Research Paper

Effects of Comprehensive Physical Exercises Combined With Cognitive Functional Therapy on Women With Low Back Pain

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ABSTRACT

Objectives: This study examined how women with low back pain (LBP) responded to comprehensive physical exercises (CPEs) combined with cognitive functional therapy (CFT) in terms of pain, disability and postural sway (PS).

Methods: A total of 45 women with non-specific chronic LBP (NSCLBP) participated in this quasi-experimental study. The participants were randomly assigned to the CPEs, CPEs combined with CFT and control group (CG) (15 participants per group). The McGill pain questionnaire, Roland-Morris disability questionnaire, and Zebris platform were used to assess pain, disability and PS in anteroposterior (AP) and mediolateral (ML) directions with eyes open and closed. For eight weeks, the participants engaged in both CPEs and CPEs combined with CFT. The CG continued their usual routine. The multivariate analysis of variance statistical test with repeated measures design was used to analyze the data ($P<0.05$).

Results: The results revealed that after eight weeks, the patient's pain and disability significantly decreased in both intervention groups compared to the CG ($P<0.001$). The CPEs combined with CFT ($P<0.001$) and the CPEs group ($P<0.001$) compared to the CG showed a significant decline in AP sways with eyes open. The AP with EC and ML with eyes open demonstrated a significant reduction in the CPEs group with CFT versus the CPEs and CG ($P<0.05$). The ML oscillations with eyes closed revealed a significant reduction in the CPEs group compared to the CG ($P=0.005$).

Discussion: The CPEs combined with the CFT group showed better results in postural control ability, especially when the eyes were closed which may be a consequence of CFT. Therefore, it is recommended to use CPEs combined with CFT to reduce pain, disability and PS in women with NSCLBP.

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Highlights

● Comprehensive physical exercises (CPEs) are recommended for women with non-specific chronic low back pain (CLBP).

● Cognitive functional therapy (CFT) combined with CPEs has a positive effect on women with non-specific CLBP.

● A decrease in postural sway (PS) during the removal of visual information was associated with the use of CFT combined with CPEs.

Plain Language Summary

Comprehensive physical exercises (CPEs) is one of the main causes of disability. For the treatment of CLBP, international clinical guidelines support the use of non-pharmacological therapies, such as physical and psychological therapies or a combination of these modalities. This study determines the impact of CPEs combined with CFT on pain, disability, and PS of women with CLBP. A total of 45 women with CLBP participated in this study for eight weeks in three groups: CPEs, CPEs with CFT and control. The results revealed that after eight weeks of intervention, reductions in pain, disability, and PS were seen in the group of CPEs combined with CFT, both with eyes open and closed, in the anteroposterior (AP) and mediolateral (ML) PS directions. According to the obtained results, it is recommended to use CPEs combined with CFT to reduce pain, disability, and PS in women suffering from CLBP.

Introduction

Low back pain (LBP) is one of the main causes of disability worldwide [1]. A personal and economic burden is brought on by the persistent pain and disability that 5% to 10% of LBP patients experience [2]. About 85% to 95% of LBP patients have non-specific chronic low back pain (NSCLBP), which is characterized as LBP that is not caused by a particular, diagnosable pathology. The burden of disability related to LBP is growing despite the significant rise in treatment costs [3, 4]. LBP is one of the most frequent reasons for work limitations in Americans under 45 years, the second most frequent cause of doctor visits, and the third most frequent cause of surgery [5]. According to research, LBP is more common than other diseases in Iran (51% of the population), with a mean prevalence of 54.2% in the 15–45 years age group and a higher mean prevalence of 62.3% in women [6]. Oliveira et al. maintained that costs associated with LBP are estimated to total 100 billion dollars in the United States of America, 3.5 billion euros in the Netherlands, 6.6 billion euros in Switzerland, 17.4 billion euros in Germany and 9.17 billion dollars in Australia [4].

