INSIGHTS-JOURNAL OF
HEALTH AND REHABILITATION

INSIGHTS-JHR
INSIGHTS-JOURNAL OF HEALTH AND REHABILITATION

EFFECT OF TELE-REHABILITATION IN BREAKING BARRIERS WITH MOBILITY IMPAIRMENTS IN RURAL AREAS: A RANDOMIZED CONTROLLED TRIAL

Original Research

Aqsa Rasheed[1], Zohaib Shahid*[2]
[1]DPTRS, MS Rehabilitation sciences, Superior University Lahore Pakistan
[2]PhD Rehabilitation Malaysia, Assistant Professor, DPTRS, Superior University Lahore Pakistan

Corresponding Author: Zohaib Shahid, PhD Rehabilitation Malaysia, Assistant Professor, DPTRS, Superior University Lahore Pakistan, Zohaib.rana@superior.edu.pk
Acknowledgement: We thank all the participants and healthcare providers for their valuable contributions to this study.

Conflict of Interest: None | Grant Support & Financial Support: None | Publication Date: 10-03-2025

ABSTRACT

Background: Tele-rehabilitation utilizes telecommunication technologies to deliver healthcare services remotely, addressing the challenges faced by patients with mobility impairments, especially in rural areas where traditional rehabilitation services are limited. It offers a viable solution to improve access to care, particularly for individuals in underserved locations.

Objective: This study aimed to evaluate the effectiveness of tele-rehabilitation in improving mobility, functional independence, and quality of life for individuals with mobility impairments residing in rural areas.

Methods: A randomized controlled trial was conducted with 92 participants, equally divided into an intervention group and a control group. The intervention group participated in a six-month tele-rehabilitation program, which included video consultations, home visits, structured phone calls, and text message reminders. The control group received standard care without additional interventions. Outcome measures included the Barrier to Care Questionnaire, the Berg Balance Scale, the Functional Independence Measure (FIM), and the WHO Quality of Life-BREF. Baseline and post-intervention assessments were conducted.

Results: The intervention group showed significant improvements in all outcome measures. Quality of life scores increased from a mean of 51.64 to 65.63, and functional independence improved from 76.90 to 97.14. Barriers to care decreased from a mean score of 4 to 2.56. Statistically significant differences were observed in mobility, functional independence, and quality of life between the intervention and control groups.

Conclusion: Tele-rehabilitation was effective in improving mobility, functional independence, and quality of life, while reducing barriers to care for rural residents with mobility impairments. These results underscore the potential of tele-rehabilitation as a viable alternative to traditional rehabilitation methods. Future studies should focus on expanding tele-rehabilitation programs to further underserved populations.

Keywords: Barrier to care, Digital health technology, Functional independence, Mobility impairment, Physiotherapy innovation, Quality of life, Remote rehabilitation, Tele-rehabilitation, Tele-Medicine

INTRODUCTION

Tele-rehabilitation has emerged as a transformative approach in overcoming barriers to healthcare access, particularly for individuals with mobility impairments living in rural or remote areas. This technology-driven method of delivering rehabilitation services allows patients to receive care remotely, eliminating the need for in-person visits, which may be challenging due to distance or mobility issues. The convenience of receiving rehabilitation services from home is of great significance in addressing the healthcare disparities faced by individuals in underserved regions. Traditionally, patients in rural areas face substantial challenges in accessing specialized rehabilitation services due to geographic isolation, limited transportation options, and a shortage of healthcare providers. Tele-rehabilitation provides a viable solution by utilizing telecommunication technologies such as video conferencing, wearable devices, and mobile applications to connect patients with healthcare professionals in real time, offering consultations, assessments, and therapeutic interventions (1,2). Research has shown that tele-rehabilitation can significantly improve healthcare outcomes for individuals with various conditions, including musculoskeletal injuries, neurological disorders, chronic pain, and post-surgical recovery (2). This mode of care provides numerous benefits, including greater accessibility, reduced travel time, lower healthcare costs, and individualized treatment plans. It ensures continuity of care through regular virtual sessions, allowing healthcare professionals to monitor patient progress, adjust treatment plans, and provide real-time support, all of which contribute to better recovery outcomes. Moreover, tele-rehabilitation platforms can offer educational resources, counseling, and motivational support to both patients and their caregivers, fostering a more holistic and engaging approach to recovery (3). Despite these advantages, the adoption of tele-rehabilitation in rural areas faces certain challenges, including limited internet connectivity, technology literacy among patients and providers, and concerns related to the security and privacy of patient data. These barriers must be addressed to fully leverage the potential of tele-rehabilitation in improving healthcare access (4).

