INSIGHTS-JOURNAL OF
HEALTH AND HEALTH AND REHABILITATION

# Comparison of Tele-Rehabilitation-Based Training and generic Home-Based Program in Enhancing Balance and Quality of Life in Chronic Stroke Patients: An Experimental Study

*Original Research*

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Conflict of Interest: None
Grant Support & Financial Support: None

**Abstract**

**Background:** Patients with chronic stroke frequently have substantial deficits in their quality of life (QOL) and balance. Conventional rehabilitation techniques, such at-home workout regimens, might not offer the individualized feedback or supervision required for the best possible outcome. A viable substitute that uses technology to provide individualized training remotely is tele-rehabilitation.

**Objective:** To compare the effectiveness of tele-rehabilitation-based training versus a generic home-based exercise program in enhancing balance and quality of life in chronic stroke patients.

**Methods:** This randomized controlled trial enrolled 42 participants aged 40-80 years, diagnosed with chronic stroke. Participants were randomly assigned to either the tele-rehabilitation group (n=21) or the control group receiving a home-based exercise program (n=21). The tele-rehabilitation group engaged in supervised sessions emphasizing core stability, balance, and strength exercises over eight weeks, while the control group performed unsupervised exercises. The Berg Balance Scale (BBS) was used to assess balance, and the Stroke-Specific Quality of Life (SS-QOL) scale measured QOL at baseline and post-intervention.

**Results:** Both groups exhibited significant improvements in balance and QOL post-intervention. The tele-rehabilitation group showed a more significant enhancement in both outcomes compared to the home-based group, with statistical significance ($p<0.05$) achieved for both balance and QOL scores.

**Conclusion:** Tele-rehabilitation is an effective intervention for improving balance and quality of life in chronic stroke patients, providing greater engagement and tailored feedback than generic home-based programs.

**Keywords:** balance improvement, chronic stroke rehabilitation, quality of life enhancement, randomized controlled trial, stroke exercise program, stroke patient care, tele-rehabilitation therapy, telehealth for stroke, virtual rehabilitation, walking stability.

 

## INTRODUCTION

Stroke continues to be a major worldwide health concern that has a profound effect on both people and civilizations. Stroke is defined as the abrupt onset of cerebral dysfunction brought on by a disruption in the blood flow to the brain. The neurological abnormalities caused by stroke can range from moderate weakness to total paralysis (1). Mobility, communication, and day-to-day activities are just a few of the facets of life that can be negatively impacted by this illness, which puts a significant strain on the afflicted people, their families, and the healthcare system. Reducing the effects of one of the world's major causes of death and disability requires the implementation of effective preventative and rehabilitation programs (2).

Stroke incidence and prevalence are increasing worldwide, underscoring how urgent it is to address this health catastrophe. The World Health Organization (WHO) estimates that 15 million people worldwide experience a stroke annually, which results in 5 million fatalities and an equivalent number of people who are permanently disabled. Stroke prevalence in Pakistan is estimated to be 1.5%, with an annual rise in incidence of about 350 per 100,000 persons, which is worrying given the trend in rates of morbidity and death. Similar challenges exist in Malaysia, where the National Stroke Registry reports that around 240 persons per 100,000 have a stroke, exerting a burden on healthcare resources and requiring successful rehabilitation programs(3).

Stroke morbidity is high and frequently leads to permanent impairments that negatively affect quality of life. Stroke survivors frequently experience difficulty carrying out regular tasks, which can cause them psychological discomfort and social isolation. The death rate varies greatly by geography, with developing nations like Pakistan and Malaysia having greater death and disability rates because they have less access to high-quality healthcare. The necessity for comprehensive stroke management techniques that include both urgent care and long-term rehabilitation is highlighted by these worrisome numbers(4).

A stroke can have a wide range of effects on the human body, although it mostly affects the motor, sensory, and cognitive systems. The inability to regulate one's motor function, particularly in the upper limbs, makes daily chores extremely difficult. Stroke survivors frequently have weakness, stiffness, and poor coordination, which makes it more difficult for them to become independent again. Sensory deficiencies can also impair proprioception and balance, which increases the risk of falls and other consequences. It is crucial to comprehend these complex impacts in order to create rehabilitation plans that are tailored to the individual requirements of stroke victims(5).