Complications of NSCLBP include the occurrence of pain, disability, change in activity level, alteration in walking pattern, loss of balance and an increase in postural sway (PS) [7, 8]. The physiological mechanisms of the balance systems, particularly the proprioceptive, are altered in LBP. As a result, the sensitivity and accuracy of these receptors decline and by transmitting inaccurate information, they cause inappropriate movement commands. Therefore, the body's posture deviates from the norm and the center of gravity sways more than natural. Meanwhile, it is crucial to be able to maintain balance during daily activities and even in sports [9].

LBP entails a sizable personal, social, and economic burden. For the treatment of LBP, international clinical guidelines support the use of non-pharmacological therapies, such as physical and psychological therapies or a combination of these modalities [10]. Numerous exercise types, such as low to moderate-intensity aerobic exercise, high-intensity aerobic exercise, muscle strength exercises, core stability exercises, and flexibility programs, have been studied for the treatment of NSCLBP [7, 11]. Experts have looked into non-invasive treatments for LBP in addition to exercise therapy programs, which are the priority in the treatment of NSCLBP. Experts during the recent decade discovered that psychological therapies can help with LBP improvement and can be used as a supplement to exercises [10]. LBP is increasingly understood to be a biopsychosocial disorder that can be impacted by a variety of interrelated factors. Pathoanatomic (like disc degeneration), physical (like protection of supporting muscles), psychological (like beliefs about back pain, depression, fear of activity, and pain self-efficacy), lifestyle (like physical inactivity, sleep deprivation, and stress), and social (like culture, socioeconomic status, work, and family life) factors are some examples of these that can vary from person to person. There is disagreement over whether individualized interventions can offer better clinical outcomes than standard interventions for LBP, even though many contend that we must target these factors (where modifiable) [12, 13].

To individualize the management of incapacitating LBP, cognitive functional therapy (CFT) was first developed as a flexible and integrative behavioral approach [12]. The researchers continued by saying that many people with LBP can benefit from the CFT's principles. A motor control disorder affects one-third of LBP patients, according to O'Sullivan. Exercises that focus on cognitive function are based on Sullivan's approach to multidimensional classification systems. These exercises are done to address the person's cognitive, functional, and lifestyle problems. Due to the fears and anxieties that a person with LBP experiences, education should be provided to the ill person to focus on the mechanism of the pain cycle and disability, increasing the person's awareness of their body and how their body reacts to perceived pain, movement, and fear [10, 12-14]. The main objectives of CFT are to make it possible for the therapist to lead each client on an individual journey that includes the following items: 1) Encouraging them to make sense of their pain in the context of their experience and from a multidimensional perspective; 2) Creating efficient strategies for controlling pain by overcoming unfavorable beliefs and emotional reactions to pain as well as altering how physical tasks are carried out (by relaxing the body and getting rid of risky behaviors); 3) Developing a healthy lifestyle [13]. Finding the most efficient treatment options is essential, as evidenced by the high prevalence of LBP in women, the high costs of care, and the disability caused by those who are affected. Accordingly, this study determines the impact of comprehensive physical exercises (CPEs) combined with CFT on pain, disability and PS of women with NSCLBP. We hypothesized that CPEs (as a general approach) along with CFT (individually) can decrease pain and disability and improve postural control of women with NSCLBP.

Materials and Methods

According to the inclusion and exclusion criteria, 45 women with NSCLBP between the ages of 20 and 50 from Arak City, Iran, participated in this quasi-experimental study. Using the G*Power software version 3.1 for the F test with effect size values of 0.5, a significance level of 0.05, and a power of 0.8, the sample size was estimated. The inclusion criteria for the study were having NSCLBP (with a history of pain of at least 3 months) as determined by a specialist doctor, being free of cardiorespiratory diseases, neuromuscular diseases, and diabetes, having no history of surgery, fractures, or serious spinal injuries, including disc herniation, having no obvious structural abnormalities in the spine, having leg lengths that differ by no more than 1 cm. Additionally, the participants were dropped from the study if they missed more than two consecutive training sessions or three sessions that were not consecutively held during the study.

