Original Article

Comparison of the Effectiveness of Telerehabilitation and Conventional Rehabilitation in Patients with Chronic Low Back Pain: A Randomized Controlled Trial

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ABSTRACT

Objectives: To compare the pain numeric rating scale (NRS) and Oswestry Disability Index (ODI) between telerehabilitation (TR) and conventional rehabilitation (CR) in patients with chronic low back pain

Study design: A randomized controlled trial

Setting: Department of Physical Medicine and Rehabilitation, King Taksin Memorial Hospital, Bangkok, Thailand

Subjects: Thirty-six participants with chronic low back pain

Methods: Participants were allocated by randomization into two groups. The conventional rehabilitation (CR) group (n = 18) was treated with a home exercise program demonstrated by a Bangkok Medical Association (BMA) specialist at the hospital, and the telerehabilitation (TR) group (n = 18) was treated with the same home exercise program by a BMA specialist via a video link. Participants in both groups were asked to do the exercises at home once a day for 8 weeks, with 10 repetitions of each exercise. NRS and ODI of both groups were rated prior to the exercise program and again at the end of the eight-week exercise program.

Results: Before beginning the exercises, the two groups had no statistically significant difference in either NRS (p = 1.00) or ODI (p = 0.97). After the 8-week exercise program, the NRS of the TR group was significantly lower than that of the CR group (p = 0.03) although the ODI was not significantly different between the two groups (p = 0.90). Group analysis found that NRS was significantly reduced by 2.06 in the CR group (p = 0.00) and 3.06 in the TR group (p = 0.00) and that ODI was significantly decreased by 12.26 in the CR group (p = 0.00) and by 12.13 in the TR group (p = 0.00) at the end of the study.

Conclusions: In treating chronic low back pain, telerehabilitation is not superior to conventional rehabilitation in reducing chronic pain, disability-related low back pain and is an option for individuals who can access the telerehabilitation service.

Keywords: conventional rehabilitation, chronic low back pain, exercise, telerehabilitation

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Introduction

Low back pain is localized below the costal margin and above the inferior gluteal folds, can occur either with or without sciatica.[1] Mechanical low back pain can be caused by overuse of back muscles by an individual with normal anatomical structure. It can also result from secondary injury or deformity. Common causes of mechanical back pain include muscle strain, herniated nucleus pulposus, osteoarthritis, and spinal stenosis.[2] Chronic low back pain is defined as pain persisting for three months or more.[1] It results in physical problems for individuals as well as socioeconomic problems for society in both developed and developing countries.[3] In addition to health problems, chronic low back pain also increases the prevalence of depression, anxiety, and sleep disturbance compared with healthy people.[1,3] The worldwide prevalence of low back pain has been reported to be around 18.3%.[4] Low back pain also limits activity, resulting in some low back pain patients becoming chronic low back pain patients. The prevalence of chronic low back pain is about 25.9%.[3] In developed countries, more than 70 percent of people have experienced low back pain during at least one period of their life.[1]

Available low back pain treatments include conservative and surgical treatment. Conservative treatment includes exercise, behavioral modification, psychological therapy, manual therapy, physical modalities, and pharmacological treatment such as analgesic drugs, non-steroidal anti-inflammatory drugs (NSAIDs), tramadol, muscle relaxants, and antidepressants.[5, 6] The American College of Physicians recommends in an evidence-based guideline that the first line of low back pain treatment is non-pharmacological conservative treatment. Physicians should recommend using non-invasive therapies before drugs or surgery. Although there are a variety of invasive treatments for chronic low back pain, invasive procedures are not the first line of treatment.[6] The most common cause of back pain is mechanical back pain, and the first-line treatment

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is exercise and education.[5] Exercise is one of the effective non-pharmacological conservative care treatments for low back pain because it has a lower potential for harm than other alternatives.[7] Self-managed home exercise programs are widely accepted and used by healthcare professionals in long-term rehabilitation therapy, defined as conventional rehabilitation.[4, 8]