For stroke survivors, balance and quality of life are essential elements in their healing process. Having trouble with balance can increase the chance of falling, which can have a big effect on a person's social and leisure activities. Quality of life is a multifaceted construct that includes social, psychological, and physical well-being. It is frequently compromised in stroke survivors because of emotional difficulties and functional constraints. Rehabilitation treatments that focus on restoring balance and strengthening overall quality of life are crucial for facilitating recovery and reintegration into society(6).

New developments in stroke rehabilitation have brought about creative methods meant to enhance patient results. Conventional methods of rehabilitation, including generic home-based exercise program concentrate on improving independence and regaining motor function without any supervision. However, other contemporary interventions like tele-rehabilitation have gained popularity as respectable substitutes. This is especially true in light of the expanding need for easily available healthcare services and current technological breakthroughs(7).

By offering customized aerobic workouts remotely, tele-rehabilitation-based aerobic training presents a potential method to stroke therapy. This approach raises general well-being and functional mobility in addition to cardiovascular health. Tele-rehabilitation removes obstacles to specialist treatment and transportation by enabling patients to participate in therapy from the comfort of their homes. Furthermore, research has demonstrated that aerobic exercise can enhance neuroplasticity in a favorable way, improving motor function and quality of life for stroke survivors(8).

On the other hand, in order to speed up rehabilitation, traditional physical therapy/ home based exercise program emphasizes rehab by providing a more dynamic and responsive environment. These techniques are used to help stroke patients regain better motor control, strength, and coordination. Although beneficial, these techniques frequently need for in-person treatment sessions, which some patients may not be able to attend, particularly those who live in remote locations or have mobility challenges(9).

There is still a large lack of comparison studies comparing the effectiveness of tele-rehabilitation-based therapies with traditional home-based exercise programs, despite the increasing corpus of research on stroke rehabilitation. Policymakers, stroke survivors, and healthcare professionals can all benefit greatly from an understanding of the variations and convergences in outcomes. This study intends to close this gap by testing the hypothesis that, in comparison to traditional home-based therapy, tele-rehabilitation-based aerobic exercise will improve upper limb function and the general quality of life in chronic stroke patients. The results may inspire novel ideas for stroke rehabilitation, which would eventually help patients and the medical community at large(10).

## METHODS

The study was conducted as a randomized controlled trial (RCT) to evaluate the effectiveness of home exercise programs and tele-rehabilitation-based training in improving balance and quality of life among chronic stroke patients. Ethical approval was obtained from the Institutional Review Board of Superior University, and the trial ran for six months following protocol approval. Participants were randomly assigned to either the tele-rehabilitation group or the control group using a parallel design (1:1). The study included patients aged 40-80 years, of both genders, who had been clinically diagnosed with chronic stroke for more than six months but not more than one year. Eligible participants were required to have minimal speech impairment and a Mini Mental State Examination (MMSE) score of at least 20, indicating sufficient cognitive function (3). Participants were excluded if they had a history of stroke recurrence, fractures, dislocations, peripheral vascular disease (such as Parkinsonism, epilepsy, multiple sclerosis, or spinal cord injury), severe cognitive impairments, comorbid heart disease or cancer, or if they were pregnant (5).

The sample size was determined using a standard formula, where n represents the required sample size per group. The parameters included $Z\ \alpha/2$ with a value of 1.96 for a 5% significance level, and $Z\beta$ as 0.84 for an 80% power level (4). The standard deviations were set at 2.01 and 1.25, with mean changes in balance and quality of life scale values at 0.4 and 1.1, respectively, for the experimental and conventional groups. This calculation led to a required sample size of 19 per group, totaling 38 participants, which was then adjusted to 42 participants to account for a 10% dropout rate (5).Randomization was performed through consecutive sampling, distributing the 42 participants equally into the experimental and control groups. An independent research assistant executed the allocation process, ensuring that neither the researcher nor the participants were aware of the group assignments (3). To further minimize bias, outcome assessors, who were unaware of the group assignments, recorded both pre- and post-treatment measurements (6).

The study employed validated outcome measures, such as the Berg Balance Scale (BBS), which is widely used to assess static and dynamic balance across 14 categories, with scores ranging from 0 to 56. The BBS has demonstrated high reliability, with intra-rater reliability of 0.98 and inter-rater reliability of 0.97 in stroke populations, making it a robust tool for evaluating functional balance in stroke survivors (7). The Stroke-Specific Quality of Life Scale (SS-QOL) was used to measure quality of life, addressing domains such as mobility, social roles, self-care, and upper limb function. This 49-item scale, with scores ranging from 49 to 245, offers a comprehensive assessment of stroke-related quality of life, validated by a Cronbach's alpha of greater than 0.73 (8).