Before beginning the work, the examiner provided a general explanation of the study and its objectives to the participants in a meeting, as well as information on how to prevent and treat NSCLBP in daily life and the benefits of different exercises in treating this condition. The consent form was then given to the participants to complete and sign if they decided to take part in the study.

For the pre-test examination and measurements in the following, participants showed up at the lab on the scheduled day. The participants first completed demographic questionnaires. They were then asked to complete the visual analog scale and disability questionnaires after the initial measurements of height and weight were made. The assessment of PSs will continue. Then, using the "RandList" randomization software, the participants were divided into three groups of CPEs, CPEs combined with CFT and control (15 people in each group). Under the researcher's supervision, two experimental groups engaged in CPEs for eight weeks throughout three weekly sessions. The post-test was then administered following the completion of the exercises under the same circumstances as the pre-test.

Study assessments

Pain assessment

The McGill pain questionnaire was employed to measure pain perception. By selecting the appropriate words, the patient can express his perception of pain in three sensory, emotional, and evaluation dimensions. This questionnaire, which includes 20 groups of words to describe pain, is an effective tool for examining quantitative and qualitative aspects of pain. The first words in each group receive a score of one according to the spatial value-based scoring system. As a result, the words selected convey the quality and the severity of the pain. The pain rating index is the total of the scores for the words chosen in various groups. A higher pain rating in-

