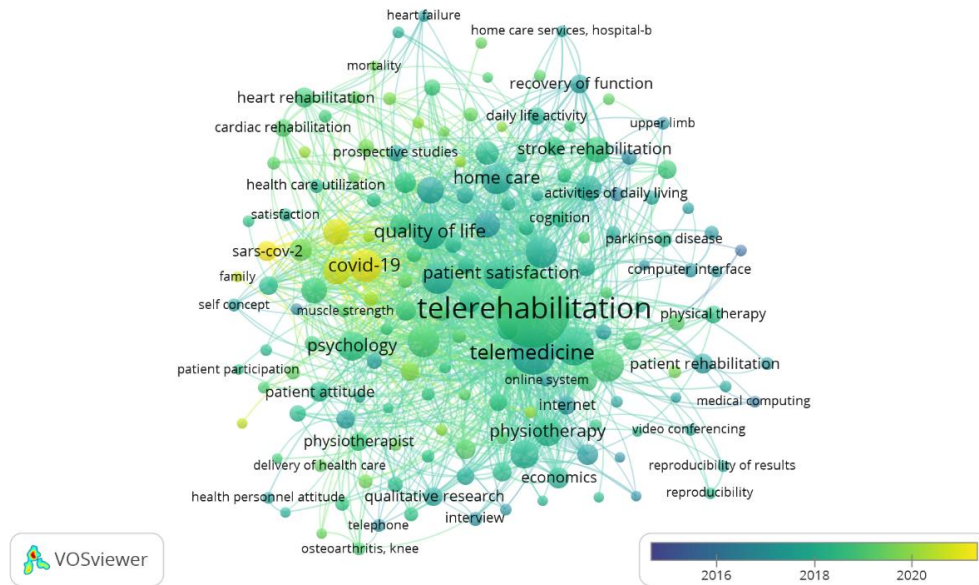
Table 2 shows the most frequent topics in telerehabilitation research based on MAXQDA Analytic Pro 2022 analysis. Rehabilitation, health, and telerehabilitation are the top three trending topics, followed by care and study. Outcome, delivery, and services are also among the most common topics. However, there is a lack of discussion on cost and assessment. Picture 5 displays the top 50 trending topics in a word cloud.