Telerehabilitation is defined as a remote science technology rehabilitation service.[9] It allows for treatment of diseases by substituting telephone and video conferencing for the traditional face-to-face approach in the patient-rehabilitator interaction. Various types of therapy, such as exercise and motor retraining, can be delivered through telerehabilitation. Telerehabilitation can be helpful in chronic low back pain patients who are not eligible for surgery. It saves the patient the cost of traveling to the hospital, facilitates patient access to treatment, and can be done at home via video conference. To maximize effectiveness, Both the physician and the patient should have access to high-quality screens and high-speed internet.[10] Additionally, telerehabilitation motivates patients to exercise because the patient is already used to being at home.[11]

There have been many studies of telerehabilitation in musculoskeletal disorders, e.g., post-total knee arthroplasty, post-total hip arthropathy, low back pain, neck pain, temporomandibular joint disorders, and chronic musculoskeletal spinal conditions.[10-16] A systematic review of 15 studies found that both patients and rehabilitation professionals were satisfied that telerehabilitation is comparable to face-to-face physician consultation in treating musculoskeletal disorders.[13] However, recent evidence has provided inconsistent results regarding the efficacy of treatment of chronic low back pain via telerehabilitation.

Telerehabilitation is a relatively new technology. It helps with the supervision of patients in remote locations and supports physiatrists by replacing face-to-face with more physician-conservative rehabilitation.[10] Telerehabilitation shown to be helpful during the COVID-19 pandemic because it allowed for provision of physical therapy patient care without the patient coming to the hospital.[17] The present study aimed to compare the effectiveness of telerehabilitation and conventional rehabilitation in patients with chronic low back pain.

Methods

This randomized controlled trial was approved by the Bangkok Metropolitan Administration Human Research Ethics Committee (Approval number S016hc/66). The sample size was calculated based on a previous study using the n4Studies application to have a power of 0.8 and an alpha value of 0.05.

Participants

Patients diagnosed with chronic low back pain who visited athe Physical Medicine and Rehabilitation outpatient clinic at King Taksin Memorial Hospital between November 2023 and January 2024 were invited to join this study. After giving their informed consent, they were recruited into the study. The inclusion criteria were age between 25 to 59 years and having pain caused by muscle strain as determined by medical history and physical examination that had persisted for at least three months. The NRS of participants was mild (1-3) or moderate (4-6) prior to the start of treatment. Patients with any of the following were excluded from the study: a history of back or spine surgery, back trauma during the previous six months, a malignancy condition, communication disorder, pregnancy, orthopedic or neurological disorders, and having no internet or mobile communication. Randomization was done by computer with patients assigned to receive either telerehabilitation (TR) or conventional rehabilitation (CR) at a 1:1 ratio.

Procedure

The physiatrist assessor interviewed participants regarding their demographics and occupation, reviewed their medical records, identified the duration of pain, asked about their maximum pain intensity, and had the patients complete the Oswestry Disability Index Thai version (ODI). All participants were assessed twice, before the initial treatment and following the last treatment.

In this two-arm randomized study, at the first hospital visit all patients in both groups were prescribed the same home exercise program and the same assessor. The assessor was the physiatrist. The assessor taught the patients a home exercise program, after which the participants made an appointment with the assessor once a week for 8 weeks. The BMA Doctor application was used at the 2^{nd} through the 8^{th} follow-up visits in the TR group, and face-to-face interaction in the hospital was used at the 2^{nd} through 8^{th} follow-up visits in the CR group. All participants were given an appointment once a week, a total of 8 times over 8 weeks, with the same assessor. The home exercise program included lumbar region and lower extremity stretching exercises (lumbar extensor, psoas major, piriformis muscles and hamstring), strengthening exercises for abdominal muscles (transverse abdominis, abdominal external/internal oblique muscles), lumbar muscles (lumbar erector spina) as well as bridging, spinal mobility (cat-camel motion exercise), McKenzie's extension and Williams's flexion exercises. Participants were asked to do all the exercises at home once a day for 8 weeks, with 10 repetitions of each exercise.

