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Effect of telerehabilitation-based core-stability exercise on pain-related disability, pain self-efficacy, and psychological factors in individuals with non-specific chronic low back pain: a randomized controlled study

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Abstract

Background Core-stability exercise is an exercise modality used in the management of patients with low back pain (LBP). Telerehabilitation is a new treatment approach that is gaining traction as an alternative rehabilitation approach. This study determined the effect of telerehabilitation-based core stability exercise (TCSE) and clinical-based core stability exercise (CCSE) on pain-related disability, pain self-efficacy, and psychological factors in patients with non-specific chronic low back pain (CLBP).

Materials and methods Fifty participants (24 males and 26 females) with a mean age of 40.28 years participated in this randomized controlled study and were recruited from the out-patients physiotherapy clinic of 2 tertiary hospitals in Lagos State and were allocated into two groups (telerehabilitation-based core stability exercise group and clinical-based core stability exercise group which serves as the control) using computer-generated random number sequence. Pain-related disability, pain self-efficacy, and psychological status were assessed at baseline, and at the completion of the 4th and 8th week. Patients received supervised intervention protocols twice weekly for 8 consecutive weeks. Independent *t*-test, Mann–Whitney *U* test, and Friedman test were used in analyzing the data at an alpha level of 5%.

Results There was a statistically significant difference ($P = 0.0001$) noted within each group (telerehabilitation-based core stability exercise group and clinical-based core stability exercise group) in all the outcome measures assessed (Pain Disability Index, Pain Self-efficacy Questionnaire and Depression-Anxiety-Stress scale) but no group was superior to one another when compared.

Conclusion Telerehabilitation-based core stability exercise was as efficacious as clinical-based core stability exercise in decreasing pain-related disability, improving pain self-efficacy and psychological factors, and should be incorporated as part of the treatment program in musculoskeletal rehabilitation for individuals with non-specific CLBP.

Trial registration PACTR202208607830603, 16th August 2022—retrospectively registered, https://pactr.samrc.ac.za/

Keywords Telerehabilitation, Pain-related disability, Pain self-efficacy, Psychological factors, Low back pain

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Introduction

Low back pain (LBP) has been both the principal cause of days lost from work and the leading indication for medical rehabilitation [1]. The occurrence of low back pain was predicted to be less than 10% of the global population in 2017 [2]. Since 1990, the primary reason for years lived with disability is Low back pain [2] which has been a concern for the global public health. There is a projection that at least 1 out of 3 individuals experiencing LBP will complain of inability to perform their day-to-day activities due to dysfunction, for 6 months or more which is referred to as high-impact chronic low back pain (CLBP) [3]. High-impact CLBP is defined as pain present on most or every day over the last 3 months and has a minimum of one major activity limitation/participation restriction [3]. The impact of CLBP can be categorized into a low-risk subgroup (score of 0–3), a medium-risk subgroup (score of 4), and a high-risk (total score of > 4) [4]. (Foster et al. 2014). Severe disability is experienced by < 28% of individuals with LBP but they account for 77% of all LBP disability [5]. This can be categorized into 4 which are minimal disability (0–20%), moderate disability (21–40%), severe disability (41–60%), crippled (61–80%), and bedbound (81–100%) [6].

Non-specific chronic low back pain (NSCLBP) is a multifactorial condition of unidentified etiology and pathogenesis occurring at a duration of 3 months or more [7]. The prevalence of NSLBP in adults has been well documented with a lifetime prevalence of over 70%, a 1-year prevalence of over 50%, and a point prevalence of over 20%, although a study has reported it to be as high as 40% [8]. Non-specific low back pain is attributed to physical and psychosocial factors, including lifestyle factors, obesity, and depression [9]. The ultimate prevention of LBP is targeting rehabilitation to reduce the deleterious effects of pain, disability, and functional loss [10]. The key goals of management for patients with LBP are pain control, functional restoration, ensuring that no future functional deficits occur, preservation of employment and productivity, and prevention of chronicity in patients with acute LBP [10].