Tele-rehabilitation also has the potential to address the specific needs of individuals with mobility impairments. By providing patients with the flexibility to engage in rehabilitation programs from home, it reduces the dependency on frequent clinic visits, thus promoting independence and autonomy. Additionally, the personalized nature of tele-rehabilitation ensures that treatment programs are tailored to the individual needs of each patient, leading to more effective and sustainable outcomes. This is particularly important for patients with chronic conditions who require long-term rehabilitation services (5). However, while tele-rehabilitation has proven effective in improving access to care, ongoing research is needed to assess its feasibility, effectiveness, and long-term impact, especially in rural and underserved areas (6). The objective of this study is to explore the effectiveness of tele-rehabilitation in overcoming barriers to mobility and enhancing healthcare access for individuals in rural areas. Through a randomized controlled trial, this research aims to assess the impact of tele-rehabilitation on patient outcomes, including mobility, independence, and overall quality of life, thereby contributing valuable insights to the growing field of remote healthcare.

METHODS

This study was designed as a randomized controlled trial (RCT) to assess the effectiveness of telerehabilitation in addressing mobility impairments among individuals in rural areas of Pakistan. The study aimed to recruit 92 participants, with 46 participants assigned to each group, based on a sample size calculation with a 5% margin of error, 95% confidence level, and 80% power. Recruitment was carried out in collaboration with local healthcare providers, particularly the Comprehensive Rehabilitation Center (CRC) at Superior University in Lahore. The participants were identified through hospital-based rehabilitation services and referred by the Rural Community-Based Rehabilitation Team following their discharge from standard physiotherapy services. Eligibility screening was conducted via telephone, with the participant's spouse or caregiver involved, and baseline assessments were performed at the participants' homes (7). Once baseline assessments were completed, participants were randomly assigned to either the intervention or control group using a computer-generated randomization sequence. Allocation concealment was maintained through the use of opaque, sealed envelopes, and recruitment staff, assessors, and data analysts were blinded to treatment allocation. The intervention group participated in a six-month structured telerehabilitation program designed to improve mobility impairments without requiring travel to urban healthcare facilities. This program included four home visits by a physiotherapist (at weeks 1, 2, 12, and 25) to monitor exercise performance, along with five structured telephone calls (at weeks 1, 4, 8, 16, and 20) to assess progress and address any barriers. Participants also received text message reminders twice weekly for the first 10 weeks and once weekly for the subsequent 16 weeks to encourage adherence to the exercise regimen. The control group continued with standard care, with no restrictions on seeking additional rehabilitation services, and received monthly phone check-ins by a blinded research assistant to ensure continued participation (8).

The primary outcome measures of the study included the Barrier to Care Questionnaire, the Berg Balance Scale (BBS), and the Functional Independence Measure (FIM). The Barrier to Care Questionnaire assessed various access-related challenges, while the BBS provided a 14-item functional balance assessment, and the FIM evaluated the level of assistance required for activities of daily living. Secondary outcome measures included the World Health Organization Quality of Life-BREF (WHOQOL-BREF), which assessed

INSIGHTS-JHR
INSIGHTS-JOURNAL OF HEALTH AND REHABILITATION

overall quality of life across physical, psychological, social, and environmental domains. These outcome measures were assessed at baseline, at the end of the six-month intervention, and six months post-intervention (12 months after baseline assessment) (9). Data analysis was performed using SPSS version 20. Normality was assessed using standard tests, and statistical significance was set at $p < 0.05$. Descriptive statistics were used to summarize baseline characteristics, and comparisons between groups were made using chi-square tests or independent t-tests. Repeated measures ANOVA was used to evaluate changes in outcome measures over time and to assess the effectiveness of telerehabilitation in improving mobility impairments and overcoming barriers to care in rural populations (10).

Ethical considerations for the study included obtaining written informed consent from all participants prior to enrollment. The study protocol was reviewed and approved by the relevant ethics committee, and all participant data were anonymized to ensure confidentiality. Ethical approval was granted by the Institutional Review Board (IRB) of the hospital involved in the study, and participant information was securely stored and kept confidential (11).