The telerehabilitation (TR) group met with the assessor at the Department of Physical Medicine and Rehabilitation, King Taksin Memorial Hospital, only at the first visit during which they were taught the home exercise program and received guidance on using the "BMA Doctor" mobile application. This application was a project of the Bangkok Metropolitan Administration which allows patients access to medical services at 11 hospitals under the Bangkok Medical Service Department. Participants in the TR group downloaded the application. Participants were required to have an updated Android or IOS mobile phone connection to the internet. After registration of the application, TR group participants pressed the "telemedicine" button on the screen to start a conversation with the assessor. This process was repeated at the 2nd through the 8th follow-up visits. All participants in the TR group received their appointments via the BMA Doctor application once a week for a total of 8 times. During the follow-up after the 8th week, the same assessor reviewed with each participant their experience with the home exercise program. The review process lasted about 15 minutes. The same form of access was used for all the follow-up periods for each participant. At the 8th and final visit, the assessor asked the patients about their maximum pain intensity and had them complete the Oswestry Disability Index Thai version (ODI).

The assessor met with members of the conventional rehabilitation (CR) group at the Department of Physical Medicine and Rehabilitation, King Taksin Memorial Hospital. The assessor taught the same home exercise program at the hospital. CR group participants were given an appointment at the hospital (face-to-face interaction) once a week for 8 weeks. During follow-up, the assessor asked the participants about and reviewed the home exercise program. At the 8th and final visit, the assessor asked the members of the CR group about their maximum pain intensity and had them complete the Oswestry Disability Index Thai version (ODI).

Outcome measures

The primary outcome was subjective pain intensity measured using a numeric rating scale (NRS) where 0 means no pain and 10 means most severe pain. The assessor asked participants to report their maximum pain at that moment. The secondary outcome was the Oswestry Disability Index score (range 0 to 100, with higher scores indicating more disability related to back pain).[18] The Oswestry Disability Index (version 1.0) Thai version was used in this study. That Index has demonstrated validity and reliability: the content validity of each item ranged from 0.6-1.0, and the Cronbach's alpha of all items was 0.8107.[19] If participants had ongoing pain during treatment, they were allowed to take acetaminophen 500 mg 1 tablet q 6 hours, but no other pain medications were allowed during the study, e.g., tramadol and oral NSAIDs.

Statistical analysis

Demographic data of participants in both groups were gathered, analyzed, and described. Quantitative data are shown as means and standard deviations. The qualitative data are shown as frequencies and percentages. IBM SPSS Statistics 26 was used for the statistical analysis. Mean differences of NRS and ODI values between groups were analyzed using an unpaired t-test for parametric data with statistical significance set at $p < 0.05$. Before and after treatment analysis within groups was done using the paired t-test for parametric data also with statistical significance set at $p < 0.05$.

In cases where participants were lost to follow-up or had only an initial assessment, the end-of-study data was imputed based on the beginning data. This method was used to avoid misleading results from intention-to-treat analysis.

Results

A total of 40 patients were initially screened, of whom 36 were enrolled. All 36 participants were allocated to groups of whom 30 completed the study, a dropout rate of 17 percent (Figure 3). All participants who completed the study were included in the statistical analysis and were analyzed according to their assigned group. Most participants in the study (61%) were female in both groups; the mean age was 39 (6.5) years, and the mean duration of pain was 10 (7.1) months. The most common occupation was office worker. (Table 1).

In the study, an intention-to-treat analysis was used. No statistically significant differences between the two groups in pain on the NRS before treatment was found (mean difference = 0.00, p = 1.00). At the end of the study, there were statistically significant differences in pain on the NRS between the two groups: the TR group had significantly lower pain on the