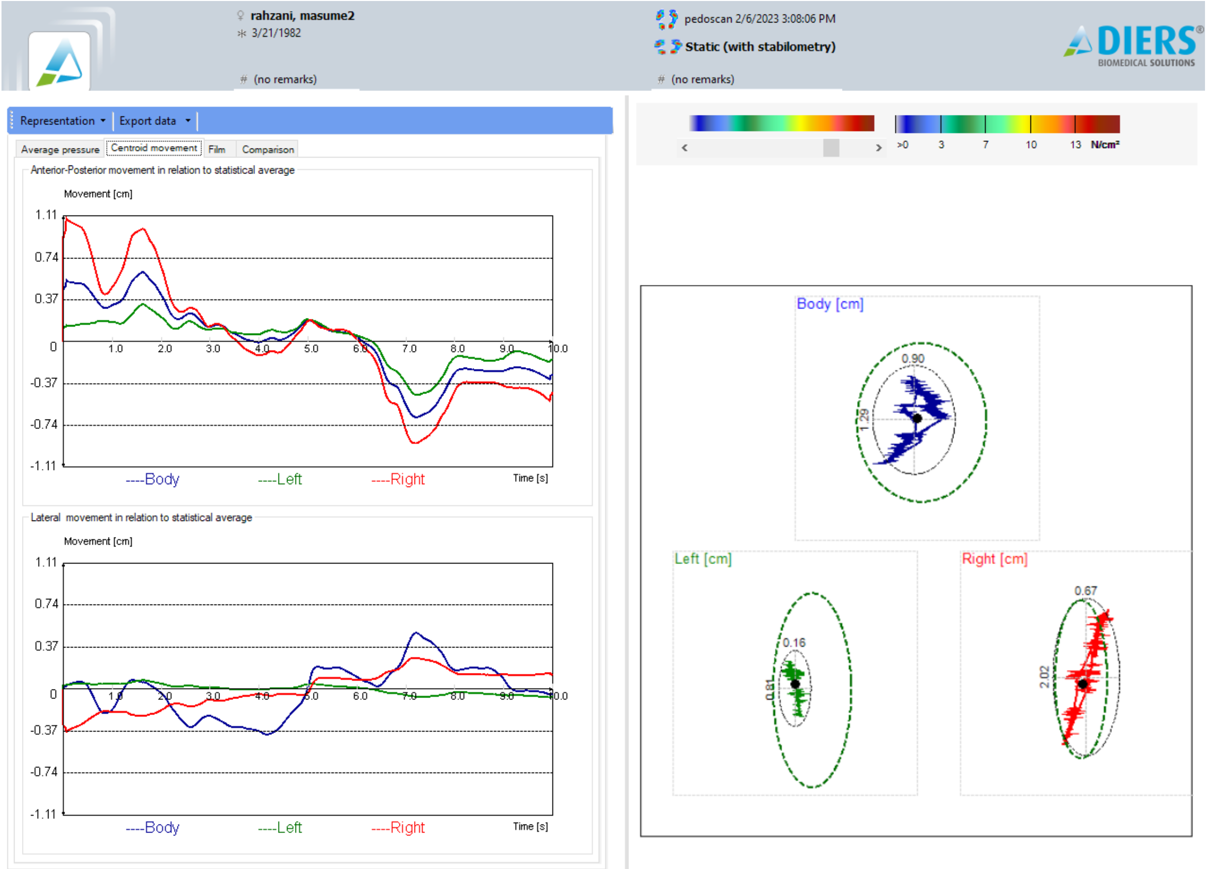

Figure 1. An example of CoP sway results in DICAM 3 software

Notes: The total body sway (blue color) was reported in this research.

dex score indicates more severe pain. Many studies have established the reliability and validity of this questionnaire. According to Waldman et al. the study's Cronbach α coefficient was 0.95 [15]. Also, Khosravi et al. reported the stability coefficient was >0.8 [16].

Roland-morris disability questionnaire

The Roland-Morris disability questionnaire is one of the most widely used tools in clinical research to evaluate the movement limitations of LBP patients. Two doctors created this questionnaire to assess how LBP patients are being treated. There are 24 items on this questionnaire, and the inclusion of the phrase "because of my low back pain" highlights its uniqueness in gathering each patient's symptoms. This questionnaire's intraclass correlation coefficient was reported to be 0.84 and the Cronbach α=0.89 [17, 18].

Postural sways (PS)

A plantar pressure platform made by Zebris Company, Germany, was used to assess PSs [9, 19]. The participants were instructed to stand on the measurement plate with their eyes open and closed, trying to move as little as possible. The device recorded the PSs during this time (30 s). Each participant was tested three times under each circumstance (eyes open and closed separately), and the analysis used the mean of the three repetitions as the final score. It was reported on the center of pressure's (Cop) movements in the anteroposterior (AP) and mediolateral (ML) directions [9, 20] (Figure 1).

Study interventions

CPEs

The participants in the experimental groups trained for eight weeks, three times per week, for 45 to 1 h each session. The subjects performed a general warm-up at the start of each training session. They then carried out separate aerobic, core stability, balance and flexibility exercises following the schedule of each session. Table 1 contains a description of the exercises.

The exercises started with running. If running was difficult for the subject or accompanied by increased pain, especially in the first and second week, it was replaced by walking or jogging. After a general warm-up (5 to 10 min), subjects performed core stability training. Then, balance exercises were performed. After that, the second aerobic stage was performed. According to the ability of the subjects, if needed, this phase was done as an interval running. In the end, stretching exercises were performed.

Exercises were designed from 2 to 3 sets, from 6 to 10 repetitions, and contractions from 10 s to 60 s. Rests between sets were 30 s and between the exercises 1–2 min (Table 1).

The overload principle was implemented as follows. As the subjects progressed, the repetitions and sets of the exercises were increased, or they were performed with stability balls or weights, or the exercises were replaced with a higher degree of difficulty (Table 1).

CFT

Along with the CPEs protocol, CFT was also used in the group of CPEs combined with CFT. To provide care that is suited to each person's particular background and context, this approach considers personal factors, such as cultural environment, treatment expectations and preferences, health literacy, levels of acceptance, and readiness for change. The interview begins with an open question like "Tell me your story," which enables individuals to express how they feel about their pain in their own unique way. The disclosure of various aspects is facilitated by sensitive, non-judgmental, and probing questions, such as pain history, the presence of underlying factors (such as social, cognitive, emotional, physical, lifestyle and health) at the time of pain onset, behavioral responses to pain, such as pain coping strategies, avoidance and/or perpetuation, protective care, postural and movement habits, and lifestyle. The therapist summed up the responses and the narrative after the interview, explaining that efforts had been made to help the patient manage their pain through training in diaphragmatic breathing, controlling sleep quality, preventing catastrophizing, using mirror vision feedback and maintaining proper posture while standing, sitting, and standing up, among other things [3, 10, 12-14].

