IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Comparative Analysis Of The Effectiveness Of Telephone-Based Exercise Intervention With Conventional Treatment In Reducing Pain Intensity In Patients With Lateral Epicondylitis

Savita Singh, Research Scholar, College of Physiotherapy, Singhania University, Jhunjhunu, Rajasthan.

Dr. Annu Jain, Associate Professor, College of Physiotherapy, Singhania University, Jhunjhunu, Rajasthan

Dr. Moattar Raza Rizvi, Professor & Dean, School of Allied Health Sciences, Manav Rachna International Institute of Research & Studies, Faridabad, India.

ABSTRACT

This study aimed to compare the effectiveness of telephone-based exercise intervention (telerehabilitation) and conventional in-person treatment for managing lateral epicondylitis, commonly known as tennis elbow. By examining outcomes such as pain intensity, grip strength, functional improvement, and quality of life, the study sought to determine whether telerehabilitation could serve as a viable alternative to traditional physiotherapy, particularly in enhancing accessibility and adherence to treatment protocols. To assess the effectiveness of a tele-rehabilitation exercise program (TG) compared to conventional in-person physiotherapy (CG) in reducing pain, improving grip strength, and enhancing health-related quality of life in patients with lateral epicondylitis. This randomized controlled trial included 50 participants diagnosed with unilateral lateral epicondylitis, randomly allocated to either TG or CG. Interventions were administered over 8 weeks. Outcomes included pain intensity (VAS), grip strength, Patient-Rated Tennis Elbow Evaluation (PRTEE) scores, and health-related quality of life (SF-36) will be measured at baseline 4 weeks and 8 weeks. Data will be analyzed using repeated measures ANOVA and independent t-tests.

Keywords: lateral epicondylitis, tele-rehabilitation, conventional physiotherapy, randomized controlled trial, pain management, grip strength.

Introduction:

Lateral epicondylitis, commonly known as tennis elbow, is a painful condition affecting the tendons that attach to the lateral epicondyle of the elbow. The management of this condition often involves physical therapy, exercise interventions, and other conventional treatments. This analysis compares the effectiveness of telephone-based exercise interventions with conventional treatment methods in reducing pain intensity, measured by the Visual Analogue Scale (VAS).

Conventional Treatments:

Conventional treatments for lateral epicondylitis encompass a range of non-surgical and surgical approaches. Each treatment option has its own set of advantages and limitations, and the best approach often involves a combination of therapies tailored to the individual patient's needs. In comparison to telephone-based exercise interventions, conventional treatments provide a more hands-on and immediate approach, though both methods aim to reduce pain and improve function. The management of lateral epicondylitis typically follows a stepwise approach, beginning with conservative measures and progressing to more invasive interventions if symptoms persist. The primary goals of treatment are pain relief, restoration of function, and prevention of recurrence. Conventional treatments for lateral epicondylitis include:

Non-Surgical Treatments

1. **Rest and Activity Modification:**
    - Avoiding activities that exacerbate pain.
    - Modifying techniques in sports or work-related tasks to reduce strain on the elbow.
2. **Physical Therapy:**
    - **Manual Therapy:** Techniques such as massage, mobilization, and manipulation performed by a physical therapist to improve elbow function.
    - **Exercise Therapy:** Structured exercise programs focusing on strengthening and stretching the forearm muscles. Eccentric exercises are particularly emphasized for tendon healing.
3. **Bracing and Splinting:**
    - **Tennis Elbow Brace:** A counterforce brace or strap applied to the forearm to reduce strain on the tendons.
    - **Wrist Splint:** May be used to immobilize the wrist and reduce stress on the elbow.
4. **Medications:**
    - **Nonsteroidal Anti-Inflammatory Drugs (NSAIDs):** Used to reduce pain and inflammation (e.g., ibuprofen, naproxen).
    - **Topical Analgesics:** Creams or gels applied to the skin over the painful area.
5. **Corticosteroid Injections:**
    - Local injections to reduce inflammation and provide short-term pain relief. However, their long-term effectiveness is debated, and repeated injections can weaken tendons.

6. **Extracorporeal Shock Wave Therapy (ESWT):**
    - A non-invasive procedure where shock waves are directed at the affected area to promote healing and reduce pain.
7. **Ultrasound Therapy:**
    - Using sound waves to stimulate blood flow and promote healing in the affected tendon.
8. **Platelet-Rich Plasma (PRP) Injections:**
    - Injections of concentrated platelets derived from the patient's own blood, aimed at promoting healing of the tendons.

Surgical Treatments

If non-surgical treatments fail to provide relief after an extended period (usually 6-12 months), surgical options may be considered. These include:

1. **Open Surgery:**
    - Involves making an incision over the elbow to remove damaged tissue and reattach healthy tendon to the bone.
2. **Arthroscopic Surgery:**
    - A minimally invasive procedure where small incisions and a camera (arthroscope) are used to remove damaged tissue and promote healing.
3. **Percutaneous Tenotomy:**
    - A procedure where small incisions or needle punctures are made to remove damaged tissue and stimulate tendon healing.

Efficacy of Conventional Treatments:

The efficacy of conventional treatments for lateral epicondylitis has been the subject of numerous studies, with varying levels of evidence:

1. Physical Therapy: A systematic review by Bisset and Vicenzino (2015) found strong evidence supporting the use of exercise and manual therapy in the management of lateral epicondylitis. Specifically:
    - Eccentric exercises have shown significant improvements in pain and function. A randomized controlled trial by Peterson et al. (2014) demonstrated that an eccentric exercise program was more effective than concentric exercises or wait-and-see approach at 3-month follow-up.
    - Manual therapy techniques, particularly mobilization with movement, have shown immediate and short-term benefits. Vicenzino et al. (2001) reported significant improvements in pain-free grip strength following mobilization with movement compared to placebo and control interventions.