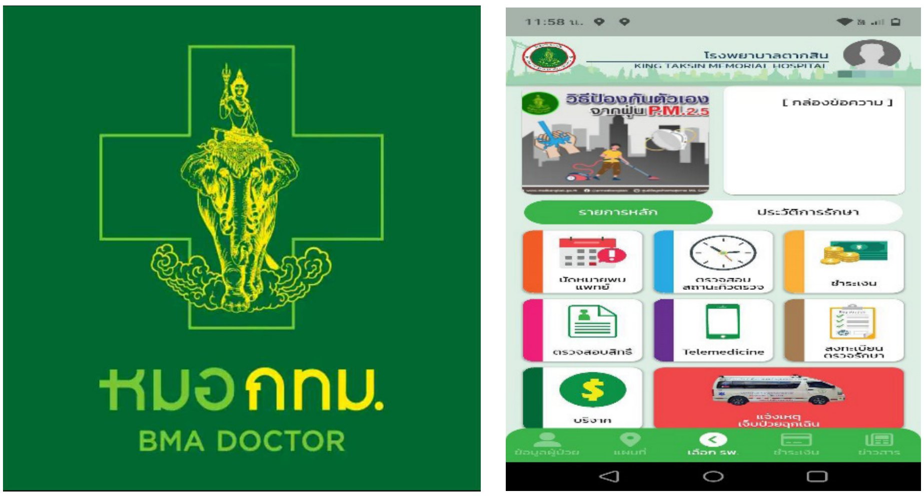

Figure 1. BMA Doctor application

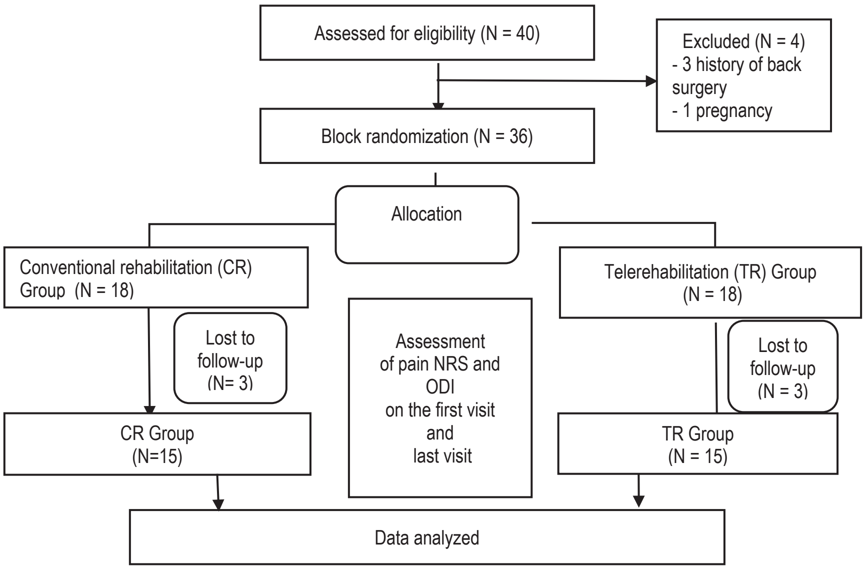

Figure 2. Schematic flow diagram of the study

Table 1. Demographic data of participants with chronic low back pain of the conventional rehabilitation (CR) and the telerehabilitation (TR) groups

	CR Group (n = 18)	TR Group (n = 18)
Age (years)[1]	39 (6.07)	39 (7.11)
Gender[2]		
Female	10 (56)	12 (67)
Male	8 (44)	6 (33)
Duration of pain (months)[1]	10 (7.61)	10 (6.78)
Occupation[2]		
Office worker	9 (50)	12 (67)
Healthcare worker	6 (33)	4 (22)
Laborer	2 (11)	2 (11)
Housewife	1 (6)	0 (0)

[1]Mean (SD); [2]number (%)

NRS than the CR group (mean difference = 1.00, p = 0.03). Within-group analysis found NRS was statistically significantly reduced in the CR group, 2.06 (p = 0.00) vs. 3.06 in the TR group (p = 0.00) (Table 2).

At the beginning of the study, there were no statistically significant differences in ODI between the groups (mean difference = 0.13, p = 0.97). After the 8-week therapy, ODI had significantly decreased in both the CR group, 12.26 (p = 0.00), and the TR group, 12.13 (p = 0.00). There were no statistically significant differences in ODI between the two groups at the end of the study (mean difference = 0.26, p = 0.90) (Table 2).