Participants in the tele-rehabilitation group received personalized exercise regimens via remote supervision, which included strengthening and balance exercises delivered through video sessions monitored by therapists. In contrast, the control group engaged in a standard home-based program that included mobility exercises but lacked personalized feedback and modifications (9). The tele-rehabilitation group consisted of 21 participants, and the control group also included 21 participants, all of whom provided informed consent and were allowed to withdraw at any point during the study, ensuring adherence to ethical guidelines(10).

The experimental group engaged in tele-rehabilitation sessions five times per week for eight weeks, with the intensity and frequency of exercises progressively increasing based on individual needs. The core stability component of the program began with the Abdominal Drawing-In Maneuver (ADIM) to activate the transversus abdominis muscle, followed by exercises focused on pelvic control, such as anterior-posterior tilts, lateral shifts, and transverse rotations (10). Additional exercises aimed at improving trunk and lower extremity strength included bridging exercises with real-time feedback and progressive challenges, such as transitioning from two-leg to one-leg bridging. Trunk control was further enhanced through curl-ups and exercises targeting the multifidus muscles. Patients in this group received ongoing monitoring and feedback through video chats, ensuring adherence and modification of the workout as necessary (10).

The control group followed a home-based physical therapy program lasting forty minutes per session, five days a week, over eight weeks. This program included stretching, mobility exercises such as transfers and gait training, and range of motion (ROM) activities (9). Participants were instructed to perform task-oriented exercises using their affected limb for daily activities, including reaching, gripping, and manipulating objects, as part of activities of daily living (ADL) training (11). Basic household tasks were incorporated to promote functional independence, such as eating, brushing teeth, and combing hair. Although the home-based program did not provide direct supervision, patients received safety instructions and compensatory strategies to reduce the risk of falls (12). The program's content was delivered in written and digital formats, emphasizing independence and self-management, with no direct supervision from a physical therapist(11).

Data analysis was performed using SPSS version 24.0, with the Shapiro-Wilk test applied to verify normality. A p-value below 0.05 indicated that the data were not normally distributed, leading to the use of non-parametric tests for within-group and between-group comparisons. The Wilcoxon sign rank test was used for within-group analysis, and the Mann-Whitney U test was applied for between-group comparisons, with a significance level set at $p < 0.05$ (CI 95%).

## RESULTS

As cited in Table 1: During the study period, 42 patients were initially enrolled. Two were excluded due to ineligibility, and two withdrew for personal reasons. Out of the remaining 38 participants, 19 were assigned to the Control Group (A), comprising 11 males and 8 females, while the Experimental Group (B) also had 19 participants, consisting of 9 males and 10 females. The p-value for gender distribution between the groups was 0.85, indicating no significant difference. The mean age of participants in the Control Group (A) was 56.2±7.3 years, while in the Experimental Group (B), the mean age was 55.8±6.9 years. The p-value for age was 0.72, showing no statistically significant difference between the two groups. The mean time since stroke occurrence was 19.5 ± 4.2 months for the Control Group (A) and 20.7 ± 4.5 months for the Experimental Group (B), with a p-value of 0.81, also indicating no significant difference. Regarding co-morbid conditions, 13 participants (52.1%) in the Control Group (A) had no co-morbid conditions, while 12 participants (48%) had co-morbidities. In the Experimental Group (B), 11 participants (44%) had no co-morbidities, while 14 participants (56%) had co-morbid conditions. The p-value for the presence of co-morbid conditions was 0.058, indicating no significant difference between the groups.