2. Orthotics and Bracing: A Cochrane review by Struijs et al. (2002) found limited evidence supporting the use of orthotic devices. However, a more recent randomized controlled trial by Altan and Kanat (2008) showed that the use of a forearm band in combination with physical therapy was more effective than physical therapy alone.
3. Medications:
    - Topical NSAIDs: A systematic review by Pattanittum et al. (2013) found moderate evidence supporting the use of topical NSAIDs for short-term pain relief in lateral epicondylitis.
    - Oral NSAIDs: While commonly prescribed, their long-term efficacy is questionable. A systematic review by Green et al. (2002) found insufficient evidence to support or refute the use of oral NSAIDs for lateral epicondylitis.
4. Corticosteroid Injections: The efficacy of corticosteroid injections has been a subject of debate. A landmark study by Coombes et al. (2013) found that while corticosteroid injections provided short-term benefits, they were associated with poorer long-term outcomes compared to placebo. Specifically:
    - At 4 weeks, 78% of patients in the corticosteroid group reported complete or much improvement, compared to 65% in the placebo group.
    - However, at 1 year, the corticosteroid group had significantly higher recurrence rates (54%) compared to the placebo group (12%).
5. Autologous Blood and PRP Injections: The evidence for these biological treatments is mixed. A systematic review by Arirachakaran et al. (2016) found that PRP injections were more effective than autologous blood injections in improving pain and function. However, the quality of evidence was low to moderate.
6. Surgical Interventions: For patients who fail conservative management, surgery can be effective. A systematic review by Buchbinder et al. (2011) found that open, percutaneous, and arthroscopic surgical techniques all showed good long-term results, with success rates ranging from 80% to 97%. However, the quality of evidence was generally low, and there was a lack of well-designed randomized controlled trials comparing surgical techniques to placebo or conservative management.

Study Design:

This study employed a prospective, parallel-group, comparative study design with convenience sampling. Participants diagnosed with unilateral lateral epicondylitis who met the eligibility criteria and provided informed consent were assigned to either the telerehabilitation group or the conventional treatment group based on logistical feasibility and participant preference. Given the nature of the interventions, blinding of participants and outcome assessors was not possible. To maintain study integrity, the allocation process was systematically documented. Participants were recruited using convenience sampling methods from outpatient clinics and medical centers.

Sample Size:

The sample size was calculated using the formula:

$$n = (Z^2 * (1-\alpha) * p(1-p)) / d^2$$

where:

$Z(1-\alpha) = 1.95$ (Z-score for the desired confidence level of 95%, which corresponds to $\alpha = 0.05$)

$p = 0.03$ (Estimated proportion or expected proportion of the population, 3% incidence) Charan et al. (2013).

$d = 0.05$ (Desired margin of error)

Substituting the values:

$n = (1.95^2 * (1-0.05) * 0.03 * (1-0.03)) / 0.05^2$

$n = (3.8025 * 0.95 * 0.03 * 0.97) / 0.0025$

$n = 0.108278125 / 0.0025$

$n = 43.31$

Rounding up to account for the sample size as a whole number and adding 20% for potential dropout, the total sample size becomes 50 participants.

Sampling Technique:

Participants were recruited from outpatient clinics and medical centers using consecutive sampling. Individuals presenting with a diagnosis of unilateral lateral epicondylitis and meeting the inclusion criteria were consecutively enrolled in the study until the target sample size was achieved. The study initially started with 54 participants (after screening 84 participants), divided equally into two groups, with 27 participants in each. Patients who faced challenges in visiting the department, such as mobility issues or geographical constraints, were specifically enrolled for the telephone-based telerehabilitation intervention. During the 12-week intervention period, the control group experienced one dropout at the mid-assessment (4 weeks) and another at the post-assessment (8 weeks), resulting in a total of 25 participants who completed the study in this group. In the telerehabilitation group, two participants dropped out at the post-assessment (8 weeks), also leaving 25 participants who completed the study. (Figure 1).