Three participants in the CR group reported taking acetaminophen as an add-on drug therapy to relieve pain; one participant in the TR group did so. No participants in either group had side effects from exercise, such as musculoskeletal injury, which is a common risk.[20]

Discussion

Low back pain is often associated with work loss and economic burden on society. General exercise is one of the non-invasive treatments for chronic lower back pain. It usually includes muscle strengthening and trunk stabilizing exercises. Twelve higher-quality trials showed a significant increase in pain relief with general exercise for chronic low back pain.[6,21] The home exercise program aims to improve the function of abdominals, back extensors, upper and lower limb muscles, and spine.[21] Telerehabilitation has been used with chronic low back pain patients. It is easy to use and convenient to access. Outcome, ease of access, quality,

Table 2. Comparison of outcome parameters between the conventional rehabilitation (CR) and the telerehabilitation (TR) groups

Parameters Mean (SD)	CR Group	TR Group	Mean difference	*p*-value
Pain numeric rating scale				
At the beginning of the study	5.53 (1.36)	5.53 (0.74)	0.00	1.00
At the end of the study	3.47 (1.41)	2.47 (0.83)	1.00	0.03*
Before and after p-value	0.00*	0.00*		
Oswestry Disability Index (percent)				
At the beginning of the study	29.73 (10.55)	29.86 (6.39)	-0.13	0.97
At the end of the study	17.47 (6.02)	17.73(5.85)	-0.26	0.90
Before and after *p*-value	0.00*	0.00*		

Between groups analysis using unpaired t-test, within-group analysis using paired t-test, *statistical significance level at $p < .05$

and lower cost are the main focus of telerehabilitation.[11] This technology initiative can enhance healthcare service in the "new normal" era after the COVID-19 pandemic.[22,23] Telerehabilitation is an exercise-based rehabilitation service which helps patients in remote locations to avoid close contact with physicians to reduce the spread of disease. This new normal medical service was designed to improve the quality of life for Thai people over the long term and to help create a more sustainable society.

This randomized controlled trial compared the effectiveness of telerehabilitation with conventional rehabilitation in patients with chronic low back pain. Most of the participants were female which is in line with a study by Alfalogy et al.[3] Although that study reported that 82.9% of patients with chronic low back pain were above 40 years, the present study found the mean age to be 39 (6.5) years.[3] Prior to the beginning of the eight-week treatment, there was no significant difference in the baseline pain NRS or ODI between the two groups. At the end of the study, there was a significant difference in pain NRS between the two groups, with the TR group having significantly lower pain NRS scores than the CR group. However, there was no significant difference in ODI between the two groups. These results suggest that both groups were able to reduce pain intensity. Although both the TR and CR groups showed an NRS pain reduction in this study, the difference in pain NRS reduction was not great, 3.47(1.41) and 2.47(0.83), respectively, and there was no clinical difference in pain intensity reduction. TR did not improve function on ODI more than CR in chronic low back pain patients. Participants in the TR group were able to communicate with the physician from remote areas. They did not have to spend time and money going to the hospital, which could be a source of added motivation and satisfaction with exercise. The CR group took slightly more acetaminophen than the TR group, but the difference was not statistically significant. That lack of difference may be because this study included only patients with mild and moderate degrees of pain at the initial treatment.

In the current study, after 8 weeks of therapy pain was significantly reduced in the CR group, which is in line with a study by Ozden et al.[4] Several studies have similarly reported on why CR can reduce pain.[4, 14, 22] For example, Villatoro-Luque et al.[22] reported that pain location only affected the level of pain during flexion and extension movements. In that study, the pain intensity when performing the knee extension test and kinesiophobia was reduced more in the telerehabilitation group than in the clinic group. The present study did not measure the pain intensity when participants performed the exercise movements.

In the present study, the TR group had greater pain reduction than the CR group, which is in line with an Ozden et al.[4] study. In contrast, other studies have reported no difference in pain reduction between a conventional group and a telerehabilitation group.[14] That difference may be due to the fact that this study and a study by Ozden et al. lasted 2 months, whereas the other studies had a longer duration, e.g., Cottrell et al.[14] measured pain-related disability, pain severity, and health-related quality of life at baseline, 3 months, 6 months, and 9 months. The Cottrell study showed no significant group-by-time interaction for either pain-related disability, pain severity, or health-related quality of life. Bailey et al.[5] conducted a longitudinal observational study which evaluated a 12-week digital care program that included 10,000 participants with chronic knee and back pain. That large, diverse, real-world population cohort study showed a longitudinal change in pain with a higher mean reduction rate in the first week, but a lower mean reduction rate at 2-5 weeks and 6-12 weeks. This result suggests that pain reduction rates can vary over time.

