

Research Paper: Comparing the Effects of Core Stability and Williams Training on Dynamic Balance and Back Pain in Women With Chronic Back Pain



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ABSTRACT

Introduction: This research aimed to compare the effects of the Williams and core stability training on dynamic balance and back pain in women with chronic back pain.

Materials and Methods: In total, 45 women with chronic back pain were selected as the available sample and were randomly divided into 3 groups of 15 participants, including core stability, Williams, and control. Before the beginning and the end of the training period, the dynamic balance with the Star Excursion Balance Test (SEBT) and low back pain with Québec Questionnaire was measured. To analyze the obtained data, Analysis of Covariance (ANCOVA) was used in SPSS at $P < 0.05$.

Results: The present study findings revealed a significant difference in core stability and Williams training on dynamic balance and improvement in the extent of low back pain in the study participants. There was a significant difference between the training groups in dynamic balance; however, there was no significant difference in the improvement of low back pain between the experimental groups.

Conclusion: To improve dynamic balance, a core stability training program is recommended, and Williams' flexor movements are more appropriate for reducing low back pain.

Introduction

A

large frequency of individuals with low back pain for whom no specific cause is found is called nonspecific low back pain patients [1]. This type of low back pain is divided into 3 groups based on the

duration of occurrence, as follows: acute (<6 weeks), subacute (between 6 weeks to 3 months), or chronic (>3 months) [2]. Chronic low back pain has numerous causes. There exist different theories to explain the causes of chronic low back pain [2]. However, its exact mechanism remains undiscovered. It is generally believed that the neural pathways that transmit pain

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messages to the brain become more sensitive over time if the pain remains untreated, and the patient's perception of pain increases; the patient, despite a relative improvement, generates the cause of the pain [2]. They still feel severe pain in the lower back. If the pain is not treated, its chronicity will also change the patient's mental state [3].

Most sources recommend exercise for treating chronic low back pain [4]. In this regard, there are various approaches to treat low back pain, which can be considered absolute rest and implementing exercise therapy [5]. However, there is little evidence that a particular type of exercise is preferable in this regard [6]. There is agreement on employing exercise therapy to prevent low back pain. Among the exercises offered to patients with chronic low back pain is a set of exercises called Williams flexion training. Williams believes that the main cause of low back pain is a disruption of the natural curvature of the spine. In other words, he believes that due to various markers, including weakness of the abdominal wall muscles, the extent of curvature or arch of the lumbar region increases, leading to low back pain. Williams also believes that due to the weakness of the gluteus muscles or the inflexibility of the muscles around the pelvis and thighs, especially the muscles behind the thighs (hamstring muscles), the individual does not use the correct pattern when working, and this factor disrupts joint movements. It is located between the pelvis and the lower back, causing low back pain. Therefore, Williams designed special exercises training or therapeutic movements to reduce the curvature or lumbar arch (lordosis), strengthen the abdominal muscles and create flexibility in the muscles around the pelvis and buttocks; as mentioned earlier, they are called those exercises or Williams's exercises training. These sports have a special position in the usual treatment of patients [7].

In this area, controlling and maintaining balance in dynamic and static conditions is a necessity to perform daily physical activities; therefore, maintaining balance is among the essential parameters in assessing individuals with balance disorders and low back pain. Research suggested that individuals with low back pain may have reduced posture control indicators and balance, which manifests as balance disorders. Controlling and maintaining balance in static or dynamic conditions is an essential need to perform daily physical activities [8]. Balancing is a complex function that involves several neuromuscular processes. Posture control in the body refers to the interaction between sensory input and motor responses required to maintain posture and balance [9].

McGill believes that in patients with low back pain, the stability of the spine should be initially increased [10]. Core stabilization exercises involve the lumbar-iliac-femoral muscles, including the abdominal, pelvic, lumbar, and pelvic floor muscles [11]. Core body stability exercises affect the mechanics and neuromuscular stability of the core body, with a major effect on the function of the upper and lower limbs [12].

Core area stability exercises increase the strength, stability, and stability of the body center, as well as the individual's ability to maintain the body's center of mass above the surface and, in turn, promote balance [11]. Among the research studies that have been conducted concerning the improvement and prevention of low back pain, we can refer to those conducted on the effect of moving in water [13]; strength training [14]; endurance training [15]; Pilates exercises [16]; Mackenzie exercises [17]; and core stability exercises [8]. However, few studies have compared the effects of core stability training (with emphasis on strengthening the core muscles of the body) and Williams's movements (with emphasis on flexibility of the muscles around the pelvis and serine) on improving chronic low back pain and dynamic balance.