The usage of digital health to administer treatment has many benefits to both the clinician as well as the patients. The patient is offered an opportunity to be independent and have the capability to decide and have personal control in the management of their condition [11]. Basically, this enables patients to actively participate in their care. It enables access to care for unhealthy individuals in remote areas irrespective of their location or for those who have mobility problems as a result of physical impairment, by lacking means of transportation and socioeconomic factors [12].

In addition, telerehabilitation reduces the cost and time spent on traveling for both the patient and healthcare provider [13]. Patients who experience long-distance traveling to get to the clinic already feel stressed and uninterested in rehabilitation and this affects recovery [14].

As telerehabilitation widens, patient continuity of care advances, as care can always be continued from where it stopped irrespective of the healthcare personnel and location. This allows clinicians to conveniently deliver and extend healthcare services to patients from the comfort of their homes, therefore eliminating the issue of distance between clinician and patient [15]. This possibility of continuous treatment in an environment the patient feels comfortable in, should help to achieve better recovery and greater functional outcomes. The delivery of treatment intervention to patients in their immediate environment and even in their workplace should help improve their recovery [16].

This study compared the efficacy of telerehabilitation-based core stability exercise (TCSE) and clinical-based core stability exercise (CCSE) on pain-related disability, pain-self efficacy, and psychological factors in patients with non-specific chronic low back pain (NSCLBP).

Methods

A single-blinded randomized controlled study registered with the Pan-African clinical trial registry (PACTR202208607830603) was employed for this study. Fifty participants were involved in this study; they were patients with NSCLBP seeking treatment from Physiotherapy Outpatient Clinics of two tertiary health institutions in Lagos State. Sample size calculation was based on a minimum effect size of 0.25 [17] and power of 80% using the G. power software calculator [18]. The study was conducted between April 2020 and July 2022. The participants included in this research were referred from physiotherapy outpatient clinics with a diagnosis of NSCLBP with and without pain radiating to one or both lower limbs (including the thigh, leg, and down to the foot), and with pain greater than 5 on the Visual Analogue Scale (VAS) and age ranging between 18 and 75 years, while participants with cognitive limitation, medical or surgical conditions which may hinder exercise performance, participants who have a history of orthopedics problem including conditions of the back that would affect their abilities to sustain core stability exercise, participants who are not knowledgeable in the use of Information and Communication Technology (ICT) were excluded from the study. The approval for the study was obtained from the Health Research and Ethics Committee of the College of Medicine University of Lagos with approval number CMUL/HREC/06/22/1066. The written informed consent to participate in the study was obtained from the participants prior to inclusion in the study. Information such as age, weight, height, and body mass index (BMI) of the participants were recorded. The assessment of the baseline outcome of the participants was achieved with the pain disability index, pain self-efficacy questionnaire, and DASS-21 questionnaire to determine the level of pain-related disability, pain self-efficacy, and psychological factors (depression, anxiety, and stress) of the participants.

Fifty-six patients with non-specific chronic low back pain were recruited for this study and were screened for inclusion in the study. Two patients did not pass the criteria for eligibility. Fifty-four patients that passed the criteria for selection were assigned randomly into 2 groups (clinical-based group and telerehabilitation-based group) using a computer-generated random number sequence which was generated before the recruitment of the patients by the research assistants. Twenty-seven participants each were assigned to a clinical-based group and a telerehabilitation-based group. To ensure adequate blinding, the allocation of study participants was done by a research assistant who was not involved in the clinical assessment and management of patients. Participants and the data analyst were blinded to interventions to reduce bias. Four patients did not complete the study because of non-compliance and illness. The groups were treated with a 30-min duration of the exercise with a frequency of two treatment sessions per week with a day interval for 8 consecutive weeks.

All the groups received a 30-min duration of the interventions twice weekly for a period of 8 weeks. Assessment of the level of pain-related disability, pain self-efficacy, and psychological factors (depression, anxiety, and stress) of the participants was done again in the 4th and 8th week. The research assistant who was the assessor did not administer any treatment on the participants. The researcher (AKA, AAR) managed the treatment protocol. The participants and data analysts were also blinded to treatment to remove bias (Fig. 1).

Clinical-based group

Participants in this group were involved in a clinical-based core-stability exercise program and this served as the control group.