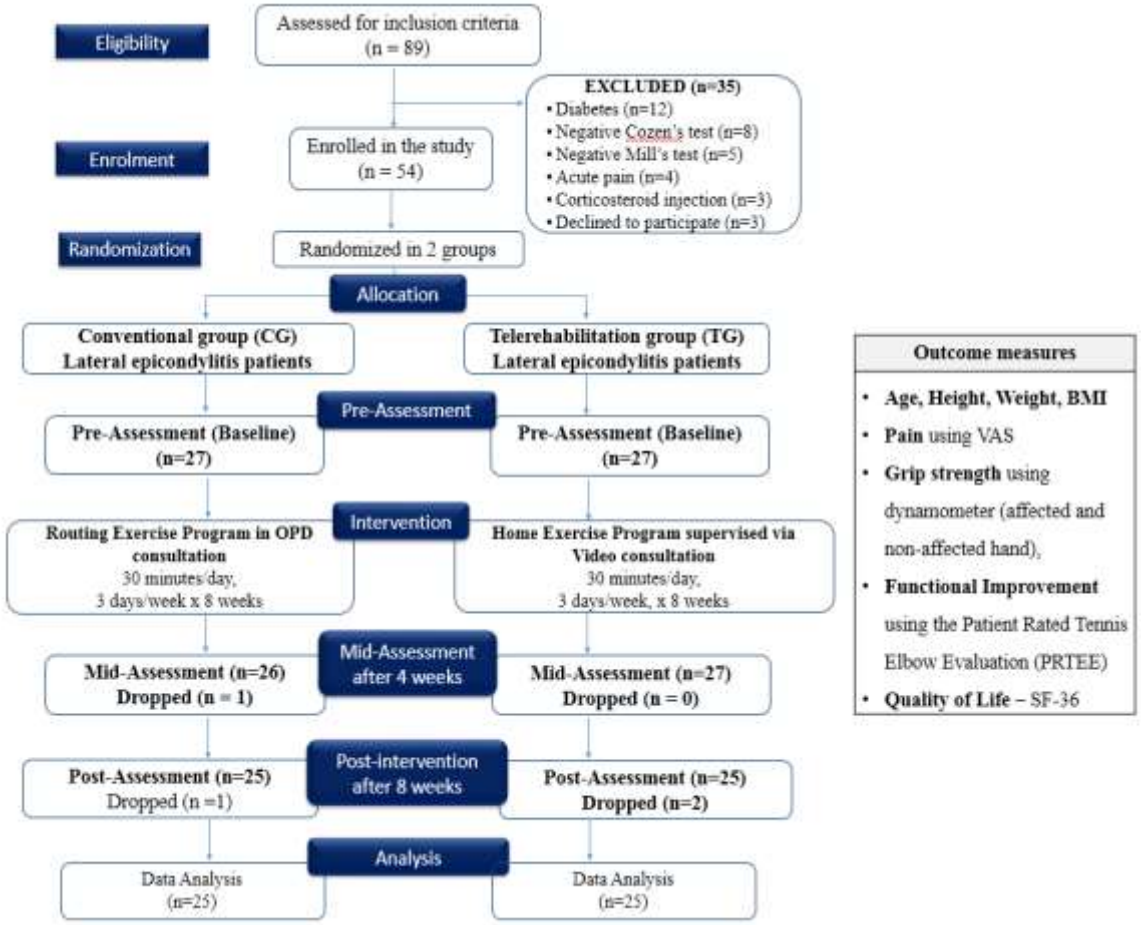

Figure 1: Flow chart of the study design Inclusion Criteria

Randomization and Blinding:

Randomization was performed using computer-generated random numbers, and the allocation sequence was concealed to ensure allocation concealment. Blinding of participants and physiotherapists delivering the interventions was not feasible due to the nature of the interventions. However, outcome assessors were blinded to the group assignments to minimize potential bias in outcome assessment.

Selection Criteria

Inclusion Criteria:

- Individuals diagnosed with lateral epicondylitis based on clinical examination and medical history will be considered.
- Localized pain and tenderness over the lateral epicondyle of the affected elbow, exacerbated by resisted wrist extension and gripping activities.
- Patients with unilateral lateral epicondylitis, characterized by chronic symptomatic inflammation of the forearm tendons at one elbow.
- Positive Cozen test on the affected side, indicative of lateral epicondylitis.
- Adult participants aged between 30 and 45 years.

- Patients with lateral epicondylitis experiencing symptoms for at least 8-10 weeks. This criterion aims to ensure that participants have chronic symptomatic inflammation of the forearm tendons at the elbow, allowing for a more consistent baseline of the condition.
- Participants must be physically capable of participating in the prescribed exercise program, which will involve eccentric strengthening exercises, stretching, and self-management strategies.
- Literacy in English or Hindi language for understanding instructions provided during the telerehabilitation sessions or in-person clinic visits
- Access to a mobile device with audio and video capabilities for video calls during the original study
- Participants must have adequate language proficiency to understand and follow instructions provided during the telerehabilitation sessions or in-person clinic visits.

Exclusion Criteria:

- Participants with severe comorbidities or medical conditions including significant cardiovascular or respiratory disorders, uncontrolled diabetes, or other conditions that may pose safety risks during physical activities that may hinder their ability to actively participate in the exercise program or undergo physiotherapy sessions
- History of significant trauma or injury to the affected elbow before or during the original study, contributing to the development of lateral epicondylitis.
- Patients who have undergone surgical interventions or corticosteroid injections for lateral epicondylitis in the affected elbow
- Aversion to manual touch or resistance to physical examination of the affected elbow due to pain sensitivity.
- Pregnant women will be excluded from the study due to potential variations in pain perception and physiological changes that could affect the outcome measures.
- Individuals with cognitive impairments or communication barriers that may hinder their ability to understand and comply with the prescribed exercises or follow-up assessments will be excluded.

Dependent Variables

- Pain VAS
- Grip strength
- Patient-Rated Tennis Elbow Evaluation (PRTEE)
- Quality of Life (QoL)- SF-36

Independent Variables

- Conventional treatment for lateral epicondylitis
- Telerehabilitation for lateral epicondylitis

Intervention Groups:

Telerehabilitation Group (TG):

Participants allocated to the telerehabilitation group were provided with remote physiotherapy sessions through telecommunication technology, such as video calls or teleconferencing software, based on the reference protocol. The telerehabilitation sessions were conducted by experienced and trained physiotherapists, following a standardized protocol. The exercise program focused on static stretching exercises for the affected forearm muscles to improve flexibility. Participants attended telerehabilitation sessions scheduled three times per week for a total duration of 8 weeks. Over the course of the study, they completed a total of 36 telerehabilitation sessions, adhering to the standardized treatment plan. Each session lasted approximately 30 minutes, consistent with the reference protocol. Additionally, participants were educated about self-management strategies for pain relief and functional improvement.

Conventional Treatment Group (CG):

Participants allocated to the conventional treatment group received standard physiotherapy care through in-person visits to the clinic. Trained physiotherapists at the clinic conducted the treatment sessions, following a standardized protocol. The exercise program in the conventional treatment group included both static stretching exercises for the affected forearm muscles to improve flexibility and eccentric strengthening exercises. The in-person treatment sessions also incorporated hands-on techniques, manual therapy, and other conventional physiotherapy modalities commonly used for managing lateral epicondylitis. The frequency of the in-person treatment sessions was scheduled three times a week for a total duration of 8 weeks. Participants attended a total of 36 in-person treatment sessions throughout the study, following the standardized treatment plan. Each in-person session lasted approximately 30 minutes, consistent with the reference protocol. Participants in the conventional treatment group were also provided with an education handbook on ergonomics and activity amendment techniques to avoid exacerbation of symptoms.

Exercise protocol:

The exercise protocol for managing Lateral Epicondylitis (Tennis Elbow) previously included a variety of stretches and strengthening exercises. The regimen began with static stretching of the Extensor Carpi Radialis Brevis, performed in a seated position with extended elbow, pronated forearm, and flexed wrist with ulnar deviation. This stretch was carefully monitored to match each patient's tolerance level, held for 30-45 seconds, and repeated six times, divided equally before and after the strengthening exercises, with brief rests between stretches.For strengthening, patients engaged in eccentric wrist extensor exercises, seated with fully extended elbows, pronated forearms, and wrists in maximum extension. They gently lowered their wrists into flexion, using the opposite hand for assistance, focusing on a controlled movement even if mild discomfort was present. This was repeated in three sets of ten repetitions, with a minute's rest between sets, and resistance was adjusted based on the patient's capability, roughly corresponding to 10 Repetition Maximum (RM).