Picture 5. Trending Topics from the MAXQDA

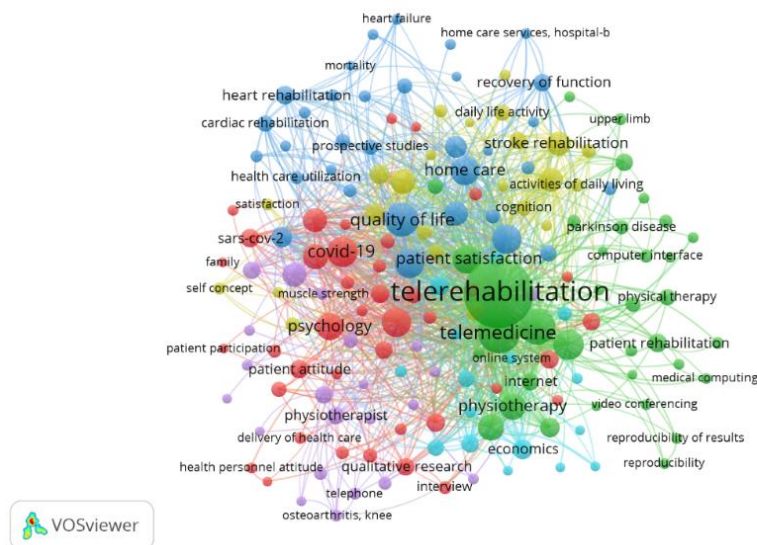


### Document Visualization of Element Distribution



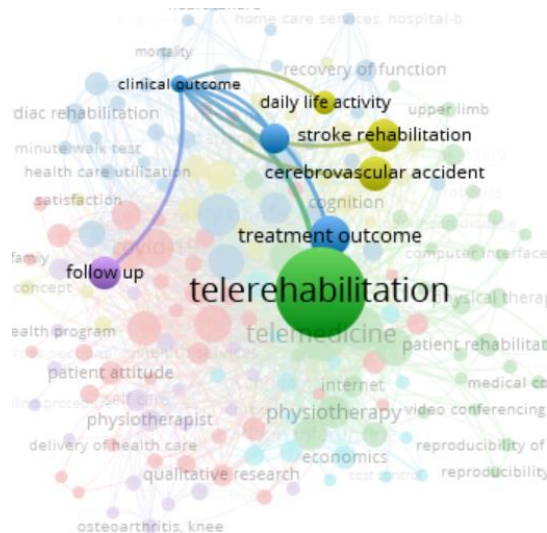
*Picture 6. The Keywords by Year*

This study examines publication volume, trends in research subjects, and yearly publication counts from 2012 to 2021. The most notable trend in research topics was observed in 2017, focusing on Telemedicine, Exercise Therapy, Home Care Services, Home Care, and Outcome Assessment. In 2018, the focus shifted toward Telehealth, Quality of Life, Health Care Delivery, Stroke Rehabilitation, Clinical Outcome, and Virtual Reality. More recently, research related to Covid-19 and the pandemic has become a trend since 2019.



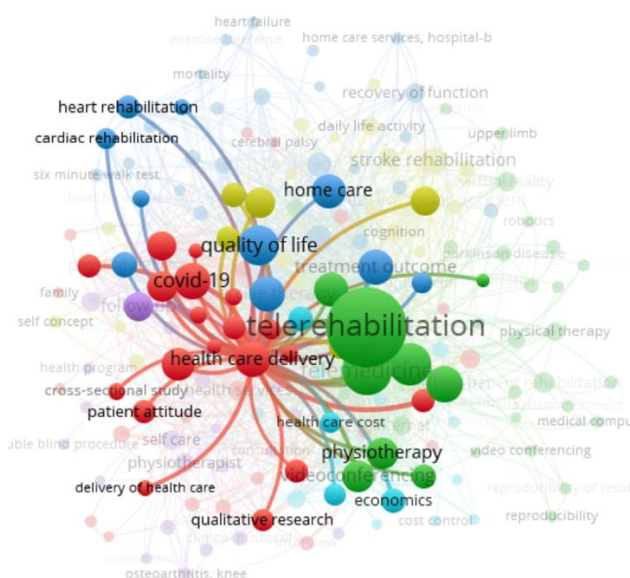
### Picture 7. Title and Description Visualization Analysis

Picture 7 displays the major concepts from the cluster density analysis. Each cluster is color-coded to indicate density, with the list providing valuable insights for future studies by identifying themes discussed in previous research. The prominent topics in Telerehabilitation Services between 2012-2021 were Home Care, Treatment Outcomes, Health Care Delivery, and COVID-19. Treatment Outcome and Health Care Delivery were particularly important, as they directly impact the outcome of telerehabilitation services for individuals with disabilities.



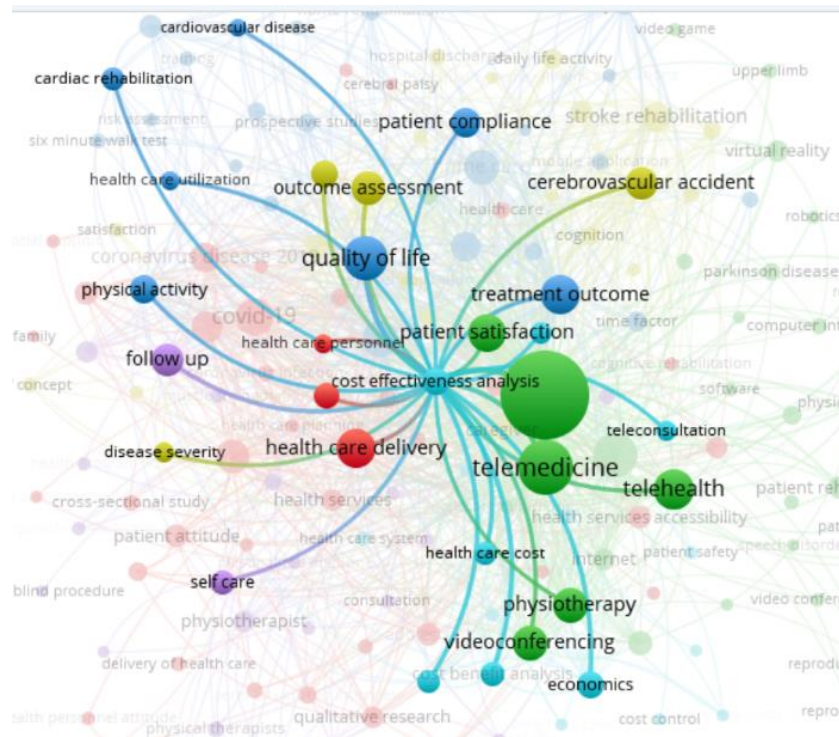
**Picture 8. Network of clinical outcomes in telerehabilitation services**