Telerehabilitation-based group

Participants in this group were involved in a telerehabilitation-based core-stability exercise program via an interactive device for 30 min duration with a frequency of two treatment sessions per week with a day interval for 8 consecutive weeks. An E-flyer was designed with the inclusion criteria of the study as a pass to participate and detailed information on the intervention procedure was written on the flyer. This E-flyer was shared across various social media platforms. Participants who fit the inclusion criteria for the study were sent a Google form to fill out. This Google form was used to assess the pain disability index, pain self-efficacy, and psychological factors (depression, anxiety, and stress) of the participants at baseline. A WhatsApp group was created for the participants for follow-up, communication, retention, and monitoring. The participants performed the exercises with instructions and supervision virtually via video conferencing, video calls, phone calls, and text messages with proper monitoring and feedback, for the stipulated period of time.

The participants were instructed and trained on how to perform the exercises before the commencement of the intervention in the various core-stability exercise positions and held those positions for a certain duration allocated to each, and these were monitored by video conferencing for 8 consecutive weeks.

Outcome measure

Pain disability index

The Pain Disability Index (PDI) is a simple and rapid instrument for measuring the impact that pain has on the ability of a person to participate in essential life activities. It can be used to evaluate patients initially monitor them over time and judge the effectiveness of interventions. The participant uses an 11-point scale ranging from 0 to 10 to rate the degree to which pain interferes with functioning in seven areas, a total score is derived by summing the responses to the 7 items [19]. Evaluation supports the use and reliability of the pain disability index, the test–retest reliability of the pain disability index is 44 and internal consistency is 0.86 [20].

Pain self-efficacy questionnaire

The Pain Self-Efficacy Questionnaire (PSEQ) is a 10-item questionnaire developed to assess the confidence people with ongoing pain have in performing activities while in pain. The participants rate their confidence from 0 points (not at all confident) to 6 points (completely confident). Total scores are calculated by summing the individual items with a range from 0 points (less self-efficacy) to 60 points (more self-efficacy). The PSEQ is applicable to all persisting pain presentations. A high score indicates greater levels of confidence in dealing with pain. High scores are strongly associated with clinically significant functional levels and provide a useful gauge for evaluating outcomes in chronic pain patients. Raw scores around 40 (percentile = 50) are associated with return to work and maintenance of functional gains, whilst lower scores (for example a raw score of 30, percentile = 18)