In addition to physical exercises, patients were provided with an educational handbook on ergonomics and activity modification techniques to mitigate symptom exacerbation, ensuring a comprehensive approach to

rehabilitation. This protocol emphasized gradual progression and pain-free execution to promote effective recovery from Tennis Elbow.

Table 1: Exercise Protocol for the Management of Lateral Epicondylitis (Tennis Elbow)(Deshak et al., 2020; Dimitrios & Pantelis, 2013; Stasinopoulos et al., 2005)

Exercise	Description	Repetitions & Sets
Wrist Extensor Stretch	Extend the affected arm, use the opposite hand to pull the wrist downwards until a stretch is felt along the top of the forearm.	Hold for 15-30 seconds, 2-3 sets
Static Stretching of Extensor Carpi Radialis Brevis	Performed in a seated position with elbow extended, forearm pronated, and wrist flexed with ulnar deviation. The stretch should be held to create tension without pain.	Hold for 30-45 seconds, 6 times (3 before and 3 after exercises)
Eccentric Strengthening of Wrist Extensors	Similar to wrist extensor flexion, focus on slowly lowering the weight over about 4-5 seconds to emphasize the eccentric phase.	10-15 reps, 2-3 sets with a one minute rest between sets; increase resistance based on a 10-repetition maximum capacity.
Forearm Pronation/Supination	Hold a dumbbell with the elbow at 90 degrees and rotate the forearm to move the palm up and down.	10-15 reps, 2-3 sets
Tennis Ball Squeeze	Squeeze a tennis ball or stress ball firmly and hold for a few seconds.	10-15 reps
Towel Twist	Hold a towel with both hands and twist it in both directions, as if wringing out water.	10-15 reps, 2-3 sets
Isometric Wrist Extension	Place hand palm down on a table, press against the table without moving the wrist.	Hold for 10-15 seconds, 5 reps
Gentle Range of Motion Exercises	Perform wrist flexion and extension, and elbow flexion and extension to increase blood flow to the area.	10-15 reps each, 2-3 sets
Wrist Flexor Stretch	Extend the affected arm, palm facing up, and use the opposite hand to gently pull the wrist downwards until a stretch is felt along the forearm.	Hold for 15-30 seconds, 2-3 sets
Finger Stretch	Place a rubber band around your fingers and thumb, then open your fingers against the resistance of the band.	10-15 reps, 2-3 sets
Self-Massage	Use the opposite hand to gently massage the muscles of the forearm, applying pressure in a circular motion.	5-10 minutes, focusing on tender areas

Proprioception Exercises	Practice balancing a light object (like a tennis ball) on the back of your hand with your arm extended, moving your arm in different directions.	5-10 minutes
Ice Therapy	Apply an ice pack to the affected area to reduce inflammation and pain.	10-15 minutes after exercises

Pain VAS

Pain levels were assessed using the Visual Analogue Scale (VAS), a widely used and validated tool for measuring subjective pain intensity in various musculoskeletal conditions. The VAS consists of a 10 cm horizontal line, with "no pain" and "worst possible pain" as anchors at each end. Participants were instructed to rate their current level of pain at the lateral epicondyle by placing a mark on the VAS line, with the distance from the "no pain" anchor to the mark measured in centimeters to provide a numerical pain score ranging from 0 to 10(Bijur et al., 2001). Pain assessments were conducted at baseline, 4 weeks, and 8 weeks to evaluate changes in pain intensity over the intervention period, with participants rating their pain during standardized activities known to exacerbate symptoms, such as gripping or resisted wrist extension.

Patient-Rated Tennis Elbow Evaluation (PRTEE)

To assess the effectiveness of our therapeutic interventions for tennis elbow, we employed the Patient Rated Tennis Elbow Evaluation (PRTEE) as a primary outcome measure. This tool is widely recognized for its ability to quantify both pain and functional disability specifically associated with tennis elbow (Rompe et al., 2007). It consists of a questionnaire divided into two main subscales: Pain and Function. The Pain subscale measures the severity of pain experienced in various situations, while the Function subscale assesses difficulty in performing specific and usual activities related to daily and occupational tasks. Each item on the questionnaire is rated on a scale from 0 (no pain or difficulty) to 10 (worst imaginable pain or inability to perform the activity), providing a comprehensive and patient-centered assessment of symptom severity and impact on function. The reliability and validity of the PRTEE have been confirmed in multiple studies, making it an ideal choice for evaluating the clinical outcomes in our study (Blanchette & Normand, 2010; Marks et al., 2021).

Grip strength

In this study, grip strength served as a crucial outcome measure for lateral epicondylitis (LE), appreciated for its established validity, reliability, and ability to quantitatively assess physical impairment (Deshak et al., 2020). Grip strength assessments were conducted using a calibrated hand-held dynamometer (Fabrication Enterprises, USA). Participants adhered to a protocol that required maintaining an upright posture with the elbow fully extended and both the shoulder and forearm aligned in a neutral position. During the assessment, participants compressed the dynamometer using the affected limb until the initial sensation of pain, measuring the pain-free grip strength (PFG). The kilogram force (kgf) exerted at this initial pain point was recorded. This procedure was repeated for a total of three trials, with 30-second rest

intervals between each to minimize fatigue. The mean value of these repetitions was calculated and represented the patient's PFG. For the unaffected arm, maximum grip strength was assessed under similar conditions but without the pain limitation.