The researcher found that Treatment Outcome, Quality of Life, Recovery of Function, Patient Attitude, and Patient Satisfaction are important factors in Telerehabilitation Services. Picture 8 depicts their close relationship.



### Picture 9. Network of delivery of healthcare

Picture 9 highlights the significant impact of design strategy on healthcare delivery. The trends in design strategy include telerehabilitation services, video conferencing, video recording, home care, and healthcare accessibility. The study also notes that patient attitude and personnel motivation are important factors affecting the efficiency of the clinical process and healthcare delivery.



**Picture 10. Network of Cost-Effectiveness Analysis**

Picture 10 illustrates how outcome evaluation, disease severity, healthcare costs, clinical effectiveness, and patient compliance are used for the cost-effectiveness analysis of telerehabilitation services. Continuous use of these services can improve quality of life and satisfaction, and their cost-effectiveness is linked to economic issues. Researchers aim to enhance patient satisfaction and cost-effectiveness by utilizing experience and cost-effectiveness analysis. VosViewer data analysis can measure patient happiness and quality of life, leading to improved efficiency.

#### Cluster Analysis

VOSviewer was used to map telerehabilitation services research into 6 clusters. Table III helps researchers begin their research by identifying clusters. Clusters 4 and 5 had 16 items each (15.2%), Cluster 6 had 12 items (11.4%), and Cluster 7 had 5 items (4.7%). Clusters 6 and 7 contained infrequently studied subject items, presenting a research gap for researchers to explore.

**Table 3. The Clusters of Keyword Analysis**

Cluster Number and Color	Items	Total	Percentage
<b>Cluster 1 Red Color</b>	adolescent, attitude of health person, cerebral palsy, clinical practice, cognitive rehabilitation, coronavirus disease 2019, coronavirus infection, covid-19, cross-sectional study, delivery of health care, disabled person, education family, health care, health care access, health care delivery, health care personnel, health care planning, health personnel attitude, health service, health services, health services accessibility, interview, motivation, multiple sclerosis, neurorehabilitation, occupational therapy pandemic, patient acceptance of health care patient attitude, patient participation, prevention and control, psychology, qualitative research, rehabilitation center, rehabilitation medicine, sars-cov-2, semi-structured interview, social support, video recording	40	23,6%
<b>Cluster 2 Green Color</b>	Clinical evaluation, computer interface, eHealth, internet, interpersonal communication, knee replacement, medical computing, Parkinson's disease, patient rehabilitation, patient satisfaction, patient treatment, physical therapy, physiotherapy, rehabilitation, rehabilitation services, remote consultation, reproducibility, reproducibility of results, robotics, software, speech disorder, speech therapy, telecommunication, telehealth, telemedicine, telepractice, telerehabilitation, upper limb, user-computer interface, video conferencing, virtual reality	35	20,7%
<b>Cluster 3 Blue Color</b>	Cardiac rehabilitation, cardiovascular disease, clinical outcome, devices, exercise therapy, exercise tolerance, health care utilization, heart failure, heart rehabilitation, home care, home care services, home care services "hospital-based", home rehabilitation, hospitalization, mobile application, mobile applications, mortality, patient compliance, physical activity, physiology, postural balance, prospective studies, quality of life, recovery of function, remote sensing, resistance training, risk assessment, risk factors, six minutes walk test, smartphone, time factor, training, treatment outcome, smartphone, software, telehealth, telerehabilitation.	33	19,5%