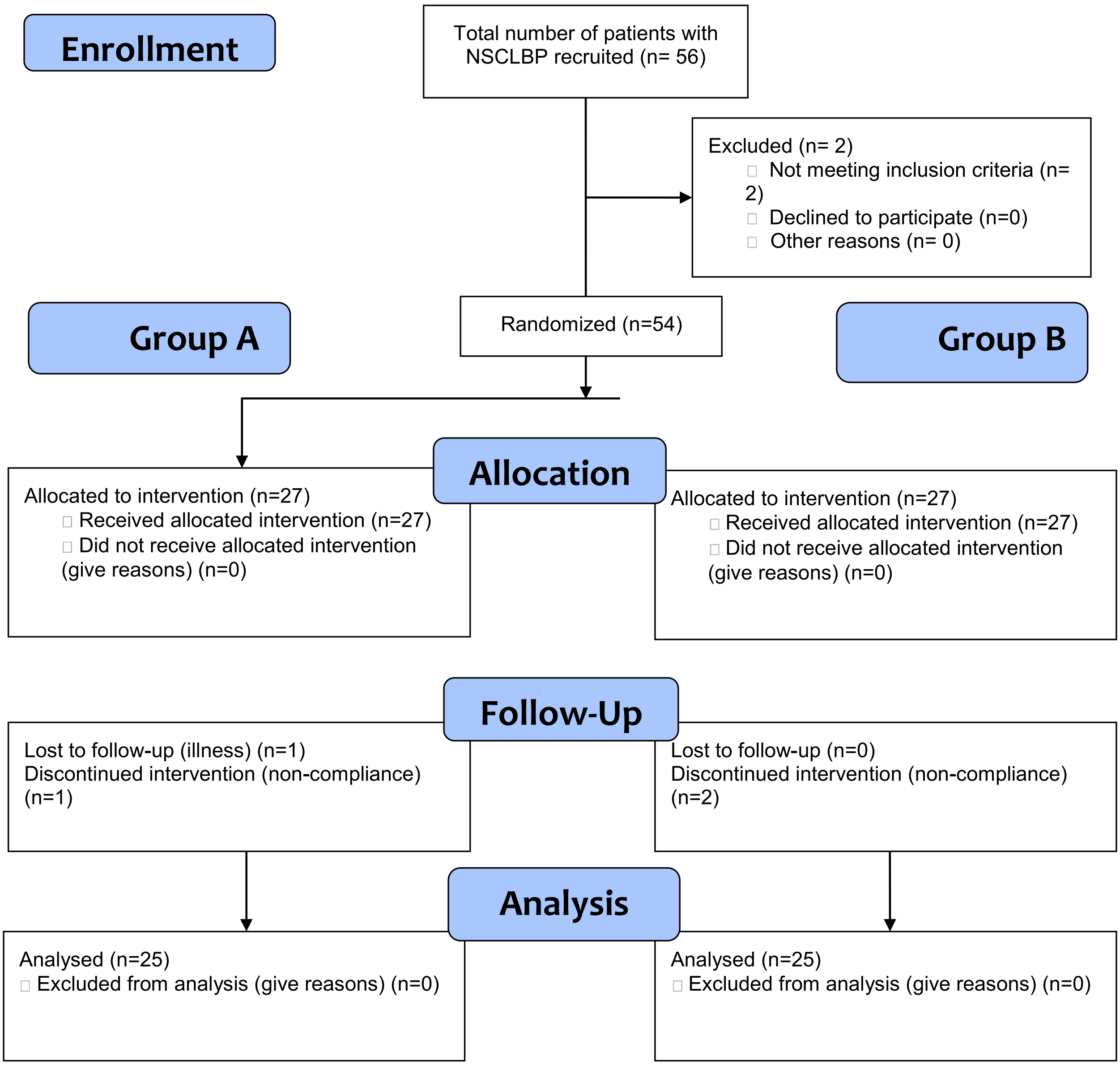

Fig. 1 Flow chart of the participants

tend to predict less sustainable gains [21]. The PSEQ has high internal consistency (0.92 Cronbach's alpha).

Depression-anxiety-stress scale 21

The DASS [22] is a set of three self-report scales designed to measure the emotional states of depression, anxiety, and stress. Each of the three DASS-21 scales contains 7 items, divided into sub-scales with similar content. The depression scale assesses dysphoria, hopelessness, devaluation of life, self-deprecation, and lack of interest/involvement, anhedonia, and inertia. The anxiety scale assesses autonomic arousal, skeletal muscle effects, situational anxiety, and subjective experience of anxious affect. The stress scale is sensitive to levels of chronic non-specific arousal. It assesses difficulty relaxing, nervous arousal, and being easily upset/agitated, irritable/over-reactive, and impatient. Scores for depression, anxiety, and stress are calculated by summing the scores for the relevant items. The reliability of DASS-21 shows that it has excellent Cronbach`s alpha values of 0.81, 0.89, and 0.78 for the sub-scales of depression, anxiety, and stress respectively. DASS-21 is found to have excellent internal consistency, discriminative, concurrent, and convergent validities.

The assessment was done at the end of the 4th and 8th week after the intervention. Instructions to abstain from any other form of management for their back pain during the period of the study were given to the participants, they were also told to inform the researchers if they had any complaints at any stage of the study.

Protocol for core stabilization exercises (CSE)

This comprises abdominal bracing, heel slides while bracing the abdomen, leg lift with abdominal bracing, bridging with abdominal bracing, bridging and leg lift with abdominal bracing, abdominal bracing in standing position, arm lift with bracing in a quadruped position, leg lift with bracing in a quadruped position, alternate arm, and leg lift with bracing in quadruped position [23].

Data analysis

The data collected were analyzed using Statistical Package for Social Science (SPSS) version 22 and summarized with descriptive statistics of frequency, percentage, mean, and standard deviation. Inferential statistic of independent *t*-test was used to compare the demographics of the two groups. A normality test was done with the Shapiro–Wilk test. Mann–Whitney *U* test (for non-parametric variables) was used to compare the quantitative data between and within the two groups. Friedman test was used to compare the variables across the weeks in each group. The alpha value was set at $p < 0.05$.