RESULTS

The Quality of Life (QOL) scores showed a significant improvement post-intervention, with Group 1 experiencing an increase from a mean of 51.64 to 65.63, while Group 2 exhibited a smaller change. The Barrier to Care Questionnaire, which initially showed a constant score of 4, improved significantly in Group 1, with a mean score of 2.56 post-intervention. The Berg Balance values remained relatively stable overall, with minor individual variations across both groups. Functional Independence, as measured by the Functional Independence Measure (FIM), demonstrated a substantial increase in Group 1, with scores rising from 76.90 to 97.14. Statistical analysis revealed that all variables followed a normal distribution, as evidenced by p-values greater than 0.05. This confirmed the appropriateness of using parametric tests for data analysis. Group 1 consistently outperformed Group 2 across all measured outcomes. Notably, post-intervention QOL scores improved significantly more in Group 1, with a mean difference of 15.83 ($p < 0.001$). Additionally, Group 1 exhibited a greater reduction in care barriers, with a mean difference of -1.65 ($p < 0.001$). Balance scores were also significantly higher in Group 1 ($p < 0.001$), and the most notable improvement was observed in the Functional Independence scores, where Group 1 outperformed Group 2 by a mean difference of 28.18 ($p < 0.001$).

Further analysis showed that all outcome measures demonstrated significant improvements post-intervention ($p < 0.001$). The QOL scores showed a significant change of -13.99 ($p < 0.001$), and Barrier to Care scores improved with a positive mean change of 1.44 ($p < 0.001$). Balance and motor control also saw a significant improvement with a mean change of -12.48 ($p < 0.001$), while Functional Independence exhibited the highest improvement with a mean change of -20.24 ($p < 0.001$).

Table: Descriptive Statistics for Study Variables

Variable	N	Min	Max	Mean	SD
Groups	92	1	2	1.59	0.495
Pre QOL Value	92	45	63	51.64	4.384
Post QOL Value	92	54	80	65.63	8.237
Pre Barrier Care Questionnaire	92	4	4	4.00	0.000
Post Barrier Care Questionnaire	92	1	4	2.56	0.877
Pre Berg Balance Value	92	18	51	36.24	8.600
Post Berg Balance Value	92	25	51	36.24	8.645
Pre Functional Independence Value	92	65	93	76.90	8.597
Post Functional Independence Value	92	80	121	97.14	14.439

Table: Test of Normality (Kolmogorov-Smirnov Test)

Variable	Group	Statistic	df	p-value
Pre & Post QOL Value	1	0.152	46	0.750
	2	0.147	46	0.639
Pre & Post Barrier Care	1	0.177	46	0.383

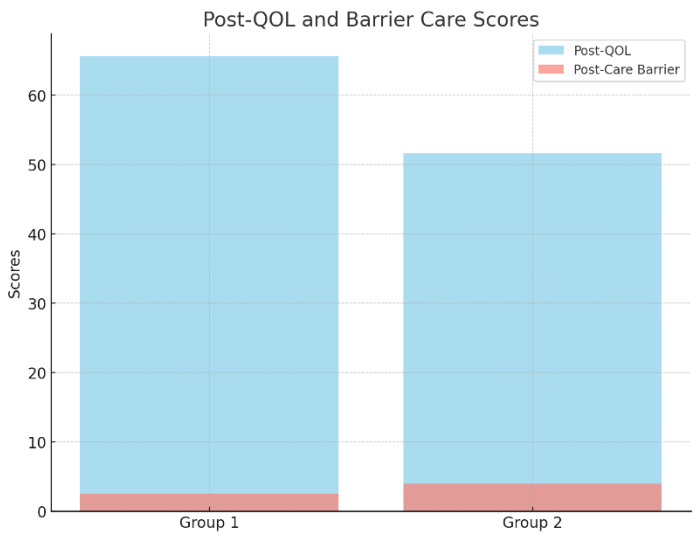
	2	0.130	46	0.325
Pre & Post Berg Balance	1	0.839	46	0.713
	2	0.008	46	0.330
Pre & Post Functional Independence	1	0.321	46	0.303
	2	0.034	46	0.125

Table: Paired Sample t-Test (Within-Group Comparison)