Additionally, women have less mobility and a higher percentage of fat, compared to men; accordingly, it reduces the strength of muscles in the central area of the body and reduces the flexibility of the muscles around the waist and pelvis. Moreover, pregnancy in women and increasing the arch of the back and reducing physical activity, and the breakdown of axial muscles make women more prone to back pain. Therefore, the present study aimed to investigate the effects of core stability training and Williams's movements on chronic low back pain and dynamic balance in women with chronic low back pain. Furthermore, we explored the potential difference between these training methods in improving chronic low back pain and the dynamic balance of women who make up half of society.

This research aimed to compare the effects of core stability training (emphasizing small, deep, and posterior muscles of the spine) and Williams's movements (emphasizing flexibility and strengthening large body muscles, like hamstring muscles) on chronic low back pain and dynamic balance in women with low back pain.

Materials and Methods

The statistical population of the present study involved women (Mean±SD: age= 41.60±3.48 years,

weight=71.87±2.35 kg, and height= 160.47±0.20 cm) with chronic low back pain who were referred to health centers in Shahrekord City, Iran, in 2019. According to the call and information - in coordination with the medical centers -, 45 volunteer companies who met the inclusion criteria of the study were selected and randomly divided into 3 groups (core stability training, Williams training, & control). The medical information of the research participants was checked through the medical records available in the referred health center.

The inclusion criteria of the study consisted of presenting chronic low back pain, not using canes and glasses, not taking pressure medication, having the necessary ability to perform movements, no hypertension, no eye surgery, no history of stroke, no history of falls, and no lower limb fractures in the last 4 years, and no use of sedatives.

The Star Excursion Balance Test (SEBT) was used to assess dynamic balance among the research participants. An octagonal star was drawn at a 45° angle to the earth. The study participants stood in the center of the star and then took one-foot position and with the other foot randomly determined the direction of the tester until it made a mistake (the foot did not move from the center of the star, did not lean on the foot performing the access, or did not fall). They operated and returned to normal position on both feet. This test was performed 3 times in each direction; finally, their mean was calculated, divided by the length of the foot (in centimeters), i.e., the distance between the anterior iliac spine and the large internal condyle. Next, it was multiplied by 100 to achieve the achievement distance in the frequency of foot length size was obtained. The test was performed in 3 replications and the participant rested for 3 minutes between each repetition. If the study participant's right foot was the dominant foot (the dominant foot was identified by tapping the foot on a soccer ball), the test was performed counterclockwise; if their left foot was the dominant foot, the test was performed clockwise [18]. Kinzey and Armstrong [19] found that the SEBT had good reliability for assessing dynamic equilibrium and ICC, ranging from 0.86 to 0.98 for assessing equilibrium.

The Quebec Back Pain Disability Scale (QBPD) was used to measure low back pain. The QBAC Functional Disability Scale is a 20-item questionnaire designed to assess the level of functional disability in patients with low back pain. This scale was used to evaluate high-quality performance statuses (content & structural validity, feasibility, language matching, & international use) and is commonly used [20]. The minimum score on this scale is 20 and the maximum is 100. Zero to 25 is a

sign of low pain, 26 to 52 reflects moderate pain, 51 to 75 indicates a lot of pain, and 75 and above is a sign of very high and very acute pain. The scoring rate of the study participants was summed according to the available options; then, multiplied by the fixed number of each option to obtain the final number. A higher score indicates greater disability [21]. It is necessary to explain the range of pain of the study participants to enter the research process according to the scale of 51-75 [22].

To control the intensity of exercise while using heart rate, the Borg questionnaire was used. Validation of this scale is $r=0.92$ [23]. Borg 13 pressure perception, i.e., applied in the relevant studies as the optimal pressure level for middle-aged individuals, was used [24].

Each training session began with a 10-minute warm-up, followed by a 40-minute central stability program; the final ten minutes were devoted to stretching exercises for the head. The experimental groups performed Williams and core stability training with moderate intensity (13 on the Borg scale). Ten minutes were considered for warm-up, 40 minutes for exercise, and 10 minutes for cooling. These pieces of training were performed in which the research participants performed them with the necessary awareness.

Core stability exercises: These training include the lumbar-iliac-thigh muscles, involving the abdominal, pelvic, lumbar, and pelvic floor muscles. These exercises affect the mechanics and neuromuscular stability of the central part of the body, which affects the function of the upper and lower limbs. Also, core stability training improves the strength, development, stability, and stability of the body center, as well as the individual's ability to keep the body's center of mass above the level of support, and possibly improve balance. The protocol used based on Jeffrey's proposed core stability training consisted of three levels, starting with level one and gradually progressing to level three. Level 1 exercises included static contractions in a stable position. Level two included dynamic movements performed in a stable environment. And the three-dynamic level exercises were unstable in the environment. Swiss balls were used to create an unstable environment [25].