Result

A total of 50 non-specific chronic low back pain (NSCLBP) patients participated in this study. The participants were randomly assigned into 2 groups. The participants of the clinical-based group consisted of 13(52%) females and 12(48%) males with a mean age of 48.88 ± 9.99 years, weight of 71.02 ± 11.14 kg, height of 1.71 ± 0.05 m, and a BMI of 24.21 ± 3.60 kg/m^2. Telerehabilitation-based group consisted of 12(48%) females and 13(52%) males with a mean age of 33.28 ± 12.24 years, weight of 68.77 ± 9.28 kg, height of 1.71 ± 0.07 m, and a BMI of 23.82 ± 2.90 kg/m^2 (Table 1).

Table 2 shows the mean score of all the demographic characteristics of the participants in the clinical-based and Telerehabilitation-based groups. Independent *t*-test showed that there was no significant difference in all the demographics with weight ($P = 0.440$), height ($P = 0.962$), or BMI ($P = 0.674$), except for age ($P = 0.0001$).

Outcome parameters at baseline, end of 4th week, and 8th week between the 2 groups.

Table 3 shows the mean score of all the outcome parameters at baseline, 4th week (mid-intervention), and the end of 8th week (post-intervention) of both groups. Mann–Whitney test showed that there was no significant difference in all the outcome parameters of the interventions, except depression, anxiety, and stress ($P = 0.001$).

Table 4 shows the comparison of the mean scores of the outcome measures. Friedman test revealed that there

Table 1 Demographic characteristics of the participants ($n = 50$)

Variables	Clinical-based group ($n = 25$)	Telerehab-based group ($n = 25$)
Sex		
Female	13(52.00)	12(48.00)
Male	12(48.00)	13(52.00)
Age (years)		
21–30	1(4.00)	15(60.00)
31–40	4(16.00)	4(16.00)
41–50	10(40.00)	4(16.00)
51–60	9(36.00)	1(4.00)
> 60	1(4.00)	1(4.00)
Mean age (years)	48.88 ± 9.99	33.28 ± 12.24
Height (m)		
1.5–1.6	1(4.00)	2(8.00)
1.61–1.7	10(40.00)	8(32.00)
1.71–1.8	14(56.00)	15(60.00)
Mean height	1.71 ± 0.05	1.71 ± 0.07
Weight (kg)		
43–82	22(88.00)	23(92.00)
83–102	3(12.00)	2(8.00)
Mean weight	71.02 ± 11.14	68.77 ± 9.28
BMI (kg/m2)		
< 18.5	2(8.00)	0(0.00)
18.5–24.9	12(48.00)	16(64.00)
25.0–29.9	11(44.00)	8(32.00)
> =30	0(0.00)	1(4.00)
Mean BMI	24.21 ± 3.60	23.82 ± 2.90

Key: *Mean ± SD* mean ± standard deviation, *BMI* Body Mass Index

< 18.5–underweight

18.5–24.9–healthy weight

25.0–29.9–overweight

≥ 30—obese

[*] Significance level $p \leq 0.05$

Table 2 Demographic characteristics of the participants

Variables	Clinical-based	Telerehab-based	*t* test	*P* value
AGE (years)	48.88 ± 9.99	33.28 ± 12.24	4.939	0.0001*
WEIGHT (kg)	71.02 ± 11.14	68.77 ± 9.28	0.778	0.440
HEIGHT (m)	1.71 ± 0.05	1.71 ± 0.07	0.048	0.962
BMI (kg/m^2)	24.21 ± 3.60	23.82 ± 2.90	0.423	0.674

Key: *Mean ± SD* mean ± standard deviation, *BMI* Body Mass Index, *t* test independent test

[*] Significance level $p \leq 0.05$

Table 3 Comparison between clinical-based and telerehabilitation-based groups at baseline, end of 4th and 8th week between the 2 groups