**Table 1: Demographics Data**

| Variables | Control Group (A) | Experimental Group (B) | P-value |
|---|---|---|---|
| Age | 56.2±7.3 | 55.8 ± 6.9 | 0.72 |
| Gender | | | |
| Male% | 11(57.1%) | 9(55%) | 0.85 |
| Female% | 8(42.9%) | 10(45%) | |
| Time since stroke occurrence(months) | 19.5 ± 4.2 | 20.7 ± 4.5 | 0.81 |
| Co-morbid condition | | | |
| Absent | 13 (52.1%) | 11 (44.0%) | 0.058 |
| Present | 12 (48.0%) | 14 (56.0%) | |

**Table 2: Test of Normality**

| Groups | Pre balance scores (p-value) | Post balance scores (p-value) | Pre QOL scores (p-value) | Post QOL scores (p-value) |
|---|---|---|---|---|
| Group A (Home based exercise program) | 0.03 | 0.02 | 0.05 | 0.03 |
| Group B (tele-rehabilitation) | 0.04 | 0.01 | 0.04 | 0.01 |

As cited in Table 2: The findings of the Shapiro-Wilk Test of Normality for balance and quality of life (QOL) scores in the experimental (tele-rehabilitation) and control (home-based exercise) groups are displayed in this table. Significant difference from normality are indicated by p-values < 0.05.

**Table 3: Within group analysis for Balance and Quality of life (Wilcoxon Signed Rank)**

| Groups | | N | Mean | Standard Deviation | P-value |
|---|---|---|---|---|---|
| Group A | Pre test | 21 | 6.21 | 0.849 | 0.000 |
| | Post test | | 3.29 | 0.558 | |
| Group B | Pre test | 21 | 5.82 | 0.983 | 0.000 |
| | Post test | | 2.47 | 0.510 | |

As cited in Table 3: For Group A (Home-Based Exercise Program), the pre-intervention balance score was 6.21±0.849, which decreased significantly to 3.29±0.558 post-intervention, indicating a substantial improvement in balance (Δ=2.92). The pre-intervention Quality of Life (QOL) score was 5.82±0.983, which also improved significantly to 2.47±0.510 post-intervention (Δ=3.35). Both reductions in balance and QOL scores were statistically significant with P=0.000.

Similarly, for Group B (Tele-Rehabilitation), the pre-intervention balance score was 5.82±0.983, which decreased significantly to 2.47±0.510 post-intervention, showing a marked improvement in balance (Δ=3.35). The pre-intervention QOL score was 6.21±0.849, which decreased to 3.29±0.558 post-intervention, reflecting a notable improvement in QOL (Δ=2.92). These changes were also statistically significant with P=0.000.

This table reflects the within-group analysis using Wilcoxon Signed Rank Test for both balance and quality of life (QOL) scores in Group A (home-based exercise) and Group B (tele-rehabilitation), with statistically significant improvements post-intervention in Group B.

**Table 4: Between Group analysis for balance and quality of life (Mann-Whitney Test)**

| Outcomes | Measurements | Group A: Generic home-based exercise program | | Group B: Telerehabilitation Training | | P-value |
|---|---|---|---|---|---|---|
| | | Mean Rank | Sum of Ranks | Mean Rank | Sum of Ranks | |
| Balance | Pretest | 26.87 | 596.00 | 22.13 | 487.00 | 0.308 |
| | Post-test | 31.91 | 712.00 | 17.06 | 371.00 | 0.000 |
| Quality of Life | Pretest | 23.00 | 507.00 | 26.00 | 576.00 | 0.337 |
| | Post-test | 13.00 | 277.00 | 36.00 | 806.00 | 0.000 |

As cited in Table 4: For balance, the pre-test scores showed no significant difference between Group A (Home-Based Exercise Program) and Group B (Tele-Rehabilitation), with a mean rank of 26.87 for Group A and 22.13 for Group B, and a P-value of 0.308. However, the post-test balance scores showed a significant difference, with Group A having a mean rank of 31.91 and Group B having a lower mean rank of 17.06, indicating that the tele-rehabilitation group showed greater improvement in balance. The P-value was 0.000, showing a statistically significant result. For Quality of Life (QOL), there was no significant difference between the two groups in the pre-test scores, with a mean rank of 23.00 for Group A and 26.00 for Group B (P-value of 0.337). However, in the post-test, there was a significant improvement in QOL for Group B (Tele-Rehabilitation), with a mean rank of 36.00 compared to Group A's mean rank of 13.00, and a P-value of 0.000. This table suggests that while both interventions improved balance and quality of life, tele-rehabilitation proved to be significantly more effective than the home-based exercise program in enhancing both outcomes at the post-test stage.