Statistical analysis

Data analysis was performed using SPSS Version 25.0 (IBM, USA) in this study. The normality of the distribution for each variable was checked using the Shapiro-Wilk test. Results indicated that the data were normally distributed, which justified the use of parametric tests for further analyses. For categorical variables such as gender distribution, educational background, and residential setting, chi-square tests were applied to assess the differences between the Control Group (CG) and the Treatment Group (TG). Regarding continuous variables, independent t-tests were employed to compare means between the two groups at baseline, ensuring no pre-treatment differences were present. Additionally, paired t-tests were utilized to analyze changes within each group before and after the treatment, while repeated measures ANOVA was used to assess the effects over time across multiple measurements, providing a comprehensive view of the treatment impacts. This structured approach to data analysis ensures a robust examination of the variables involved and supports the reliability of the study findings.

Demographic and Baseline Characteristics

This study compared the effectiveness of tele-rehabilitation and conventional outpatient therapy for treating medial epicondylitis, examining two distinct treatment groups. The Control Group (CG) underwent conventional training during outpatient consultations, while the Treatment Group (TG) participated in a home-based exercise program facilitated through video consultation (telerehabilitation). We assessed demographic, educational, and baseline characteristics to ensure comparability between the groups and to isolate the effects of the treatment modalities. Additionally, specific variables such as weekly working time and duration of symptoms were analyzed to gauge any differences in the treatment impact across the two modalities.

Gender Distribution: The analysis revealed no statistically significant difference in sex distribution between the CG and the TG (Chi-Square = 0.082, df = 1, p = 0.774). The CG comprised 14 females (56%) and 11 males (44%), while the TG included 15 females (60%) and 10 males (40%).

Educational Background: Similarly, there were no significant differences observed in educational levels between the two groups (Chi-Square = 0.359, df = 2, p = 0.836). The distribution within the CG was 15 graduates (60%), 6 postgraduates (24%), and 4 doctorates (16%). The TG consisted of 17 graduates (68%), 5 postgraduates (20%), and 3 doctorates (12%).

Residential Setting: The residential area also showed no significant association with the group assignment (Chi-Square = 0.333, df = 1, p = 0.564). In the CG, 9 participants (36%) were from rural areas and 16 (64%) from urban areas, compared to 11 participants (44%) from rural areas and 14 (56%) from urban areas in the TG.

Limitations of the study

This study faced several limitations that should be considered when interpreting the results. The relatively small sample size may limit the generalizability of the findings, and the short duration of eight weeks might not be sufficient to observe the long-term effects of the interventions on lateral epicondylitis. A longer follow-up period could provide insights into sustained effectiveness and potential relapse rates. Additionally, some data, such as pain levels and adherence to the exercise regimen, were self-reported by participants, which could introduce bias or inaccuracies. The lack of blinding, where participants were aware of their group allocation, might have influenced their perception of treatment effectiveness and reported outcomes. The study's participants may not represent the broader population affected by lateral epicondylitis, limiting the diversity of the sample. Furthermore, the effectiveness of telerehabilitation can be influenced by the quality of internet connections and participants' familiarity with technology, which could affect the comparability of the interventions. Monitoring adherence to home-based exercise programs posed challenges, leading to potential variations in how diligently participants followed the prescribed regimens. The study also focused solely on exercise-based interventions, without considering other potential treatments such as pharmacological therapies or surgical options, which might also be effective for some patients.

Results: Both interventions showed significant improvements over time with no significant differences between groups in reducing pain intensity and enhancing grip strength. For pain (VAS), significant time effects were noted with $\eta^2p = 0.92$, $p < 0.001$ for the control group, showing a reduction from baseline 7.56 ± 1.23 to 2.92 ± 0.64 at 8 weeks. Similar results were observed in the treatment group with $\eta^2p = 0.92$, $p < 0.001$, reducing from 7.72 ± 0.89 to 3.28 ± 0.68. Grip strength improvements in the dominant hand showed no significant differences between groups ($\eta^2p = 0.02$, $p = 0.36$), with the control group increasing from 37.38 ± 11.21 kgf to 46.86 ± 7.93 kgf, and the treatment group from 36.61 ± 13.17 kgf to 44.72 ± 7.81 kgf. PRTEE scores across all subscales indicated significant improvements in both groups with no significant interaction effects, suggesting comparable efficacy in improving functional outcomes. Health-related quality of life as measured by SF-36 also showed no significant changes over time or between groups, suggesting stability across all domains.

Conclusions:

Tele-rehabilitation is as effective as conventional physiotherapy in treating lateral epicondylitis, providing significant reductions in pain and improvements in grip strength and functional outcomes. These findings support tele-rehabilitation as a feasible alternative to conventional therapy, offering potential benefits in accessibility and patient adherence. The findings indicate that both telerehabilitation and conventional in-person treatments are effective in reducing pain and improving functional outcomes in patients with lateral epicondylitis. Significant reductions in pain levels were observed in both groups over the study period. Patients receiving conventional treatment showed a notable decrease in pain, with similar significant pain reduction observed in those participating in the telerehabilitation program. These results highlight the effectiveness of both modalities in managing pain, with no substantial differences between the two

groups.Grip strength assessments for both the dominant and non-dominant hands showed comparable improvements in both groups. Patients undergoing conventional treatment exhibited an increase in grip strength for both hands, and those in the telerehabilitation group experienced similar improvements. This suggests that both approaches are equally effective in enhancing grip strength, an important measure of functional recovery in lateral epicondylitis.

Functional improvements, as measured by the Patient-Rated Tennis Elbow Evaluation (PRTEE), were also significant in both groups. Patients in the conventional treatment group showed substantial improvements in pain, specific activities, usual activities, and overall function. The telerehabilitation group exhibited similar gains, indicating that remote exercise programs can effectively enhance daily and specific functional activities.

The quality of life, assessed through the Short Form Health Survey (SF-36), remained stable across the study period for both groups, suggesting that the interventions helped maintain or slightly improve overall well-being without significant differences between the treatment modalities.

Overall, the study concludes that telephone-based exercise intervention is as effective as conventional in-person physiotherapy in managing lateral epicondylitis. The comparable outcomes across pain reduction, grip strength, functional improvements, and quality of life measures support the viability of telerehabilitation as a flexible and accessible treatment option. These findings are particularly relevant for patients who may face logistical challenges in attending regular in-person sessions, offering an alternative that can potentially enhance adherence and accessibility to effective treatment for lateral epicondylitis.