Variable	Mean Difference	Std. Dev	Std. Error	95% CI (Lower-Upper)	t	df	p-value
Pre & Post QOL	-13.989	4.407	0.459	-14.902 to -13.077	-30.077	91	<0.001
Pre & Post Barrier Care	1.440	0.877	0.091	1.259 to 1.622	15.759	91	<0.001
Pre & Post Berg Balance	-12.478	5.091	0.531	-13.533 to -11.424	-23.508	91	<0.001
Pre & Post Functional Independence	-20.239	6.106	0.637	-21.504 to -18.975	-31.793	91	<0.001

Table: Independent t-Test (Between-Group Comparison)

Variable	Levene's Test (F)	Sig.	Mean Difference	t	df	P Value
Pre QOL Value	7.543	0.007	11.654	60.220	<0.001	<0.001
Post QOL Value	0.423	0.517	15.828	74.736	<0.001	<0.001
Pre Barrier Care	12.199	0.476	13.390	57.429	<0.001	<0.001
Post Barrier Care	8.457	0.043	12.513	59.703	<0.001	<0.001
Pre Berg Balance	8.456	0.237	6.415	67.046	<0.001	<0.001
Post Berg Balance	2.578	0.290	16.495	58.581	<0.001	<0.001
Pre Functional Independence	9.541	0.132	16.128	63.542	<0.001	<0.001
Post Functional Independence	4.909	0.324	28.184	58.612	<0.001	<0.001



INSIGHTS-JHR
INSIGHTS-JOURNAL OF HEALTH AND REHABILITATION

DISCUSSION

The findings of this study support the effectiveness of tele-rehabilitation in overcoming barriers related to mobility impairments in rural areas. The results demonstrate significant improvements in quality of life (QOL) and functional independence, with patients in the intervention group showing considerable progress compared to the control group. These improvements align with previous studies that have highlighted the benefits of telerehabilitation in providing accessible care to patients who face geographic or mobility-related challenges. A number of studies have shown that tele-rehabilitation can improve patient outcomes by offering continuous education, monitoring, and therapeutic interventions without the need for travel, which is particularly beneficial for patients in underserved areas (12-15). However, other research has identified challenges in implementing tele-rehabilitation programs. For instance, some studies have pointed out issues related to patient engagement and adherence, especially in cases where remote supervision is required. One study reported that patients felt less motivated when not directly supervised by a therapist, which limited the overall effectiveness of telerehabilitation for certain individuals (16). This observation emphasizes the need for personalized strategies to address individual patient needs and to consider factors such as motivation and the level of supervision required (17-19).

Further supporting the findings of this study, research focused on patients with traumatic brain injuries and those recovering from surgery has demonstrated the effectiveness of telerehabilitation in improving mobility and functional outcomes. These studies show that, with well-structured exercise programs, telerehabilitation can result in notable improvements in balance and mobility, suggesting that home-based programs can be particularly effective when they are tailored to the needs of the patient. Additionally, studies comparing face-to-face therapy with telerehabilitation for conditions like hip fractures have shown that remote therapy can produce comparable results to traditional in-person rehabilitation (20-22). Despite these successes, some studies have highlighted significant barriers that still need to be addressed in the broader implementation of tele-rehabilitation. For example, research on telerehabilitation for individuals with chronic obstructive pulmonary disease (COPD) found that, while it provided convenience for patients, it did not significantly improve clinical outcomes compared to traditional in-person rehabilitation. Additionally, patients faced technological barriers such as poor internet connectivity and difficulties using the required devices, which hindered their participation and affected the overall effectiveness of the program (21). This underlines the importance of ensuring that patients have the necessary technological infrastructure and support to fully engage with tele-rehabilitation services (23-25).

The use of advanced technologies such as virtual reality and augmented reality has also shown promise in enhancing the effectiveness of telerehabilitation programs. Studies on virtual reality-based rehabilitation have demonstrated the potential of these cutting-edge tools to improve rehabilitation outcomes, suggesting that such technologies could play a critical role in the future of remote therapy (22). Incorporating these technologies into tele-rehabilitation programs could help address some of the limitations observed in traditional approaches, providing more engaging and interactive rehabilitation experiences (26). Despite the promising results, there are several limitations that need to be considered. Technological barriers remain a significant challenge, particularly in rural and resource-limited settings. Variations in the types of interventions used across studies also make it difficult to draw direct comparisons or to standardize approaches. Additionally, many studies, including this one, focus on short-term outcomes, and there is a need for further research to evaluate the long-term impact of telerehabilitation on functional outcomes and quality of life. More comprehensive studies are needed to better understand how tele-rehabilitation can be integrated into routine healthcare practice and how its benefits can be sustained over time (12,19).