Williams' flexion training program included 7 movements, as follows:

Pelvic tilt exercises: Lie on your back with knees bent, feet flat on the floor. Flatten the small of your back against the floor, without pushing down with the legs. Hold for 5-10 seconds.

Partial sit-ups: The athlete lies in the “hooking” position (supine with knee bent and feet flat). With hands behind his or her head, the athlete elevates the upper torso until the scapulae clear the resting surface, and stress is placed on the rectus abdominus. After returning to the start position, the sit-up is repeated for a prescribed number of repetitions.

Knee-to-chest: Single Knee to chest. Lie on your back with knees bent and feet flat on the floor. Slowly pull your right knee toward your shoulder and hold 5-10 seconds. Lower the knee and repeat with the other knee.

Double knee to chest: Begin as in the previous exercise. After pulling the right knee to chest, pull the left knee to chest and hold both knees for 5 to 10 seconds. Slowly lower one leg at a time.

Hamstring stretch: Lying supine, the athlete places both hands around the back of one knee. The athlete straightens his or her knee and pulls the thigh toward his or her head so the hip goes into flexion. Williams believed that flexible hamstrings are necessary to accomplish full flexion of the lumbar spine. Although tight hamstrings limit lumbar flexion in standing with knee straight, we now know that tight hamstrings tilt the pelvis posteriorly and promote trunk flexion.

Standing lunges: This exercise results in some extension of the lumbar spine when performed properly. Nonetheless, it is a good stretching exercise for the entire lower extremity, especially the iliopsoas, which may be a perpetrator of low back pain if it is abnormally tight or in spasm. The athlete begins the forward lunge in a standing position with the feet shoulder-width apart. He or she then takes a big step forward with the right leg and plants the foot out front, keeping the body relatively straight. The knee should stay over your ankle and not extend out over the toes to minimize stress on the knee joint.

Seated trunk flexion: This exercise is performed by sitting in a chair and flexing forward in a slumped position. Maximum trunk flexion is obtained and direct stretching of the lumbosacral soft tissue structures occurs.

Full squat: William’s squat position is with the feet placed shoulder-width apart, the hip and knees are flexed to the maximum available range of motion, and the lumbar spine is rounded into flexion. Upon reaching maximum depth, the athlete “bounces the buttocks up and down” 15 to 20 times, with 2 to 3 inches of excursion on each bounce, then repeats 3 to 4 times [26].

Core stability exercises are training that includes the lumbar-iliac-thigh muscles, involving the abdominal, pelvic, lumbar, and pelvic floor muscles. These exercises affect the mechanics and neuromuscular stability of the central part of the body, which affects the function of the upper and lower limbs. Additionally, core stability training improves the strength, development, and stability of the body center, as well as the individual’s ability to keep the body’s center of mass above the level of support, and possibly improve balance. The protocol used based on Jeffrey’s proposed core stability training consisted of three levels, starting with level one and gradually progressing to level three. Level 1 exercises included static contractions in a stable position. Level two included dynamic movements performed in a stable environment. The 3-dynamic level exercises were unstable in the environment. Swiss balls were used to create an unstable environment [25].

SPSS was used for analyzing the obtained data. First, the Shapiro-Wilkes test was used to ensure the normality of the collected data. Next, Levene’s test was used to homogenize the variances ($P \geq 0.05$). Then, after confirming the linear relationship between dynamic balance and low back pain with the pretest, to control the effect of pretest and intergroup comparison in posttest by Analysis of Covariance (ANCOVA) was employed. To determine the difference between groups Tukey post hoc test was applied in SPSS. First, the Shapiro–Wilk test was used to ensure the normality of the data. After confirming no difference between groups in the pretest and the linear relationship between dynamic balance and low back pain with the pretest, to control the effect of pretest and intergroup comparison in the posttest, ANCOVA was used. To determine the difference between groups from Tukey post hoc test was applied in SPSS ($P < 0.05$).

Results

The demographic characteristics of the study participants in the study are reported in Table 1. The highest BMI concerned the central stability training group. The lowest height was respected by the control group. The Mean±SD pretest-posttest values of low back pain and the dynamic balance of the participants are presented in Table 2.