Statistical analysis

SPSS software, version 26 was used to analyze the data. The Shapiro-Wilk test is used to determine whether the data are normally distributed and the mixed-model repeated measures. Time (pre-test vs post-test) and group (CPEs plus CFT, CPEs and control) were the within-between subject factors, respectively. The Bonferroni post hoc test was used to compare groups and times if there was a significant interaction between time and group as well as a main effect for both variables (time×group). All statistical tests for the main effect and interactions were given a significance level of P<0.05. The percentage of changes was calculated using the Equation 1:

1. (Pre-test-Post-test)/Pre-test×100.

Results

The Mean±SD of the demographic data of the participants are provided in Table 2. The results of the statistical test are provided in Table 3.

The results show that all the variables are significantly affected by the main effects of time, group (aside from the variable of ML sways with closed eyes) and the interactive effect of time×group. The group effect was not statistically significant only in the variable measuring ML sways with eyes closed (P=0.189) (Table 3). The outcomes of the Bonferroni post hoc test for pairwise comparison of significant differences between times and groups are presented in the sections that follow.

The post-test results for the pain variable revealed a significant difference (P<0.001) between the pre-test and post-test of the two intervention groups. The results of the post hoc test comparing the groups also revealed a significant difference between the CPEs group combined with CFT (P<0.001) and the CPEs group (P<0.001) and the control group (CG) in the post-test of pain. Following are the percentages of pain changes in various groups: CPEs combined with CFT=84.58%, CPEs group=80.58% and CG=0.8%.

The results of the follow-up disability test revealed a significant difference between the pre-test and post-test of the CPEs group combined with CFT and the CPEs group (P<0.001). Additionally, when the groups were compared, the post-test results in the GEs group with CFT and the CPEs group and CG differed significantly (P<0.001). The two training groups did not significantly differ from one another (P=0.142).

The results of the follow-up test of AP sways with eyes open (CPEs combined with CFT [P<0.001) and CPEs [P=0.004]) and ML sways with eyes open (CPEs combined with CFT [P<0.001] and CPEs [P=0.027]) showed a significant difference in the pre-test and post-test comparison of the intervention groups. In the comparison between groups in the post-test, the group that performed CPEs combined with CFT (P<0.001) and the group that