While tele-rehabilitation shows considerable promise in improving mobility and functional outcomes for patients with mobility impairments in rural areas, there is still much to be explored. Future research should aim to standardize intervention methods, address technological barriers, and evaluate the long-term effects of tele-rehabilitation. By doing so, it will be possible to fully realize the potential of tele-rehabilitation as a viable and effective solution for improving access to rehabilitation services in underserved regions.

CONCLUSION

In conclusion, this study demonstrates that telerehabilitation can significantly enhance quality of life, functional independence, and balance, while effectively reducing care barriers for individuals with mobility impairments in rural areas. The intervention, particularly in Group 1, proved to be highly effective in improving key rehabilitation outcomes, highlighting its potential as a valuable tool in overcoming geographic and mobility-related challenges. These findings underscore the importance of accessible, technology-driven rehabilitation approaches and suggest that further exploration of the underlying factors contributing to these improvements could provide valuable insights for optimizing telerehabilitation programs.

AUTHOR CONTRIBUTIONS

Author	Contribution
Aqsa Rasheed	Conceptualization, Methodology, Formal Analysis, Writing - Original Draft, Validation, Supervision Investigation, Data Curation, Formal Analysis, Software Formal Analysis, Writing - Review & Editing
Zohaib Shahid	Methodology, Investigation, Data Curation, Writing - Review & Editing Software, Validation, Writing - Original Draft Writing - Review & Editing, Assistance with Data Curation

REFERENCES

1. Alexander M. Telerehabilitation: Principles and Practice: Elsevier Health Sciences; 2021.

2. Seron P, Oliveros M-J, Gutierrez-Arias R, Fuentes-Aspe R, Torres-Castro RC, Merino-Osorio C, et al. Effectiveness of telerehabilitation in physical therapy: a rapid overview. Physical therapy. 2021;101(6):pzab053.

3. Shaw MT, Best P, Frontario A, Charvet LE. Telerehabilitation benefits patients with multiple sclerosis in an urban setting. Journal of telemedicine and telecare. 2021;27(1):39-45.

4. Saywell NL, Vandal AC, Mudge S, Hale L, Brown P, Feigin V, et al. Telerehabilitation after stroke using readily available technology: A randomized controlled trial. Neurorehabilitation and neural repair. 2021;35(1):88-97.

5. Uswatte G, Taub E, Lum P, Brennan D, Barman J, Bowman MH, et al. Tele-rehabilitation of upper-extremity hemiparesis after stroke: Proof-of-concept randomized controlled trial of in-home constraint-induced movement therapy. Restorative Neurology and Neuroscience. 2021;39(4):303-18.

6. Alayat MS, Almatrafi NA, Almutairi AA, El Fiky AAR, Elsodany AM. The Effectiveness of Telerehabilitation on Balance and Functional Mobility in Patients with Stroke: A Systematic Review and Meta-Analysis. International Journal of Telerehabilitation. 2022;14(2).

7. Osei SKJ, Adomako–Bempah E, Yeboah AA, Owiredu LA, Ohene LA. Nurse-led telerehabilitation intervention to improve stroke efficacy: Protocol for a pilot randomized feasibility trial. Plos one. 2023;18(6):e0280973.

8. Gatica-Rojas V, Cartes-Velásquez R. Telerehabilitation in Low-Resource Settings to Improve Postural Balance in Older Adults: A Non-Inferiority Randomised Controlled Clinical Trial Protocol. International Journal of Environmental Research and Public Health. 2023;20(18):6726.

9. Hao J, Pu Y, Chen Z, Siu K-C. Effects of virtual reality-based telerehabilitation for stroke patients: A systematic review and meta-analysis of randomized controlled trials. Journal of Stroke and Cerebrovascular Diseases. 2023;32(3):106960.

10. Turolla A, Rossettini G, Viceconti A, Palese A, Geri TJPt. Musculoskeletal physical therapy during the COVID-19 pandemic: is telerehabilitation the answer? 2020;100(8):1260-4.

11. Maresca G, Maggio MG, De Luca R, Manuli A, Tonin P, Pignolo L, et al. Tele-neuro-rehabilitation in Italy: state of the art and future perspectives. 2020;11:563375.