In the present study, the differences between the treatment groups in disability related to low back pain were measured by changes in ODI scores using the Oswestry Disability Index (version 1.0) Thai version. That index has been shown to have good internal consistency, with the content validity of each item ranging from 0.6-1.0, and a Cronbach's alpha of all items of 0.8107. In this study, there were no statistically significant differences in the baseline ODI between the two groups. At the end of the study, there was again no significant difference in ODI between the two groups. This result is in line with a study done by Cottrell et al.[14], whereas other studies have reported significant differences in ODI between the two groups at the end of the study.[4] The present study focused on mild to moderate degree pain, so only low baseline Oswestry Disability Index scores were detected.

In this study, NRS was significantly reduced (by 2.06 in the CR group and 3.06 in the TR group) at the end of the treatment period. ODI significantly decreased (by 12.26 in the CR group and 12.13 in the TR group) between preintervention and postintervention after the 8-week therapy, which is in line with a study by Ozden et al.[4] No statistically significant improvements in pain, function, quality of life, or kinesiophobia were found in either the CR group or the TR group. This study's positive results support using telerehabilitation as a treatment for chronic low back pain.

This study had some limitations. First, the study did not assess long-term outcomes, e.g., 3, 6, and 9 months. Second, the study did not monitor either patient satisfaction or quality of life. Third, the sample size was relatively small, and the BMA doctor application was Thai, which might limit the generalizability of the results. Fourth, this study used NRS for pain assessment. Although all participants were able to communicate well, NRS is subjective. Fifth, because of the study design the assessor in this study could not be blinded. Further study is needed to explore clinical outcomes during a long-term follow-up period.

Conclusions

Based on the findings of this study, telerehabilitation provides no additional benefits in terms of pain relief over conventional rehabilitation in patients with chronic low back pain although it does reduce inconvenience and travel expense for patients. BMA Doctor use of telerehabilitation positively affects clinical pain and disability outcomes. Telerehabilitation may be another option for treatment in patients with chronic low back pain. It should be considered for individuals who can access the service.

Disclosure

The authors certify no conflict of interest with any financial organization regarding the materials discussed in the manuscript.