**Table 3. The Clusters of Keyword Analysis (cont')**

Cluster Number and Color	Items	Total	Percentage
<b>Cluster 4</b> <b>Yellow Color</b>	activities of daily living, caregiver, cerebrovascular accident, clinical effectiveness, cognition, cognitive defect, daily life activity, disability, disability evaluation, disease severity, hospital discharge, length of stay, outcome assessment, outcome assessment (health care), outpatient, patient care, satisfaction, self-concept, stroke patient, stroke rehabilitation, telerehabilitation, total quality management, treatment duration	23	13,6%
<b>Cluster 5</b> <b>Purple Color</b>	Clinical protocol, clinical protocols, comparative effectiveness, consultation, double-blind procedure follow-up, health program, muscle strength, osteoarthritis, osteoarthritis "knee", patient education, patient monitoring, patient referral, personalized medicine, physical therapists, physiotherapist, pulmonary rehabilitation, self-care, self-report, self-management, technology, telephone	22	13%
<b>Cluster 6</b> <b>Light-Blue Color</b>	cost-benefit analysis, cost control, cost-effectiveness analysis, cost-benefit analysis, economics, health care cost, health care costs, health care quality, health care system, long-term care, online system, patient safety, physiologic monitoring, standards, teleconsultation, telemonitoring	16	9,4%

Table 3 identifies specific topics of interest through cluster analysis. The six clusters cover healthcare access, physiotherapy, clinical outcomes, cost-benefit analysis, and personalized medicine. The researchers found that the key issues relevant to the study were healthcare delivery, clinical outcome and effectiveness, and cost benefits.

**Table 4. Cluster Theme based on Keyword Analysis**

Cluster Theme	Author	Purpose	Finding
<b>Cluster I: factors of healthcare delivery and rehabilitation</b>	(Tchero et al., 2018)	This systematic review and meta-analysis examined whether telerehabilitation is effective for post-stroke patients.	Most included studies revealed that both groups were equivalent regarding patients' satisfaction with care, Caregiver Strain Index, and health-related quality of life (for stroke survivors). Telerehabilitation can be a good substitute for standard rehabilitation therapy for poststroke patients in rural or underserved places.



**Table 4. Cluster Theme based on Keyword Analysis (cont')**

Cluster Theme	Author	Purpose	Finding
<b>Cluster I: factors of healthcare delivery and rehabilitation</b>	(Stephenson et al., 2021)	The study examined the platforms, technical requirements, training, support, accessibility, cost, acceptability, and usefulness of stroke telerehabilitation therapies.	The study discovered that integrating telerehabilitation into stroke care and producing transferable knowledge on scalability and routinization of this service paradigm present substantial hurdles. The study suggests techniques including ensuring enough training and technological infrastructure, encouraging collaborative decision-making, and considering patient preferences to enhance the implementation of telerehabilitation therapy.
<b>Cluster II: How technology is used in healthcare and rehabilitation</b>	(Gandolfi et al., 2017)	The main objective of this study was to compare the enhancements in postural stability resulting from in-home virtual reality balance training supervised remotely and in-clinic balance training involving sensory integration.	According to the study, analyses showed significant Time Group interactions in the Dynamic Gait Index for the in-clinic group and significant between-group variations in improvement on the Berg Balance Scale for the VR (Virtual Reality) telerehabilitation group. Apart from fall frequency, both groups displayed variations with time in each outcome measure.
	(Maria Souza Mattos de Araújo Vieira, Alves de Andrade and de Oliveira Sato, 2021)	This overview examined the data from telerehabilitation systematic reviews for treating musculoskeletal pain.	Three hundred ninety (390) possibly relevant studies were found through the search, and 16 systematic reviews were also included in this summary. The majority of the meta-analyses in the eleven reviews had good methodological quality. Two of three high-quality systematic studies found no evidence for non-specific low back pain. In contrast, five of six systematic reviews found evidence favoring telemedicine interventions for chronic pain problems.
<b>Cluster III: Clinical Outcomes</b>	(Nelson et al., 2017)	This study intends to ascertain if a telerehabilitation therapy administered remotely is cost-efficient for healthcare professionals and patients while being just as successful as face-to-face rehabilitation in the THR population.	Prior studies examining the effectiveness of telerehabilitation in postoperative orthopedic problems have shown encouraging outcomes. Telerehabilitation after THR might be useful in resolving access concerns in this group if it is as successful as in-person therapy. Also, allowing patients to approach their rehabilitation more autonomously may assist in lowering the cost of healthcare services.