Table 1. CPEs

	Exercise	1st Week	2nd Week	3rd Week	4th Week	Exercise	5th Week	6th Week	7th Week	8th Week
Aerobic	Running	5 min	6 min	7:30 s	9 min	Running	10 min	12:30s	15 min	15 min
Core stability training	Abdominal contraction	20 s×3	20 s×3	20 s×3	30 s×3	Squat with ball	3×10s†	3×15s†	3×20 s†	3×20 s†
	Bird-dog	3×8 rep	3×8 rep	3×8 rep	3×10 rep	Straight leg bridge	3×10s†	3×15s†	3×20 s†	3×20 s†
	Slow curl-ups	2×6 rep	3×6 rep	-	-	Crunch	3×10s†	3×15s†	3×20 s†	3×20 s†
	Slow sit-ups	2×6 rep	3×6 rep	-	-	Plank/push-up	3×10 s†	3×15 s†	3×20 s†	3×20 s†
	Glute bridge	3×8 rep	3×8 rep	3×8 rep	-	Lunge	3×10 s†	3×15 s†	3×20 s†	3×20 s‡
	Squat	-	3×8rep	3×8 rep	3×10 rep	flutter kicks	3×10 s†	3×15 s†	3×12 s†	3×15 s‡
	Superman	-	-	-	3×10 s	Superman	3×15 s	3×15 s	3×15 s	3×20 s‡
	Abdominal curl up with slight rotation	-	-	-	3×10 s	Abdominal contraction	3×40 s	3×50 s	3×55 s	3×60 s
Balance training	Balance exercise	3×10 s standing on one leg	3×10 s standing on one leg	3×12 s standing on the BOSU ball	3×12 s standing on the BOSU ball	Balance exercise with BOSU ball	3×15 closed eyes	3×15 s closed eyes	3×15 s single leg	3×15 s single leg
Aerobic 2	RunningΨ	5 min	6 min	7:30s	9 min	RunningΨ	10 min	12:30s	15 min	15 min
Flexibility training	Cat-cow	3×8 rep	3×8 rep	3×8rep	3×8 rep	Cat-cow	3×20 s	3×20 s	3×20 s	3×20 s
	Quadriceps muscles stretch	3×15 s	3×15 s	3×15s	3×15 s	Quadriceps muscles stretch	3×20 s	3×20 s	3×20 s	3×20 s
	Hamstring muscles stretch	3×15 s	3×15 s	3×15s	3×15 s	Hamstring muscles stretch	3×20 s	3×20 s	3×20 s	3×20 s
	Quadratus lumborum stretch	3×15 s	3×15 s	3×15s	3×15 s	Quadratus lumborum stretch	3×20 s	3×20 s	3×20 s	3×20 s
	Deep glute stretches	-	-	3×15s	3×15 s	Deep glute stretches	3×20 s	3×20 s	3×20 s	3×20 s
	Shin stretch	-	-	-	3×15 s	Shin stretch	3×20 s	3×20 s	3×20 s	3×20 s
	Prone torso twist	-	-	-	3×15 s	Prone torso twist	3×20 s	3×20 s	3×20 s	3×20 s

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ΨInterval running according to each person's ability, †Exercises with a stability ball, ‡Exercises with weights.

Table 2. Demographic characteristics of the participants (n=15)

Group	Mean±SD			
	Age (y)	Weight (kg)	Height (cm)	BMI (kg/m²)
CPEs with CFT	39.46±3.66	74.86±5.79	162.86±3.31	28.21±1.83
CPEs	38.73±4.33	74.2±5.23	163.4±4.92	27.79±1.6
Control	39.06±4.39	72.13±8.12	162.2±5.1	27.41±2.96
P	0.889	0.493	0.768	0.619

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Abbreviations: CPE: Comprehensive physical exercise; CFT: Cognitive functional therapy; BMI: Body mass index.

Table 3. The results of the MANOVA test with repeated measurement design

Variables (Unit)	Groups	Week 0	Week 8	Effect	F	P	Effect Size	Size (%)
Pain	CPEs with CFT	41.53±4.13	6.4±4.1	Time	756.96	<0.001*	0.947	84.58
	CPEs	39.13±3.11	7.6±4.4	Group	84.56	<0.001*	0.801	80.58
	Control	40.26±6.24	40±5.9	Time×group	186.44	<0.001*	0.899	-0.8
Disability	CPEs with CFT	12.06±2.08	Time (2±1.8)		344.36	<0.001*	0.891	83.41
	CPEs	11.4±2.02	3.33±1.54	Group	39.63	<0.001*	0.654	70.78
	Control	11.13±1.5	11.73±1.98	Time×group	108.03	<0.001*	0.837	5.39
AP sway OE (cm)	CPEs with CFT	1.03±0.34	0.64±0.28	Time	21.97	<0.001*	0.343	37.86
	CPEs	1.02±0.26	0.76±0.22	Group	11.03	<0.001*	0.345	25.49
	Control	1.25±0.39	1.21±0.24	Time×group	4.49	0.017*	0.176	3.2
ML sway OE (cm)	CPEs with CFT	1.24±0.36	0.68±0.26	Time	26.18	<0.001*	0.383	45.16
	CPEs	1.31±0.46	1.08±0.35	Group	7.26	0.002*	0.257	17.55
	Control	1.43±0.33	1.32±0.34	Time×group	5.30	0.009*	0.202	7.69
AP sway CE (cm)	CPEs with CFT	1.08±0.23	0.75±0.2	Time	9.34	0.004*	0.182	30.55
	CPEs	1.26±0.37	1.17±0.31	Group	6.60	0.003*	0.239	7.14
	Control	1.25±0.29	1.30±0.45	Time×group	7.68	0.001*	0.268	-4
ML sway CE (cm)	CPEs with CFT	1.41±0.4	0.98±0.31	Time	10.42	0.002*	0.199	30.4
	CPEs	1.40±0.44	1.29±0.45	Group	1.73	0.189	0.076	7.85
	Control	1.42±0.39	1.44±0.33	Time×group	6.37	0.004*	0.233	-1.4