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References

1. Morso L, Lykkegaard J, Andersen MK, Hansen A, Stochkendahl MJ, Madsen SD, et al. Providing information at the initial consultation to patients with low back pain across general practice, chiropractic and physiotherapy - a cross-sectorial study of Danish primary care. Scand J Prim Health Care [Internet]. 2022 Sep [cited 2022 Dec 13] PMC9848345]; 40(3):[370-8 pp.]. Available from: https://www.ncbi.nlm.nih.gov/pubmed/36314134. doi:10.1080/02813432.2022.2139465.
2. Borenstein D. Mechanical low back pain--a rheumatologist's view. Nat Rev Rheumatol [Internet]. 2013 Nov [cited 2022 Dec 13]; 9(11):[643-53 pp.]. Available from: https://www.ncbi.nlm.nih.gov/pubmed/24018549. doi:10.1038/nrrheum.2013.133.
3. Alfalogy E, Mahfouz S, Elmedany S, Hariri N, Fallatah S. Chronic Low Back Pain: Prevalence, Impact on Quality of Life, and Predictors of Future Disability. Cureus [Internet]. 2023 Sep [cited 2024 Jan 9] PMC10590648]; 15(9):[e45760 p.]. Available from: https://www.ncbi.nlm.nih.gov/pubmed/37872924. doi:10.7759/cureus.45760.
4. Ozden F, Sari Z, Karaman ON, Aydogmus H. The effect of video exercise-based telerehabilitation on clinical outcomes, expectation, satisfaction, and motivation in patients with chronic low back pain. Ir J Med Sci [Internet]. 2022 Jun [cited 2022 Dec 13]; 191(3):[1229-39 pp.]. Available from: https://www.ncbi.nlm.nih.gov/pubmed/34357527. doi:10.1007/s11845-021-02727-8.
5. Bailey JF, Agarwal V, Zheng P, Smuck M, Fredericson M, Kennedy DJ, et al. Digital Care for Chronic Musculoskeletal Pain: 10,000 Participant Longitudinal Cohort Study. J Med Internet Res [Internet]. 2020 May [cited 2022 Dec 13] PMC7248800]; 22(5):[e18250 p.]. Available from: https://www.ncbi.nlm.nih.gov/pubmed/32208358. doi:10.2196/18250.
6. Hong JY, Song KS, Cho JH, Lee JH, Kim NH. An Updated Overview of Low Back Pain Management. Asian Spine J [Internet]. 2022 Dec [cited 2024 Jan 9] PMC9827206]; 16(6):[968-82 pp.]. Available from: https://www.ncbi.nlm.nih.gov/pubmed/34963043. doi:10.31616/asj.2021.0371.
7. Shebib R, Bailey JF, Smittenaar P, Perez DA, Mecklenburg G, Hunter S. Randomized controlled trial of a 12-week digital care program in improving low back pain. NPJ Digit Med [Internet]. 2019 [cited 2022 Dec 13] PMC6550254]; 2:[1 p.]. Available from: https://www.ncbi.nlm.nih.gov/pubmed/31304351. doi:10.1038/s41746-018-0076-7.
8. Peterson S. Telerehabilitation booster sessions and remote patient monitoring in the management of chronic low back pain: A case series. Physiother Theory Pract [Internet]. 2018 May [cited 2022 Dec 13]; 34(5):[393-402 pp.]. Available from: https://www.ncbi.nlm.nih.gov/pubmed/29125371. doi:10.1080/09593985.2017.1401190.
9. Peretti A, Amenta F, Tayebati SK, Nittari G, Mahdi SS. Telerehabilitation: Review of the State-of-the-Art and Areas of Application. JMIR Rehabil Assist Technol [Internet]. 2017 Jul [cited 2022 Dec 13] PMC5544892]; 4(2):[e7 p.]. Available from: https://www.ncbi.nlm.nih.gov/pubmed/28733271. doi:10.2196/rehab.7511.
10. Ozel M, Kaya Ciddi P. The effectiveness of telerehabilitation-based structured exercise therapy for chronic nonspecific neck pain: A randomized controlled trial. J Telemed Telecare [Internet]. 2022 May [cited 2022 Dec 13]:[1357633X221095782 p.]. Available from: https://www.ncbi.nlm.nih.gov/pubmed/35570728. doi:10.1177/1357633X221095782.
11. Jansen-Kosterink S, Huis in 't Veld R, Wever D, Hermens H, Vollenbroek-Hutten M. Introducing remote physical rehabilitation for patients with chronic disorders by means of telemedicine. Health and Technology [Internet]. 2015 [cited 2022 Dec 13]; 5(2):[83-90 pp.]. doi:10.1007/s12553-015-0111-5.
12. Mani S, Sharma S, Singh DK. Concurrent validity and reliability of telerehabilitation-based physiotherapy assessment of cervical spine in adults with non-specific neck pain. J Telemed Telecare [Internet]. 2021 Feb; [cited 2022 Dec 13]; (2):[88-97 pp.]. Available from: https://www.ncbi.nlm.nih.gov/pubmed/31272309. doi:10.1177/1357633X19861802.
13. Amin J, Ahmad B, Amin S, Siddiqui AA, Alam MK. Rehabilitation Professional and Patient Satisfaction with Telerehabilitation of Musculoskeletal Disorders: A Systematic Review. Biomed Res Int [Internet]. 2022 [cited 2024 Jan 9] PMC9363217]; 2022:[7366063 p.]. Available from: https://www.ncbi.nlm.nih.gov/pubmed/35958819. doi:10.1155/2022/7366063.
14. Cottrell MA, O'Leary SP, Raymer M, Hill AJ, Comans T, Russell TG. Does telerehabilitation result in inferior clinical outcomes compared with in-person care for the management of chronic musculoskeletal spinal conditions in the tertiary hospital setting? A non-randomised pilot clinical trial. J Telemed Telecare [Internet]. 2021 Aug [cited 2024 Jan 9]; 27(7):[444-52 pp.]. Available from: https://www.ncbi.nlm.nih.gov/pubmed/31771410. doi:10.1177/1357633X19887265.
15. Fandim JV, Costa LOP, Yamato TP, Almeida L, Maher CG, Dear B, et al. Telerehabilitation for neck pain. Cochrane Database of Systematic Reviews [Internet]. 2021 [cited 2024 Jan 9]. doi:10.1002/14651858.Cd014428.
16. Mehendale P, Iyenagar M, Bhatt GD, Kothary K. Telerehabilitation for a Non-specific Low Back Pain: A Case Report. Cureus [Internet]. 2023 Oct PMC10680045]; 15(10):[e47854 p.]. Available from: https://www.ncbi.nlm.nih.gov/pubmed/38021986. doi:10.7759/cureus.47854.
17. Fiani B, Siddiqi I, Lee SC, Dhillon L. Telerehabilitation: Development, Application, and Need for Increased Usage in the COVID-19 Era for Patients with Spinal Pathology. Cureus [Internet]. 2020 Sep [cited 2022 Dec 13] PMC7577310]; 12(9):[e10563 p.]. Available from: https://www.ncbi.nlm.nih.gov/pubmed/33101809.