Table 4. Cluster Theme based on Keyword Analysis (cont')

Cluster Theme	Author	Purpose	Finding
Cluster III: Clinical Outcomes	(Bini & Mahajan, 2016)	Fifty-one (51) patients were randomly assigned to the intervention group, which used a mobile device and asynchronous video program, or the control group, which underwent outpatient physical therapy. Outcome data were gathered using validated instruments before surgery and at a minimum three-month follow-up.	The study involved 29 patients and found no significant difference in clinical outcomes or patient satisfaction between those receiving asynchronous telerehabilitation via a handheld device and those receiving conventional therapy. However, the study found that the telerehabilitation group used hospital-based resources 60% less frequently. The findings suggest that asynchronous telerehabilitation could be a viable alternative to in-person therapy or real-time video visits.
Cluster IV: The clinical effectiveness of stroke telerehabilitation	(Laver et al., 2020)  (Cramer et al., 2019)	The study assessed how telerehabilitation and traditional face-to-face rehabilitation affected stroke survivors' ability to use their upper and lower limbs and carry out everyday tasks.  The study aimed to ascertain if arm movement therapy given at home using a telerehabilitation (TR) system is as effective as in-clinic therapy for enhancing motor function in stroke patients.	There were 1,068 patients across 17 randomized controlled trials in the research. According to the study, telerehabilitation helped stroke survivors with their everyday tasks and ability to use their upper and lower limbs more effectively. The authors hypothesized that telerehabilitation could be a good option for stroke patients seeking traditional face-to-face therapy.  Telerehabilitation was shown to be just as effective as standard in-clinic rehabilitation in this randomized, assessor-blinded, non-inferiority clinical study of 124 persons who had recently suffered a stroke for improving motor status (Fugl-Meyer arm motor scale) and increasing patient understanding of stroke.  Telehealth is beneficial for providing rehabilitation therapy, enhancing patient outcomes following a stroke, and perhaps facilitating better access to rehabilitation therapy.



Table 4. Cluster Theme based on Keyword Analysis (cont')

Cluster Theme	Author	Purpose	Finding
Cluster V: the use of technology and personalized approaches in clinical protocols	(Sarfo et al., 2018)	The study aimed to assess how home-based tele-supervised rehabilitation affected stroke patients' physical function and see if it may lessen the load on carers.	In all studies examined, the study found that telerehabilitation interventions were linked to significant improvements in the recovery from motor deficits, higher cortical dysfunction, and depression in the intervention groups. However, only 8 of the 22 studies found significant differences between the intervention and control groups in favor of the telerehabilitation group, while the remaining studies found nonsignificant differences.
	(Cirillo & Valencia, 2019)	The project intends to investigate how big data analytics may enhance patient outcomes and lower healthcare costs in customized medicine.	The study's findings imply that big data analytics may enhance patient outcomes and lower medical expenses. The study concludes that major scientific and technological advancements will be needed to build robust systems for the efficient use of biomedical Big Data in personalized medicine.
Cluster VI: Economic evaluation of telehealth and its impact on healthcare costs and quality	(Rinaldi et al., 2020)	To compile and assess the available research on the expense and efficacy of mobile health treatments for type 2 diabetes mellitus.	Depending on the kind, quantity, or mix of technologies utilized, interventions might cost anywhere from 1.8 and 10101.1 INR per patient per year. The studies that provided cost-effectiveness data showed that the treatments were very cost-effective, with costs per QALY ranging from 0.4 to 62.5 percent of the nation's GDP per capita. On average, the quality of limited economic analyses' quality was worse than comprehensive analyses. Depending on the kind and mix of technology utilized, the cost of mHealth interventions varied significantly; nonetheless, where cost-effectiveness data were published, the intervention was effective financially.
	(De La Perrelle et al., 2020)	The objective of this systematic review was to locate and summarize research that provides information on the costs and cost-effectiveness of QICs.	Despite using QICs in healthcare, few researchers have examined their costs or economic assessments. Eight studies were included, including acute and long-term care, community addiction treatment, and managing chronic diseases. Five were deemed of excellent quality and supported the creation of QICs as efficient means of implementation. The cost reductions to the healthcare environment found in these studies offset the expense of the collaboration itself.