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Abbreviations: CPE: Comprehensive physical exercise; CFT: Cognitive functional therapy; AP: Anteroposterior; ML: Mediolateral; OE: Open eyes; CE: Closed eyes.

*Significant difference at P≤0.05.

performed CPEs (P<0.001) compared to the control both showed a significant decline in AP sways with eyes open. Between the intervention groups, there was no difference (P=0.578). The results of the ML sways with eyes open follow-up test revealed a significant decline in the CPEs groups combined with CFT compared to the CPEs group (P=0.004) and CG (P<0.001) after eight weeks of intervention. The CPEs group and the CG did not differ from one another (P=0.148).

Only the group of CPEs combined with CFT showed a significant difference between the pre-test and post-test comparison of AP and ML sways with eyes closed (P<0.001). The CPEs group with CFT demonstrated a significant reduction in AP sways with the eyes closed in the post-test when compared to the CPEs group (P=0.004) and the CG (P<0.001). The ML oscillations revealed a significant reduction in sways in the CPEs group when compared to the CG (P=0.005).

Discussion

This study examined how CPEs combined with CFT affected the pain, disability, and PS of women with NSCLBP. According to the results, patients' pain, disability and AP posture sways all decreased after eight weeks of CPEs but there was no difference in ML and AP sways with eyes open and closed. On the other hand, reductions in pain, disability, and PS were seen in the group of CPEs. combined with CFT, both with eyes open and closed, in the AP and ML directions. When the groups were compared, a significant difference was found between the CPEs group with CFT and the CPEs and CGs in the variables of ML sways with eyes open and closed and AP sways with eyes closed.

The soft tissues and muscles surrounding the spine must be strong; otherwise, NSCLBP will develop. The researchers' main contention is that the inability of the muscles to support passive structures against additional load may result in the destruction of these pain-sensitive structures and ultimately result in the pain of these people. These weaknesses have been linked by researchers to incorrect body positions that people adopt while engaging in various activities. Skeletal muscle factors, particularly in recent years, the deep muscles of the spine and pelvis, are one of the theories put forth for the origin of back pain. This indicates that the dysfunction of these muscles results in a flaw in the spine's regulatory system, which in turn leads to LBP [10, 12].

Being overweight is known as one of the risk factors for low back pain. Several studies have shown that after controlling factors, such as age and sex, the prevalence of LBP increases significantly in people with a high body mass index (BMI) [21-23]. One of the proposed mechanisms for the relationship between LBP and weight is that high BMI leads to additional mechanical load on the spine and causes pain [21].