	Outcome measure	Clinical-based group Median (IQR) *N* = 25	Telerehab-based group Median (IQR) *N* = 25	Mann–Whitney value	*p* value
(Pre-Rx) Baseline	PDI	27.00(16.50–42.50)	28.00(14.50–42.00)	296.50	0.756
	PSEQ	38.00(33.00–47.50)	43.00(35.00–47.00)	281.00	0.541
	DASS	8.00(2.00–15.00)	28.00(11.00–44.00)	140.00	0.001*
(Mid-Rx) End of 4th week	PDI	22.00(11.00–38.00)	25.00(10.50–38.50)	304.50	0.877
	PSEQ	43.00(37.00–50.50)	46.00(40.50–49.50)	306.00	0.899
	DASS	6.00(4.00–9.00)	20.00(7.00–26.00)	142.50	0.001*
(Post-Rx) End of 8th week	PDI	20.00(9.00–32.00)	20.00(9.00–29.00)	295.00	0.734
	PSEQ	49.00(41.50–53.00)	50.00(42.50–52.00)	312.00	0.992
	DASS	4.00(1.00–6.00)	14.00(4.00–18.00)	139.00	0.001*

Key: *Mean ± SD* mean ± standard deviation, *Rx* treatment, *PDI* Pain Disability Index, *PSEQ* Pain Self-efficacy Questionnaire, *DASS* Depression Anxiety Stress Scale, *IQR* interquartile range

* Significance level $p \leq 0.05$

Table 4 Friedman test of outcome measure parameters at pre-treatment (baseline), mid-treatment (end of 4th week), and post-treatment (end of 8th week) of clinical-based and telerehabilitation-based groups

	Outcome measure	Pre-Rx (baseline) Median (IQR)	Mid-Rx (4th week) Median (IQR)	End of 8th week Median (IQR)	Friedman test	*p* value
Clinical-based group	PDI	27.00(16.50–42.50)	22.00(11.00–38.00)	20.00(9.00–32.00)	47.66	0.0001*
	PSEQ	38.00(33.00–47.50)	43.00(37.00–50.50)	49.00(41.50–53.00)	48.08	0.0001*
	DASS	8.00(2.00–15.00)	6.00(4.00–9.00)	4.00(1.00–6.00)	23.09	0.0001*
Telerehab group	PDI	28.00(14.50–42.00)	25.00(10.50–38.50)	20.00(9.00–29.00)	46.65	0.0001*
	PSEQ	43.00(35.00–47.00)	46.00(40.50–49.50)	50.00(42.50–52.00)	48.00	0.0001*
	DASS	28.00(11.00–44.00)	20.00(7.00–26.00)	14.00(4.00–18.00)	35.08	0.0001*

Key: *IQR* interquartile range, *PDI* Pain Disability Index, *PSEQ* Pain Self-efficacy, *DASS* Depression Anxiety Stress Scale, *Rx* treatment, *Clinical-based group* clinical-based core stability exercise program, *Telerehab-based group* telerehabilitation-based core stability exercise program

* Significant at $P < 0.05$

was a significant difference across the periods of assessment in all the outcomes assessed (pain-related disability ($P = 0.0001$), pain self-efficacy ($P = 0.0001$), and depression, anxiety, and stress ($P = 0.0001$) in both groups.

Discussion

The aim of this study was to examine the effect of telerehabilitation-based and clinical-based core stability exercises on pain-related disability, pain self-efficacy, and psychological factors in patients with non-specific chronic low back pain (NSCLBP).

In this randomized controlled study, there was a significant improvement in the outcome measures assessed in the 2 groups. The finding of this study showed that clinical-based core stability exercise is effective in the improvement of pain-related disability in patients with NSCLBP. This finding supports the result of Akodu and Akindutire [9] who in their study reported that the improvement in the outcome measure assessed could be due to the re-establishment of the normal control of the local muscles; lumbar multifidus and transversus abdominis, which reduced the activity of more superficial muscles (rectus abdominis, external oblique, and internal oblique) which, when recruited, stabilized the spine and increased activity in the lumbar muscles which resulted in a decrease in pain-related disability level in patients with NSCLBP. The result is in accordance with the outcome of the research of Bagheri et al. [24] who reported that core stability exercise (CSE) was effective in reducing pain and disability in patients with NSCLBP.