Future implications of the study

Despite these limitations, the study's findings have several future implications. The feasibility and effectiveness of telerehabilitation for lateral epicondylitis suggest that it could be integrated into standard care protocols, especially for patients with limited access to in-person therapy. Future research should include longer follow-up periods to assess the long-term effects and sustainability of telerehabilitation interventions, providing a clearer picture of their enduring impact on patient outcomes. Conducting studies with larger and more diverse populations would enhance the generalizability of the findings, allowing for more nuanced conclusions about the effectiveness of different treatment modalities across various demographics. Exploring the combination of telerehabilitation with other treatment modalities such as medication, manual therapy, and surgical interventions could help determine the most effective comprehensive treatment plans. As technology advances, future studies could investigate the use of more sophisticated digital tools and platforms for telerehabilitation, potentially improving the quality and efficacy of remote interventions. Research into the development of educational and support resources for patients undergoing telerehabilitation could enhance adherence and engagement, leading to better outcomes. Evaluating the cost-effectiveness of telerehabilitation compared to conventional in-person treatments would provide valuable data for healthcare policymakers and providers. Finally, future research could focus on developing and testing personalized rehabilitation programs that tailor exercise regimens to individual patient needs and capabilities, potentially improving treatment effectiveness and patient satisfaction.

References:

- Aben, A., et al. (2018). Patient's perspective on self-management in the recovery from lateral epicondylitis. Physiotherapy Theory and Practice, 34(5), 378-385.
- Almathami, H. K. Y., Win, K. T., & Vlahu-Gjorgievska, E. (2020). Barriers and facilitators that influence telemedicine-based, real-time, online consultation at patients' homes: systematic literature review. Journal of Medical Internet Research, 22(2), e16407.
- Behnoush, B., Tavakoli, N., Bazmi, E., Nateghi Fard, F., Pourgharib Shahi, M. H., Okazi, A., & Mokhtari, T. (2016). Smartphone and Universal Goniometer for Measurement of Elbow Joint Motions: A Comparative Study. Asian Journal of Sports Medicine, 7(2), e30668.
- Bennell, K. L., et al. (2017). Effectiveness of an internet-delivered exercise and pain-coping skills training intervention for persons with chronic knee pain: a randomized trial. Annals of Internal Medicine, 166(7), 453-462.
- Bennell, K. L., Lawford, B. J., Metcalf, B., Mackenzie, D., Russell, T. G., van den Berg, M., ... & Hinman, R. S. (2020). Physiotherapists and patients report positive experiences overall with telehealth during the COVID-19 pandemic: a mixed-methods study. Journal of Physiotherapy, 66(4), 267-277.
- Bennell, K. L., Lawford, B. J., Metcalf, B., Mackenzie, D., Russell, T. G., van den Berg, M., ... & Hinman, R. S. (2020). Effectiveness and cost-effectiveness of a physiotherapy-guided exercise and pain management program for older adults with knee osteoarthritis: the PARTNER pragmatic randomised controlled trial protocol. BMC Musculoskeletal Disorders, 21(1), 1-19.
- Bennell, K. L., Lawford, B. J., Metcalf, B., Mackenzie, D., Russell, T. G., van den Berg, M., ... & Hinman, R. S. (2020). Effectiveness and cost-effectiveness of a physiotherapy-guided exercise and pain management program for older adults with knee osteoarthritis: the PARTNER pragmatic randomised controlled trial protocol. BMC Musculoskeletal Disorders, 21(1), 1-19.
- Bennell, K. L., Lawford, B. J., Metcalf, B., Mackenzie, D., Russell, T. G., van den Berg, M., ... & Hinman, R. S. (2020). Effectiveness and cost-effectiveness of a physiotherapy-guided exercise and pain management program for older adults with knee osteoarthritis: the PARTNER pragmatic randomised controlled trial protocol. BMC Musculoskeletal Disorders, 21(1), 1-19.
- Bennell, K. L., Nelligan, R., Dobson, F., Rini, C., Keefe, F., Kasza, J., ... & Hinman, R. S. (2017). Effectiveness of an internet-delivered exercise and pain-coping skills training intervention for persons with chronic knee pain: a randomized trial. Annals of Internal Medicine, 166(7), 453-462.
- Bijur, P. E., Silver, W., et al. (2001). Reliability of the visual analog scale for measurement of acute pain. Academic emergency medicine, 8(12), 1153-1157.
- Coombes, B. K., Bisset, L., & Vicenzino, B. (2015). Management of lateral elbow tendinopathy: one size does not fit all. Journal of Orthopaedic & Sports Physical Therapy, 45(11), 938-949.