Table 4 categorizes documents into themes, with Cluster 1 on healthcare delivery and rehabilitation, Cluster 2 on technology in healthcare, and Cluster 3 on clinical outcomes. Cluster 4 focuses on the clinical effectiveness of stroke telerehabilitation, Cluster 5 on technology and personalized approaches in clinical protocols, and Cluster 6 on the economic evaluation of telehealth. These clusters represent significant issues in telehealth and telerehabilitation.

**Table 5. Keywords Relationship on Telerehabilitation Services**

	Code 1	Code 2	Pearson correlation coefficient
Telerehabilitation Services	Telerehabilitation	Health	0.962644
	Telerehabilitation	Therapy	0.921129
	Telerehabilitation	Aged	0.908462
	Telerehabilitation	Stroke	0.899436
	Telerehabilitation	Telemedicine	0.882853
	Telerehabilitation	Covid-19	0.851146
	Telerehabilitation	Treatment	0.826441
	Telerehabilitation	Quality	0.772149
	Telerehabilitation	Outcome	0.748812
	Telerehabilitation	Delivery	0.611458
	Telerehabilitation	Technology	0.572538
	Telerehabilitation	Physiotherapy	0.468891
	Telerehabilitation	Feasibility	0.427715

Table 5 shows the Pearson correlation between telerehabilitation and various indicators of Telerehabilitation Services (e.g., Health, Therapy, Stroke). NVIVO 12 Plus analysis found a correlation range of 0.427715 to 0.962644, indicating a relationship between telerehabilitation and the components or indicators mentioned.

## Discussion

Telerehabilitation is an emerging approach that provides rehabilitation services remotely, enabling patients to receive care from their homes. This study examines telerehabilitation's effectiveness, implementation, and economic feasibility through a comprehensive bibliometric analysis of 357 documents over the last ten years (2012-2021). The analysis revealed a rise in the number of articles on the assessment of telerehabilitation services, with the United States having the highest number of documents, followed by Australia and Italy. The study also identified six clusters of themes related to telerehabilitation, with healthcare delivery "process", clinical outcome and effectiveness, and cost benefits being the most critical issues. The findings suggest that telerehabilitation is an effective and viable approach that can improve access to rehabilitation services and enhance patient outcomes while offering potential cost benefits. These findings may affect the field's design and implementation of telerehabilitation services and policy and regulation.

Telemedicine has shown promising evidence for the efficacy of teleradiology, tele-mental health, and home telecare for certain chronic conditions. However, few studies support the cost benefits of telemedicine and no evidence of the long-term outcomes of telemedicine. In contrast, telerehabilitation effectively improves physical

function, quality of life, pain, and disability. Many excellent quality studies, including 11 studies with control groups, reported comparable or superior clinical outcomes compared to traditional interventions. Additionally, although fewer studies have examined process measures, the results suggest a positive trend in the impact of telerehabilitation on process outcomes, particularly adherence and compliance (Cottrell et al., 2018). According to a study conducted by (Bettger and Resnik, 2020b), telerehabilitation was found to be just as effective as conventional care or in-person rehabilitation in improving physical function, quality of life, pain, and disability.

Moreover, the researchers observed that telerehabilitation resulted in lower costs and higher patient satisfaction. Another study conducted by (Seron et al., 2021c) also supports the effectiveness of telerehabilitation. The researchers found that telerehabilitation services effectively decreased outpatient visits, enhanced functional outcomes, and improved quality of life.

According to research by (Skolarus et al., 2014), patients who got post-stroke rehabilitation had a 16% reduced risk of mortality after 90 days of discharge and a 20% lower chance of hospital readmission than those who did not. Telehealth modalities can improve healthcare delivery and reduce costs by increasing communication between patients and providers and improving the quality of care. By reducing the need for travel, telehealth can increase communication between patients and providers while also improving the quality of care. Patients are also empowered to manage their chronic conditions more effectively, leading to increased self-awareness and better overall health outcomes. Therefore, it is recommended that both providers and patients embrace telehealth as a valuable tool for improving healthcare delivery (Kruse et al., 2017). Utilizing the skills and expertise of paramedics beyond their traditional emergency response role to support preventative and rehabilitative healthcare initiatives is called community paramedicine. This innovative approach can enhance healthcare access and delivery, particularly in underserved or remote communities (van Vuuren et al., 2021).