doi:10.7759/cureus.10563.

18. Ghogawala Z, Dziura J, Butler WE, Dai F, Terrin N, Magge SN, et al. Laminectomy plus Fusion versus Laminectomy Alone for Lumbar Spondylolisthesis. N Engl J Med [Internet]. 2016 Apr [cited 2022 Dec 13]; 374(15):[1424-34 pp.]. Available from: https://www.ncbi.nlm.nih.gov/pubmed/27074067. doi:10.1056/NEJMoa1508788.
19. MD NS. The Oswestry Low Back Pain DisabilityQuestionnaire (Version 1.0) Thai Version. J Med Assoc Thai 2007 [Internet]. 2007 [cited 2022 Dec 13]; 90(7):[1417-22 pp.].
20. Copley JB, Lindberg JS. The risks of exercise. Adv Ren Replace Ther [Internet]. 1999 Apr [cited 2022 Dec 13]; 6(2):[165-71 pp.]. Available from: https://www.ncbi.nlm.nih.gov/pubmed/10230884. doi:10.1016/s1073-4449(99)70035-x.
21. Kuukkanen T, Malkia E, Kautiainen H, Pohjolainen T. Effectiveness of a home exercise programme in low back pain: a randomized five-year follow-up study. Physiother Res Int [Internet]. 2007 Dec [cited 2022 Dec 13]; 12(4):[213-24 pp.]. Available from: https://www.ncbi.nlm.nih.gov/pubmed/17849435. doi:10.1002/pri.378.
22. Villatoro-Luque FJ, Rodriguez-Almagro D, Aibar-Almazan A, Fernandez-Carnero S, Pecos-Martin D, Ibanez-Vera AJ, et al. Telerehabilitation for the treatment in chronic low back pain: A randomized controlled trial. J Telemed Telecare [Internet]. 2023 Aug 30 [cited 2024 Jan 9];[1357633X231195091 p.]. Available from: https://www.ncbi.nlm.nih.gov/pubmed/37649362. doi:10.1177/1357633X231195091.
23. Bise CG, Cupler Z, Mathers S, Turner R, Sundaram M, Catelani MB, et al. Face-to-face telehealth interventions in the treatment of low back pain: A systematic review. Complement Ther Clin Pract [Internet]. 2023 Feb [cited 2024 Jan 9] PMC9613794]; 50:[101671 p.]. Available from: https://www.ncbi.nlm.nih.gov/pubmed/36379145. doi:10.1016/j.ctcp.2022.101671.