- Coombes, B. K., Bisset, L., Brooks, P., Khan, A., & Vicenzino, B. (2013). Effect of corticosteroid injection, physiotherapy, or both on clinical outcomes in patients with unilateral lateral epicondylalgia: a randomized controlled trial. JAMA, 309(5), 461-469.
- Coombes, B. K., Connelly, L., Bisset, L., & Vicenzino, B. (2016). Economic evaluation favours physiotherapy but not corticosteroid injection as a first-line intervention for chronic lateral epicondylalgia: evidence from a randomised clinical trial. British Journal of Sports Medicine, 50(22), 1400-1405.
- Coombes, B. K., et al. (2013). Effect of corticosteroid injection, physiotherapy, or both on clinical outcomes in patients with unilateral lateral epicondylalgia: a randomized controlled trial. JAMA, 309(5), 461-469.
- Cottrell, M. A., et al. (2017). Real-time telerehabilitation for the treatment of musculoskeletal conditions is effective and comparable to standard practice: a systematic review and meta-analysis. Clinical Rehabilitation, 31(5), 625-638.
- Cottrell, M. A., et al. (2018). Real-time telerehabilitation for the treatment of musculoskeletal conditions is effective and comparable to standard practice: a systematic review and meta-analysis. Clinical Rehabilitation, 32(3), 395-407.
- Cottrell, M. A., Galea, O. A., O'Leary, S. P., Hill, A. J., & Russell, T. G. (2017). Real-time telerehabilitation for the treatment of musculoskeletal conditions is effective and comparable to standard practice: a systematic review and meta-analysis. Clinical rehabilitation, 31(5), 625-638.
- Cottrell, M. A., Hill, A. J., O'Leary, S. P., Raymer, M. E., & Russell, T. G. (2018). Clinicians' perspectives of a novel home-based multidisciplinary telehealth service for patients with chronic spinal pain. International Journal of Telerehabilitation, 10(2), 81-88.
- Cuesta-Vargas, A. I., Galán-Mercant, A., & Williams, J. M. (2020). The use of inertial sensors system for human motion analysis. Physical Therapy Reviews, 15(6), 462-473.
- Dong, W., Goost, H., Lin, X. B., Burger, C., Paul, C., Wang, Z. L., ... & Kabir, K. (2016). Treatments for shoulder impingement syndrome: a PRISMA systematic review and network meta-analysis. Medicine, 95(10), e3059.
- Eriksson, L., Lindström, B., & Ekenberg, L. (2009). Patients' experiences of telerehabilitation at home after shoulder joint replacement. Journal of Telemedicine and Telecare, 15(5), 221-225.
- Eriksson, L., Lindström, B., & Ekenberg, L. (2020). Patients' experiences of telerehabilitation for the treatment of tennis elbow: A qualitative study. Journal of Telemedicine and Telecare, 26(10), 619-626.
- Farrar, J. T., Young Jr, J. P., LaMoreaux, L., Werth, J. L., & Poole, R. M. (2001). Clinical importance of changes in chronic pain intensity measured on an 11-point numerical pain rating scale. Pain, 94(2), 149-158.
- Fung, V., et al. (2012). Use of Nintendo Wii Fit™ in the rehabilitation of outpatients following total knee replacement: a preliminary randomised controlled trial. Physiotherapy, 98(3), 183-188.

- Garnevall, B., Rabey, M., & Edman, G. (2013). Psychosocial and personality factors and physical measures in lateral epicondylalgia reveal two groups of "tennis elbow" patients, requiring different management. Scandinavian Journal of Pain, 4(3), 155-162.
- Giggins, O. M., et al. (2017). Biofeedback in rehabilitation. Journal of NeuroEngineering and Rehabilitation, 14(1), 65.
- Green, S., Buchbinder, R., Barnsley, L., Hall, S., White, M., Smidt, N., & Assendelft, W. (2002). Non-steroidal anti-inflammatory drugs (NSAIDs) for treating lateral elbow pain in adults. Cochrane Database of Systematic Reviews, (2).
- Gruchow, H. W., & Pelletier, D. (1979). An epidemiologic study of tennis elbow: incidence, recurrence, and effectiveness of prevention strategies. The American Journal of Sports Medicine, 7(4), 234-238.
- Haker, E. (1993). Lateral epicondylalgia: diagnosis, treatment and evaluation. Critical Reviews in Physical and Rehabilitation Medicine, 5(2), 129-154.
- Hamilton, P. G. (1986). The prevalence of humeral epicondylitis: a survey in general practice. Journal of the Royal College of General Practitioners, 36(291), 464-465.
- Hawker, G. A., Mian, S., et al. (2011). Measures of adult pain: Visual analog scale for pain (vas pain), numeric rating scale for pain (nrs pain), mcgill pain questionnaire (mpq), short-form mcgill pain questionnaire (sf-mpq), chronic pain grade scale (cpgs), short form-36 bodily pain scale (sf-36 bps), and measure of intermittent and constant osteoarthritis pain (icoap). Arthritis care & research, 63(S11), S240-S252.
- Heales, L. J., Lim, E. C. W., Hodges, P. W., & Vicenzino, B. (2017). Sensory and motor deficits exist on the non-injured side of patients with unilateral tendon pain and disability—implications for central nervous system involvement: a systematic review with meta-analysis. British Journal of Sports Medicine, 51(2), 124-129.
- Khalil, M. M., Afifi, A., & Amin, K. M. (2019, December). Mobile-based environment to facilitate rehabilitation of adults post-injuries. In *2019 14th International Conference on Computer Engineering and Systems (ICCES)* (pp. 222-227). IEEE.
- Kloek, C. J., et al. (2018). Effectiveness and cost-effectiveness of a blended exercise intervention for patients with hip and/or knee osteoarthritis: study protocol of a randomized controlled trial. BMC Musculoskeletal Disorders, 19(1), 230.
- Kraushaar, B. S., & Nirschl, R. P. (1999). Tendinosis of the elbow (tennis elbow): clinical features and findings of histological, immunohistochemical, and electron microscopy studies. Journal of Bone and Joint Surgery, 81(2), 259-278.
- Kruse, C. S., Karem, P., Shifflett, K., Vegi, L., Ravi, K., & Brooks, M. (2018). Evaluating barriers to adopting telemedicine worldwide: A systematic review. Journal of Telemedicine and Telecare, 24(1), 4-12.
- Kruse, C. S., Krowski, N., Rodriguez, B., Tran, L., Vela, J., & Brooks, M. (2017). Telehealth and patient satisfaction: a systematic review and narrative analysis. BMJ Open, 7(8), e016242.