The reduction in pain can be attributed to muscular contractions during spinal stabilization exercises which provide sensory input to trigger different pain inhibitory mechanisms in the central nervous system. These led to a rise in the plasma serotonin level, which is a likely means of spinal stabilization exercises-induced analgesia [25].

The result of this study conforms to the previous studies of Suh et al. [26], Bagheri et al. [24], and Akodu et al.

[27] who in their own studies reported that CSE was effective in reducing pain and disability in patients with NSCLBP. This finding is also in line with the study of Hlaing et al. [28] who concluded in their study that despite the effectiveness of both core stabilization and strengthening exercises in reducing pain, core stabilization exercise is superior to strengthening exercise. It is effective in improving proprioception, balance, and percentage change of muscle thickness of TrA and LM, and reducing functional disability and fear of movement in patients with subacute NSLBP.

The finding of this study showed that clinical-based core stability exercises showed significant improvement in pain self-efficacy in patients with NSCLBP. This report supports the study of Shinohara et al. [29] who, in their study on improvement in disability mediates the effect of pain self-efficacy in chronic low back pain patients with exercise therapy. They concluded that exercise improved disability, and the improved disability by exercise mediated the effect of increased self-efficacy on pain relief in CLBP patients. Improvement in self-efficacy was significantly correlated with improvement in pain and disability which was mediated by exercise, this conforms to the findings of this study. The result of this study conforms to the study of Edmond et al. [30], who concluded that the increase in self-efficacy observed during treatment was associated with improvements in function and pain outcomes at discharge. The finding concurs with the report of the study by Souza et al. [31] which investigated self-efficacy levels in patients discharged from a physical therapy service after completing a treatment program for chronic musculoskeletal conditions, who showed the association between low self-efficacy and higher pain intensity at discharge.

The result of this study revealed that there was a significant improvement in the psychological status (depression, anxiety, and stress) using clinical-based core stability exercises in patients with NSCLBP. This could be a result of the reduction in the pain-related disability of the participants post-treatment after undergoing stabilization exercise training.

The finding of this study supports the previous study of Akodu et al. [32], who reported that stabilization exercise is effective in the improvement of the psychological aspect of quality of life, as well as the social status of patients with NSCLBP. According to Sribastav et al. [33], depression has a bidirectional relationship with pain. A cross-sectional study by Antunes et al. [34], on the relationship between chronic low back pain and depression, as well as kinesiophobia concluded that the prevalence of depression is high in patients with CLBP and that their depression is associated with poor quality of life.

The finding of this study also showed a significant reduction in the stress levels in patients with NSCLBP after treatment with clinical-based core stability exercise. This finding is consistent with the study of Paungmali et al. [35] on the immediate effects of core stabilization exercise on β-endorphin and cortisol levels among patients with chronic non-specific low back pain, who in the meta-analysis used core stabilization exercise with one training session per week, a training volume of ten repetitions per exercise, and an intensity of approximately 10% of body mass, reported a significant reduction in physiological stress after 8 weeks of intervention. This is contrary to the study of Barros dos Santos et al. [36] who reported increased cortisol serum levels in individuals with LBP, which could be due to the inconsistencies regarding the outcomes of the interventions on the stress levels assessed by the cortisol levels. The finding of this study aligns with Sousa et al. [37] who mentioned an ally in the regulation of the cortisol levels in individuals with LBP may be physical exercise, as it reduces the cortisol serum levels and increases functional capacity.

The result of this research showed that telerehabilitation-based core stability exercise is effective in the improvement of pain-related disability in patients with NSCLBP.

According to the results of Özden et al. [38], video exercise–based telerehabilitation had a positive effect on clinical parameters, expectation, satisfaction, and motivation for rehabilitation in patients with chronic low back pain. In another comprehensive randomized controlled study, Shebib et al. [39] discussed the effectiveness of the 12-week digital care program with an extensive assessment. Unlike this research, there was a sensor-based exercise tracking technology in their study. The authors provided CLBP rehabilitation with a more holistic approach, including cognitive behavioral therapy and a general education program. The results were similar to our study, and telerehabilitation was more effective than usual conventional care in terms of pain and disability. Furthermore, Cottrell et al. [40] performed a systematic review and meta-analysis, analyzing the effectiveness of real-time telerehabilitation with musculoskeletal conditions when compared to standard face-to-face practice; this review demonstrated telerehabilitation to be effective in improving physical function, disability, and pain.