12. Bilwani S, Anjum G. Gender differences in making moral decisions: The ethics of care perspective in Pakistan. Ethics and social welfare. 2022;16(1):73-89.

13. Chen, S.-C., C.-H. Lin, S.-W. Su, Y.-T. Chang and C.-H. Lai (2021). "Feasibility and effect of interactive telerehabilitation on balance in individuals with chronic stroke: a pilot study." Journal of NeuroEngineering and Rehabilitation18(1): 71.

14. Gomes de Souza e Silva, E. M., S. Tomaz da Silva, L. Januário de Holanda, D. Tezoni Borges, A. P. MendonçaFernandes, K. Evangelista Rodrigues da Silva, T. Souza Ribeiro, L. Protásio de Melo, R. A. de Medeiros Valentim and D. J. F. i. P. Alves Pinto Nagem (2023). "Effects of a self-care educational program via telerehabilitation on quality of life and caregiver burden in amyotrophic lateral sclerosis: a single-blinded randomized clinical trial protocol." 14: 1164370.

15. Wang, X., T. Wu, B. Fei, X. Li, Y. Tang, Y. Zheng, Y. Jia, J. Ding and M. Hu (2023). "Access barriers to care for patients with silent cerebrovascular disease (SCD) in rural China: A cross-sectional questionnaire-based study." Clinical eHealth6: 10-16.

16. Afzal, Mamoona Tasleem, Aleeza Sana, Sher Alam Khan, Ali Ghulam, Mehboob Ur Rehman Kashif, and Rahim Jan. 2024. "Telemedicine and Its Effect on Chronic Disease Management in Remote Communities." Insights-Journal of Health and Rehabilitation 2, no. 2: 200–207. https://doi.org/10.71000/767ppr94.

17. Arienti C, Lazzarini SG, Andrenelli E, Cordani C, Negrini F, Pollini E, et al. Rehabilitation and COVID-19: systematic review by Cochrane Rehabilitation. Eur J Phys Rehabil Med. 2023;59(6):800-18.

18. Goffredo M, Baglio F, R DEI, Proietti S, Maggioni G, Turolla A, et al. Efficacy of non-immersive virtual reality-based telerehabilitation on postural stability in Parkinson's disease: a multicenter randomized controlled trial. Eur J Phys Rehabil Med. 2023;59(6):689-96.

19. Havran MA, Bidelspach DE. Virtual Physical Therapy and Telerehabilitation. Phys Med Rehabil Clin N Am. 2021;32(2):419-28.

20. Lee AC, Deutsch JE, Holdsworth L, Kaplan SL, Kosakowski H, Latz R, et al. Telerehabilitation in Physical Therapist Practice: A Clinical Practice Guideline From the American Physical Therapy Association. Phys Ther. 2024;104(5).

21. Malik AN, Tariq H, Afridi A, Rathore FA. Technological advancements in stroke rehabilitation. J Pak Med Assoc. 2022;72(8):1672-4.

22. Muñoz-Tomás MT, Burillo-Lafuente M, Vicente-Parra A, Sanz-Rubio MC, Suarez-Serrano C, Marcén-Román Y, et al. Telerehabilitation as a Therapeutic Exercise Tool versus Face-to-Face Physiotherapy: A Systematic Review. Int J Environ Res Public Health. 2023;20(5).

23. Pak SS, Janela D, Freitas N, Costa F, Moulder R, Molinos M, et al. Comparing Digital to Conventional Physical Therapy for Chronic Shoulder Pain: Randomized Controlled Trial. J Med Internet Res. 2023;25:e49236.

24. Seron P, Oliveros MJ, Gutierrez-Arias R, Fuentes-Aspe R, Torres-Castro RC, Merino-Osorio C, et al. Effectiveness of Telerehabilitation in Physical Therapy: A Rapid Overview. Phys Ther. 2021;101(6).

25. Suso-Martí L, La Touche R, Herranz-Gómez A, Angulo-Díaz-Parreño S, Paris-Alemany A, Cuenca-Martínez F. Effectiveness of Telerehabilitation in Physical Therapist Practice: An Umbrella and Mapping Review With Meta-Meta-Analysis. Phys Ther. 2021;101(5).

26. Tore NG, Oskay D, Haznedaroglu S. The quality of physiotherapy and rehabilitation program and the effect of telerehabilitation on patients with knee osteoarthritis. Clin Rheumatol. 2023;42(3):903-15.