- Laver, K. E., Adey-Wakeling, Z., Crotty, M., Lannin, N. A., George, S., & Sherrington, C. (2020). Telerehabilitation services for stroke. Cochrane Database of Systematic Reviews, (1).
- Lowe, A., Wessel, J., & Battie, M. C. (2003). Test-retest reliability, construct validity, and responsiveness of a functional pain scale for tennis elbow. *Physiotherapy Canada*, *55*(2), 114-123.
- Lucado, A. M., Dale, R. B., Vincent, J., & Day, J. M. (2019). Do joint mobilizations assist in the recovery of lateral elbow tendinopathy? A systematic review and meta-analysis. Journal of Hand Therapy, 32(2), 262-276.
- MacDermid, J. C. (2005). The Patient-Rated Tennis Elbow Evaluation (PRTEE)© User Manual. School of Rehabilitation Science, McMaster University, Hamilton, Ontario, Canada.
- Mamais, I., Papadopoulos, K., Lamnisos, D., & Stasinopoulos, D. (2020). Effectiveness of low level laser therapy (LLLT) in the treatment of lateral elbow tendinopathy (LET): an umbrella review. Lasers in Medical Science, 35(6), 1279-1288.
- Mani, S., Sharma, S., Omar, B., Paungmali, A., & Joseph, L. (2017). Validity and reliability of Internet-based physiotherapy assessment for musculoskeletal disorders: a systematic review. Journal of Telemedicine and Telecare, 23(3), 379-391.
- Nouri, S., Khoong, E. C., Lyles, C. R., & Karliner, L. (2020). Addressing equity in telemedicine for chronic disease management during the Covid-19 pandemic. NEJM Catalyst Innovations in Care Delivery, 1(3).
- Nussbaum, E. L., et al. (2021). Effectiveness of ultrasound-guided vs landmark-guided corticosteroid injection for lateral epicondylitis: A systematic review and meta-analysis. Physical Therapy, 101(3), pzab024.
- Odole, A. C., & Ojo, O. D. (2013). A telephone-based physiotherapy intervention for patients with osteoarthritis of the knee. International Journal of Telerehabilitation, 5(2), 11-20.
- Olaussen, M., Holmedal, Ø., Lindbaek, M., Brage, S., & Solvang, H. (2017). Treating lateral epicondylitis with corticosteroid injections or non-electrotherapeutical physiotherapy: a systematic review. BMJ Open, 3(10), e003564.
- Pastora-Bernal, J. M., et al. (2017). Evidence of benefit of telerehabitation after orthopedic surgery: a systematic review. Journal of Medical Internet Research, 19(4), e142.
- Peterson, M., et al. (2011). Eccentric or concentric exercises for the treatment of tendinopathies? Journal of Orthopaedic & Sports Physical Therapy, 41(6), 342-351.
- Rompe, J. D., Overend, T. J., & MacDermid, J. C. (2007). Validation of the Patient-rated Tennis Elbow Evaluation Questionnaire. Journal of Hand Therapy, 20(1), 3-11.
- Russell, T. G., Jull, G. A., & Wootton, R. (2003). Can the Internet be used as a medium to evaluate knee angle? Manual Therapy, 8(4), 242-246.
- Sanders, T. L., Maradit Kremers, H., Bryan, A. J., Ransom, J. E., Smith, J., & Morrey, B. F. (2015). The epidemiology and health care burden of tennis elbow: a population-based study. The American journal of sports medicine, 43(5), 1066-1071.

- Scott Kruse, C., Karem, P., Shifflett, K., Vegi, L., Ravi, K., & Brooks, M. (2018). Evaluating barriers to adopting telemedicine worldwide: A systematic review. Journal of Telemedicine and Telecare, 24(1), 4-12.
- Tack, C., et al. (2019). Combining eHealth with evidence-based approaches in the treatment of chronic musculoskeletal pain. Pain Management, 9(5), 487-497.
- Tenforde, A. S., Hefner, J. E., Kodish-Wachs, J. E., Iaccarino, M. A., & Paganoni, S. (2020). Telehealth in physical medicine and rehabilitation: A narrative review. PM&R, 12(5), 404-417.
- Thanasas, C., Papadimitriou, G., Charalambidis, C., Paraskevopoulos, I., & Papanikolaou, A. (2011). Platelet-rich plasma versus autologous whole blood for the treatment of chronic lateral elbow epicondylitis: a randomized controlled clinical trial. The American Journal of Sports Medicine, 39(10), 2130-2134.
- Viswas, R., et al. (2012). Comparison of effectiveness of supervised exercise program and Cyriax physiotherapy in patients with tennis elbow (lateral epicondylitis): a randomized clinical trial. The Scientific World Journal, 2012, 939645.
- Vos, T., Flaxman, A. D., Naghavi, M., Lozano, R., Michaud, C., Ezzati, M., ... & Aboyans, V. (2012). Years lived with disability (YLDs) for 1160 sequelae of 289 diseases and injuries 1990–2010: a systematic analysis for the Global Burden of Disease Study 2010. The Lancet, 380(9859), 2163-2196.
- Vuvan, V., et al. (2020). Psychological factors not strength deficits are associated with severity of gluteal tendinopathy: A cross-sectional study. European Journal of Pain, 24(4), 818-830.
- Walker-Bone, K., Palmer, K. T., Reading, I., Coggon, D., & Cooper, C. (2004). Prevalence and impact of musculoskeletal disorders of the upper limb in the general population. Arthritis care & research, 51(4), 642-651.
- Walker-Bone, K., Palmer, K. T., Reading, I., Coggon, D., & Cooper, C. (2012). Occupation and epicondylitis: a population-based study. Rheumatology, 51(2), 305-310.
- Wang, Q., Markopoulos, P., Yu, B., Chen, W., & Timmermans, A. (2019). Interactive wearable systems for upper body rehabilitation: a systematic review. Journal of Neuroengineering and Rehabilitation, 16(1), 1-21.
- Weber, C., et al. (2015). Efficacy of physical therapy for the treatment of lateral epicondylitis: a meta-analysis. BMC Musculoskeletal Disorders, 16(1), 223.
- Williamson, A., & Hoggart, B. (2005). Pain: a review of three commonly used pain rating scales. Journal of Clinical Nursing, 14(7), 798-804.
- Zanotelli, A. B., Santos, M. C. L., do Amaral Alves, A. D., & de Camargo, O. P. (2021). Comparison between platelet-rich plasma and corticosteroid injection in the treatment of lateral epicondylitis: A systematic review and meta-analysis. Journal of Shoulder and Elbow Surgery, 30(6), 1439-1450.