## DISCUSSION

In this study, compared to the home-based exercise program group (Group A), the tele-rehabilitation group (Group B) demonstrated a more notable improvement in balance. This is consistent with studies by FS Sarfo et al in 2018, who discovered that because tele-rehabilitation is customized and interactive, it improves postural control and balance in stroke survivors. Our study's strength is that it validates this conclusion across a population of people who have had chronic strokes, indicating the flexibility of tele-rehabilitation across various stages of recovery. Similarity: Based on structured feedback mechanisms, both studies show that tele-rehabilitation provides better balance outcomes (3).

Although there was some improvement in the home-based group, it was not as much as in the tele-rehabilitation group. This is in line with a study by H. Tehero et al., in 2018 that discovered that home-based programs frequently don't provide stroke patients with the intensity and feedback required to support their best possible balance recovery. Our research adds to this, though, by demonstrating that home-based programs are nevertheless, if less so, successful. Similarity: The results are in line with earlier studies that draw attention to the shortcomings of home-based programs because they don't provide regular therapy feedback (4).

After the intervention, the Quality of Life (QOL) scores of both groups improved, but the tele-rehabilitation group's improvement was greater. These results are corroborated by a study by Appleby et al in 2019, which demonstrates that real-time engagement with therapists during tele-rehabilitation can greatly enhance patients' evaluations of their health. This implies that, as our study showed, more participation in tele-rehabilitation positively improves quality of life. Similarity: Because of increased patient involvement, both studies concur that tele-rehabilitation can enhance QOL more successfully (5).

Although statistically significant, the home-based group's improvement in QOL was not as great as that of the tele-rehabilitation group. This result is consistent with Kenis et al in 2022 research, which showed that home-based programs frequently fail to duplicate the comprehensive advantages of organized rehabilitation. The drawback is that home-based programs might not fully address emotional and social aspects of QOL in the absence of direct supervision. Similarity: Both studies show that tele-rehabilitation has a greater impact on quality of life (QOL) than home-based therapies (6).

One of the study's strengths is the comparability in pre-intervention balance scores between the two groups, which guarantees that both groups began from comparable baselines. Additionally, comparable baseline measurements offer a solid basis for assessing post-intervention gains, lowering the possibility of baseline bias, according to research by Saito et al in 2021. Similarity: The significance of similar baseline measurements for assessing the efficacy of interventions is emphasized in both studies (7).

The study by Bernocchi et al in 2018, which demonstrated that stroke patients receiving tele-rehabilitation experienced better motor function improvements due to individualized, adaptive training plans, is consistent with the significant improvement in post-intervention balance scores in the tele-rehabilitation group. Our study's strength is its confirmation of these results across a new outcome, balance, demonstrating the adaptability of tele-rehabilitation in stroke recovery. Similarity: Both studies imply that better recovery outcomes result from tele-rehabilitation's capacity to adjust to each patient's unique demands (8).

The home-based group's slower development in balance rehabilitation was one of the study's shortcomings. Research by Korteanou et al in 2021, who found that home-based workouts' efficacy is limited by the absence of real-time feedback and supervision, corroborates this conclusion. The potential for lower patient motivation and adherence which was mentioned in both studies is this situation's vulnerability. Similarity: Because professional assistance is lacking in home-based programs, both research acknowledge their shortcomings (9).

Our research demonstrates that tele-rehabilitation improved QOL and balance more than other treatments, most likely as a result of increased patient participation. A study by Schrodor et al in 2029, supports this view, indicating that tele-rehabilitation's interactive platforms drive patients to stick to their exercise plans better. As both studies demonstrate, the power of tele-rehabilitation is in its capacity to sustain participation through tailored feedback. Similarity: Both research point to improved functional results as a result of increased participation in tele-rehabilitation programs (10).

The results of our investigation were not substantially impacted by the distribution of genders. But according to research by MA Van et al, men frequently recover their motor skills more quickly than women, which may indicate that a patient's gender influences how they respond to rehabilitation. This discrepancy could be the result of different adherence rates or physiological variations, suggesting that further research on gender-specific issues may be necessary. Difference: Previous research suggests that there may be gender variations in rehabilitation results, even though our study did not identify a gender effect (11).

Our study's and tele-rehabilitation overall limitations stem from their reliance on technology, which some patients may not be able to use. Similar concerns were expressed by F. Vilayate et al in 2020, who pointed out that socioeconomic hurdles, particularly in rural or underserved communities, can limit access to tele-rehabilitation. This is an important factor to take into account before expanding the use of tele-rehabilitation. Similarity: Both studies acknowledge that access to technology may be a hindrance to tele-rehabilitation becoming widely used (12).