According to the results obtained by Shiri et al., walking and cycling are effective ways to reduce pain and prevent back pain among people with overweight who suffer from low back pain [23]. On the other hand, the use of training methods based on weight loss for these people requires long-term training periods and control of other factors, such as nutrition. In this regard, the results of the study by Roffey et al. showed that the positive effects of weight loss were reversed, probably due to the subsequent weight gain of the participants in the follow-up phase of the study [24]. Therefore, weight loss interventions may be prone to adherence problems and outcomes may depend on maintenance of weight loss. So, in the case of choosing a weight loss exercise method to improve back pain, studies should be planned long-term and its effects should be investigated. The participants of the current study were overweight, but according to the results of previous studies, we did not use a weight loss exercise method. We used aerobic exercises considering their benefits for these subjects. By increasing the flow of blood and nutrients to the soft tissues in the back, aerobic exercise reduces muscle stiffness that may be the cause of back pain [11]. Also, aerobic exercise increases the production of endorphins (Kenny, Gordon), which is a factor in reducing the perception of pain. Endorphins act like the drugs codeine and morphine in the body [25]. For patients with CLBP, physical activity (PA) to increase aerobic capacity and muscle strength, particularly back extensor muscles, is important for assisting them in completing daily activities. However, it has been discovered that the effectiveness of various exercises in reducing LBP varies. Furthermore, excessive or insufficient PA may be linked to LBP, indicating the complexity of PA as an intervention for LBP [11]. Because of this, it can be challenging to recommend a specific treatment when the cause of LBP is unknown and CPEs are frequently recommended instead. In this regard, the current study's exercise program was generally selected. It can be said that performing CPEs has increased strength, endurance, flexibility, coordination, static and dynamic stability, neuro-muscular control, movement control, modification of movement pattern, and muscle relaxation, which has improved patients' performance and decreased pain and physical disability. This is just one of the potential explanations for why exercises are effective.

According to the results of percentage changes, pain decreased in both training groups, but the CFT group experienced a greater change. Doctors have used a variety of methods to treat pain for many years. The role of psychological factors and treatments based on these factors have been noted since Melzak and Wall introduced the concept of three dimensions of pain in the gate control theory of pain, which considered the intensity and nature of pain as a function of sensory, cognitive, and emotional mechanisms [3]. The overall objective of CFT in patients with chronic LBP is to substitute adaptive states for maladaptive cognitions, behaviors, emotions, and coping mechanisms. Although CFT alone does not consider all factors that might be significant and involved, such as biological factors in chronic LBP, it is still effective in improving therapeutic care for LBP patients. The study's findings show that CFT significantly lowers the degree of pain catastrophizing in people with chronic back pain, improves pain management, boosts people's confidence in carrying out activities despite pain, and lessens the signs of stress, depression, and anxiety in people with chronic pain [12].

According to the findings, CPEs combined with CFT significantly improved all variables when compared to the CG. To effectively control the position of the center of mass and ultimately maintain balance and equilibrium, the nervous system must produce muscle forces. Regardless of the source, pain changes postural control strategies. Patients with LBP have impaired postural control. When balance is momentarily disturbed, a recovery strategy for the proper posture is offered. This task requires the use of proprioceptive postural control strategies, which appear to be different in people with LBP and may result in a reduction in overall postural stability. People without LBP are unable to use multi-part control, which is based on all balance strategies and is used by healthy people with normal postural stability. The results indicate that CPEs and CFT have given participants better performance than the other two study groups in terms of their ability to control posture sway, particularly when the eyes are closed. Accordingly, CFT's contribution to this situation has been successful. The findings of this study are consistent with those of O'Sullivan et al. [12], Vibe Fersum et al. [3], He et al. (2022) [26] and De Lira et al. (2022) [27]. It is suggested to compare the effectiveness of comprehensive exercises with other exercises in future studies. It is also recommended to investigate the long-term effects of these exercises with and without CFT.

Conclusion

It is recommended to use a comprehensive program of aerobic, core stability, balance, and flexibility exercises to help patients with NSCLBP, the results. In addition to physical therapy and targeted exercises, it is recommended that cognitive behavioral therapy be incorporated into the exercise protocols of female patients with chronic LBP.

Ethical Considerations

Compliance with ethical guidelines

This study was approved by the Ethics Committee of Arak University (Code: IR.ARAKU.REC.1401.020) and was listed in the Iranian Registry of Clinical Trials (IRCT) (Code: IRCT20220722055522N1).Before experimental procedures began, all the participants reviewed and voluntarily signed an informed written consent form.

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Authors' contributions

Conceptualization, methodology and supervision: Zahra Raeisi; Data collection: Mahsa Asgari; Data analysis, investigation and writing: All authors.

Conflict of interest

The authors declared no conflict of interest.

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