Telerehabilitation can potentially improve patient outcomes while reducing the burden on the healthcare system. Telerehabilitation was equally effective as conventional rehabilitation in improving patient-reported outcomes and function. Telerehabilitation had similar or lower dropout rates than conventional rehabilitation (Suso-Martí et al., n.d.). These results highlight the potential of telerehabilitation to provide accessible and effective care for patients who may face geographical, physical, or economic barriers to conventional rehabilitation. Methodological concerns identified in telerehabilitation research are widespread across various rehabilitation research areas. Researchers often face challenges in maintaining a high level of scientific rigor in their studies, which can lead to potential biases and undermine the validity of their findings. Another challenge in rehabilitation research is the small sample size of the patient population, which can limit the power and generalizability of the results. This challenge can be even more pronounced in telerehabilitation research, where the patient population may be geographically dispersed and difficult to recruit.

Clinical outcomes were a popular research topic, with many studies conducted, but there were comparatively few investigations on cost-related findings. Moreover, most of the research focused on only one aspect, and the number of studies that examined all three concepts (clinical outcomes, clinical process, and cost findings) was minimal. This study relied solely on the Scopus database, which, as previously stated, could be considered a limitation.

(Bettger & Resnik, 2020) discovered that telerehabilitation was just as effective as conventional care or in-person rehabilitation in improving physical function, quality of life,

pain, and disability. They also found that telerehabilitation resulted in lower costs and higher patient satisfaction. Similarly, (Seron et al., 2021) found that telerehabilitation services effectively decreased outpatient visits, enhanced functional outcomes, and improved quality of life. They observed that telerehabilitation was feasible and acceptable to patients and providers. Furthermore, telerehabilitation was as effective as conventional rehabilitation in improving patient-reported outcomes and function while having similar or lower dropout rates than conventional rehabilitation (Suso-Martí et al., 2021).

Telehealth has demonstrated improved outcomes, convenience, effectiveness, and low cost, benefiting healthcare providers and patients. Telehealth modalities can increase communication, improve the quality of care, and empower patients to manage their chronic conditions more effectively. It is recommended that both providers and patients embrace telehealth as a valuable tool for improving healthcare delivery (Kruse et al., 2017b). Telerehabilitation is a cost-effective alternative to in-person rehabilitation (Kairy et al., 2013) that can significantly reduce healthcare costs (Kruse et al., 2017b) by reducing travel, hospitalization, and equipment costs. The utilization of telerehabilitation has been linked to a reduction in hospital admissions and emergency department visits. In other words, telerehabilitation has positively impacted the overall healthcare system by minimizing the need for hospitalization and emergency room visits. This reduction in hospitalization rates can be attributed to the accessibility and convenience of telerehabilitation, which allows patients to receive healthcare services in the comfort of their homes without traveling to healthcare facilities. As a result, telerehabilitation has the potential to not only improve the quality of care for patients but also reduce the burden on healthcare systems by preventing unnecessary hospitalizations and emergency department visits. (Cox et al., 2021).

Telerehabilitation has potential benefits for improving access to rehabilitation services, reducing costs, and enhancing patient outcomes. However, implementation requires overcoming barriers such as a lack of technical skills and access to technology, concerns about privacy and security, and issues with licensing and reimbursement. Resistance to change, cost of equipment, patient age, and education level are other obstacles (Kruse et al., 2018). Despite these challenges, telerehabilitation has demonstrated positive outcomes and cost-effectiveness. Further research is needed to optimize telerehabilitation models and address potential barriers (Cottrell et al., 2016; Kruse et al., 2018).

Clinical outcomes were a popular research topic, with many studies conducted, but there were comparatively few investigations on cost-related findings. Moreover, most of the research focused on only one aspect, and the number of studies that examined all three concepts (clinical outcomes, clinical process, and findings) was minimal. This study relied solely on the Scopus database, which, as previously stated, could be considered a limitation.

## CONCLUSION

In conclusion, the findings showed that telerehabilitation significantly impacts health, therapy, aged, stroke, telemedicine, COVID-19, treatment, quality, outcome, delivery, technology, physiotherapy, and feasibility. Despite potential benefits, the adoption of telerehabilitation presents challenges that need to be addressed, including appropriate technology and infrastructure, data privacy and security, and additional training for

healthcare professionals. Healthcare providers should embrace these tools as valuable assets; further research is needed to identify best practices for their implementation.

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