Even though the home-based group in our study showed gains, their slower development may have been due to adherence issues. Research by M. hamedani et al, which discovered that home-based programs frequently have worse adherence rates, lends support to this. The absence of supervision in home-based programs is a drawback that may result in lower patient compliance. Similarity: Adherence problems are identified in both studies as a major drawback of home-based rehabilitation initiatives (13).

Our study's results on the efficacy of tele-rehabilitation point to its potential as a useful tool for patients in underserved or distant areas, where access to in-person therapy may be limited. M kaleic et al, discovered comparable outcomes, demonstrating that tele-rehabilitation can help rural stroke patients get the healthcare they need. Similarity: The importance of tele-rehabilitation in enhancing healthcare access, especially for underprivileged populations, is highlighted in both studies (14).

Lack of long-term follow-up data to evaluate the sustainability of the changes is one of our study's limitations. While there is hope for short-term benefits, research by YC. Shin in 2019 indicates that the long-term impacts of tele-rehabilitation are still unknown. Longer follow-up times should be included in future research to see how long-lasting the gains are. Dissimilarity: Langhorne's research emphasizes the significance of long-term evaluation in tele-rehabilitation outcomes, in contrast to our work (15).

Our study's randomized controlled design reduces bias and enables more reliable judgments about the therapies' efficacy, which is one of its strongest points. This is in line with the findings of Cramer et al. (2017), who also evaluated the efficacy of tele-rehabilitation using randomized controlled trials (RCTs), highlighting the significance of this methodological approach in guaranteeing accurate results. Similarity: Both studies highlight the importance of RCTs in supplying solid proof of the effectiveness of tele-rehabilitation (16).

The outcome measures of our study offer a thorough understanding of functional and subjective recovery, especially for balance and quality of life. Previous researches also emphasized how crucial it is to use a variety of outcome indicators in order to fully evaluate the effects of rehabilitation programs. Our study's strength is that it included both subjective (QOL) and objective (balance) assessments, providing a comprehensive evaluation of recovery. Similarity: To completely capture the impact of stroke rehabilitation therapy, both research emphasize how important it is to include a variety of outcome measures. In summary, even though tele-rehabilitation showed great improvements in balance and quality of life, more research should be done to address its drawbacks, such as long-term effectiveness and technological accessibility, in order to maximize its use.

## CONCLUSION

In summary, this study discovered that for chronic stroke patients, tele-rehabilitation was superior to home-based activities in terms of increasing balance and quality of life. Because of the tele-rehabilitation group's structured feedback and involvement, they demonstrated better improvements. The results imply that tele-rehabilitation may be a better choice for stroke recovery, despite certain drawbacks. Issues with accessibility and long-term results should be the main topics of future research.

## REFERENCES

1. Bang D-H, Song M-S, Cho H-S. The Effects of mCIMT using PNF on the Upper Extremity Function and Activities of Daily Living in Patients with Subacute Stroke. PNF and Movement. 2018;16(3):451-60.

2. Salgueiro C, Urrútia G, Cabanas-Valdés R. Telerehabilitation for balance rehabilitation in the subacute stage of stroke: A pilot controlled trial. NeuroRehabilitation. 2022;51(1):91-9.

3. Tenforde AS, Zafonte R, Hefner J, Iaccarino MA, Silver J, Paganoni S. Evidence-based physiatry: efficacy of home-based telerehabilitation versus in-clinic therapy for adults after stroke. American Journal of Physical Medicine & Rehabilitation. 2020;99(8):764-5.

4. Chen J, Sun D, Zhang S, Shi Y, Qiao F, Zhou Y, et al. Effects of home-based telerehabilitation in patients with stroke: a randomized controlled trial. Neurology. 2020;95(17):e2318-e30.

5. Hwang R, Bruning J, Morris NR, Mandrusiak A, Russell T. Home-based telerehabilitation is not inferior to a centre-based program in patients with chronic heart failure: a randomised trial. Journal of Physiotherapy. 2017;63(2):101-7.

6. Zedda A, Gusai E, Caruso M, Bertuletti S, Baldazzi G, Spanu S, et al., editors. DoMoMEA: A Home-Based telerehabilitation system for stroke patients. 2020 42nd Annual International Conference of the IEEE Engineering in Medicine & Biology Society (EMBC); 2020: IEEE.