The finding of this research supports the study of Alsobayel et al. [41] who reported that telerehabilitation has a positive therapeutic impact on pain and function and was an acceptable method of delivering physiotherapy services for patients who presented with musculoskeletal conditions in Saudi Arabia with significant improvements in pain, disability, and health status.

This is in accordance with the study of Gialanella et al. [42] who showed that home-based telerehabilitation may serve as an alternative option for delivering outpatient rehabilitation for patients suffering from chronic musculoskeletal pain (i.e., neck, shoulder, back) compared to the usual healthcare or clinical-based rehabilitation. A study by Lara-Palomo et al. [43] also reported that patients with chronic low back pain who followed the e-Health program showed greater post-treatment improvement than those who followed the home disability rehabilitation program.

The finding of this study also revealed that telerehabilitation-based core stability exercises showed a marked improvement in pain self-efficacy in patients with NSCLBP. Previous studies by Ferrari et al. [44] and Marshall et al. [1] showed self-efficacy moderately correlating with pain intensity and strongly associated with disability.

The result of this study showed that telerehabilitation-based core stability exercises produced a marked improvement in the psychological factors (depression, anxiety, and stress) of patients with NSCLBP. This finding correlates with the study of Hernando-Garijo et al. [45] who showed that a telerehabilitation program based on aerobic exercise was effective in reducing pain intensity, mechanical pain sensitivity, and psychological distress.

The findings of this research revealed that there was a statistically significant reduction in the psychological status (depression and anxiety) of the patients in the two groups (telerehabilitation and clinical-based group), this could be a result of the reduction in the pain-related disability of the participants post-treatment after undergoing stabilization training.

There has not been much comprehensive research done on telerehabilitation for core stability exercises, resulting in the non-availability of research findings to compare the result of this with.

The result of this research showed there was a marked improvement in outcome measures (pain-related disability, pain self-efficacy, and psychological factors) in both clinical and telerehabilitation groups. There was a significant reduction in pain-related disability combined with core-stability exercise in both clinical and telerehabilitation groups, and no significant difference was found between the 2 groups in pain-related disability and pain self-efficacy. This means that no group was superior to each other when compared.

Limitations of the study

A shortcoming of this study was the technical difficulties of some patients in meeting up with follow-up sessions due to poor internet connection.

Patient compliance was limited in the telerehabilitation group as some patients were faced with distractions from home activities and family members which interrupted their treatment sessions.

Conclusion

Telerehabilitation-based core stability exercises were as efficacious as clinical-based core stability exercises in decreasing pain-related disability, improving pain self-efficacy and psychological factors (depression, anxiety, and stress) and should be incorporated/ integrated as part of the treatment approach in musculoskeletal rehabilitation for patients with non-specific chronic low back pain. Hence, telerehabilitation-based core stability exercises may help bridge the gap in the non-availability of clinic-based core stability exercises, especially for patients in remote settings.

Abbreviations

BMI	Body Mass Index
CCSE	Clinical-based core stability exercise
CSE	Core stabilization exercise
CLBP	Chronic low back pain
DASS-21	Depression-Anxiety-Stress Scale 21
ICT	Information and Communication Technology
LBP	Low back pain
LM	Lumbar multifidus
NSCLBP	Non-specific chronic low back pain
TCSE	Telerehabilitation-based core stability exercise
PDI	Pain Disability Index
PSEQ	Pain Self-Efficacy Questionnaire
TrA	Transversus abdominis
VAS	Visual Analogue Scale

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Authors' contributions

Conception and design: AK, AR; acquisition of data: AR; analysis and interpretation of data: AK; drafting the article: AK; revising the article: AR, RA, AT; final approval: AK, AR, RA, AT. All authors read and approved the final manuscript.

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Availability of data and materials

The findings and data of the study are available with the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate

The health research and ethics committee approved the conduct of this research with approval number; CMUL/HREC/06/22/1066. Written informed consent to participate in the study was obtained from the participants and the confidentiality of their data was guaranteed and no harm/risk whatsoever was associated with the involvement in the study.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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