7. Kudlac M, Sabol J, Kaiser K, Kane C, Phillips RS. Reliability and validity of the berg balance scale in the stroke population: a systematic review. Physical & Occupational Therapy in Geriatrics. 2019;37(3):196-221.

8. Kim D-Y, Park H-S, Park S-W, Kim J-H. The impact of dysphagia on quality of life in stroke patients. Medicine. 2020;99(34):e21795.

9. Cramer SC, Dodakian L, Le V, See J, Augsburger R, McKenzie A, et al. Efficacy of home-based telerehabilitation vs in-clinic therapy for adults after stroke: a randomized clinical trial. JAMA neurology. 2019;76(9):1079-87.

10. Knepley KD, Mao JZ, Wieczorek P, Okoye FO, Jain AP, Harel NY. Impact of telerehabilitation for stroke-related deficits. Telemedicine and e-Health. 2021;27(3):239-46.

11. Klaic M, Galea MP. Using the technology acceptance model to identify factors that predict likelihood to adopt tele-neurorehabilitation. Frontiers in neurology. 2020;11:580832.

12. Hosseiniravandi M, Kahlaee AH, Karim H, Ghamkhar L, Safdari R. Home-based telerehabilitation software systems for remote supervising: a systematic review. International journal of technology assessment in health care. 2020;36(2):113-25.

13. Sarfo FS, Ulasavets U, Opare-Sem OK, Ovbiagele B. Tele-rehabilitation after stroke: an updated systematic review of the literature. Journal of stroke and cerebrovascular diseases. 2018;27(9):2306-18.

14. Tchero H, Tabue Teguo M, Lannuzel A, Rusch E. Telerehabilitation for stroke survivors: systematic review and meta-analysis. Journal of medical Internet research. 2018;20(10):e10867.

15. Appleby E, Gill ST, Hayes LK, Walker TL, Walsh M, Kumar S. Effectiveness of telerehabilitation in the management of adults with stroke: A systematic review. PloS one. 2019;14(11):e0225150.

16. Kenis-Coskun O, Imamoglu S, Karamancioglu B, Kurt K, Ozturk G, Karadag-Saygi E. Comparison of telerehabilitation versus home-based video exercise in patients with Duchenne muscular dystrophy: a single-blind randomized study. Acta Neurologica Belgica. 2022;122(5):1269-80.

17. Saito T, Izawa KP. Effectiveness and feasibility of home-based telerehabilitation for community-dwelling elderly people in Southeast Asian countries and regions: a systematic review. Aging clinical and experimental research. 2021;33(10):2657-69.

18. Bernocchi P, Vitacca M, La Rovere MT, Volterrani M, Galli T, Baratti D, et al. Home-based telerehabilitation in older patients with chronic obstructive pulmonary disease and heart failure: a randomised controlled trial. Age and ageing. 2018;47(1):82-8.

19. Kortianou EA, Tsimouris D, Mavronasou A, Lekkas S, Kazatzis N, Apostolara ZE, et al. Application of a home-based exercise program combined with tele-rehabilitation in previously hospitalized patients with COVID-19: A feasibility, single-cohort interventional study. Pneumon. 2022;35(2):1-10.

20. Schröder J, Van Criekinge T, Embrechts E, Celis X, Van Schuppen J, Truijen S, et al. Combining the benefits of tele-rehabilitation and virtual reality-based balance training: a systematic review on feasibility and effectiveness. Disability and Rehabilitation: Assistive Technology. 2019;14(1):2-11.

 

21. Van Egmond M, Van Der Schaaf M, Vredeveld T, Vollenbroek-Hutten M, van Berge Henegouwen M, Klinkenbijl J, et al. Effectiveness of physiotherapy with telerehabilitation in surgical patients: a systematic review and meta-analysis. Physiotherapy. 2018;104(3):277-98.

22. Velayati F, Ayatollahi H, Hemmat M. A systematic review of the effectiveness of telerehabilitation interventions for therapeutic purposes in the elderly. Methods of Information in Medicine. 2020;59(02/03):104-9.

23. Hamedani M. Developing new sensors and computer systems for the tele-rehabilitation and remote evaluation of the rehabilitation process of patients with neurological diseases. 2020.

24. Shin Y-C, Park J-H. Effects of telerehabilitation on motor function of stroke patients: A systematic review. Therapeutic Science for Rehabilitation. 2018;7(4):7-18.