According to Table 2, in the pretest, the highest value of pain sensation and the highest score of dynamic balance belonged to the Williams training group. The lowest amount of pain in the posttest concerned the Williams training group. Furthermore, the lowest extent of dynamic balance in the posttest respected the control

Table 1. Demographic characteristics of the study participants

Groups	Mean±SD			
	BMI, kg/m ²	Weight, kg	Height, cm	Age, y
Control	25.73±3.10	69.46±6.64	155±0.07	44.53±4.80
Williams' training	25.56±2.84	72.63±7.02	160±0.06	39.13±6.31
Core stability training	26.13±8.39	73.53±8.39	158±0.06	41.15±5.24

group. According to Table 2, the value of back pain in both training groups decreased from pretest to posttest. Additionally, the dynamic balance score of the two groups improved from pretest to posttest.

The results of comparing Williams' training program and core stability on dynamic balance and low back pain are presented in Table 3.

The result of the Bonferroni post hoc test to investigate the difference between Williams training methods

Table 2. The Mean±SD pretest and posttest scores of low back pain and dynamic balance in the study participants

Parameters	Groups	Mean±SD	
		Pretest	Posttest
Back pain	Control	31.00±16.54	37.73±9.92
	Williams' training	37.73±20.40	19.86±6.12
	Core stability training	34.00±12.68	21.80±10.71
Dynamic balance	Control	92.20±6.84	83.60±8.63
	Williams' training	94.80±7.84	101.06±6.95
	Core stability training	92.50±6.84	102.00±7.84

Table 3. One-way ANCOVA data on the mean scores of posttest of dynamic balance and back pain

Source of Changes	Sum of Squares	df	F	P	Eta-Squared	Power
Per test (dynamic balance)	728.00	1	24.22	0.001	0.47	0.99
Williams-control	789.00	1	29.25	0.001	0.52	0.99
Per test (Back pain)	653.75	1	26.92	0.001	0.49	0.99
Williams-control	1109.64	1	45.70	0.001	0.62	1.00
Per test (dynamic balance)	590.12	1	12.12	0.002	0.31	0.91
Core stability-control	658.13	1	13.51	0.001	0.33	0.94
Per test (back pain)	873.77	1	11.17	0.002	0.29	0.89
Core stability-control	403.12	1	5.15	0.03	0.16	0.59
Per test (dynamic balance) group	760.28	1	25.42	0.001	0.38	0.99
	1227.44	2	20.52	0.001	0.50	1.00
Per test (back pain) group	98.95	1	16.07	0.001	0.28	0.97
	746.39	2	6.06	0.005	0.22	0.86

Table 4. Results of Tukey post hoc test in dynamic balance score and low back pain in Williams training and core stability exercise groups

Compare	Characteristic	Mean Difference	P
Williams-Core stability	Dynamic balance	15.38	0.001
	Back Pain	2.75	0.34

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and central stability on low back pain and dynamic balance is reported in [Table 3](#).

According to [Table 4](#), there was no statistically significant difference between the two training methods in the rate of low back pain; however, there was a statistically significant difference in the dynamic balance between the presented training methods.

Discussion

The current study aimed to compare the effects of a central stability training course and Williams training on dynamic balance and low back pain in women with chronic low back pain. According to the obtained information, the Williams training program and central stability presented a significant effect on the dynamic balance and recovery of chronic low back pain in the research participant. There was a significant difference between the groups participating in the pretest research and the controls, as well as between the experimental groups of Williams exercise and central stability in dynamic equilibrium. Low back pain with imbalance is so common that it can even damage the lumbar vertebrae and intervertebral discs [\[27\]](#).

Controlling and maintaining balance in dynamic and static conditions is an essential need to perform daily physical activities. Accordingly, maintaining balance is among the critical parameters in evaluating individuals with balance disorders and low back pain [\[27\]](#). Balance is a typical motor reaction in the human body that depends on the integration of the stimuli of the visual, central nervous, and inner ear systems and the muscles of the body also play an essential role in its formation and maintenance [\[27\]](#). When a subject has to maintain balance, a flood of sensory information must be integrated into the central nervous system. Moreover, the muscles are always involved according to the mechanical need to move [\[28\]](#).

Mechanisms that improve balance through exercise include increased strength and flexibility of the trunk muscles, increased muscle blood flow, and the intervertebral disc. The results obtained from the effect of exer-

cise and physical activity in the treatment of low back pain are not similar; however, most studies and therapies have focused on improving flexibility and strength, and strengthening the lumbar spine. Reports indicated that Williams and Mackenzie exercise programs affect balance, which can be beneficial for the balance of individuals with low back pain due to the involvement of lower body muscles [\[29\]](#). In the Williams movement training program, the goal is the inherent control of the spine and lumbar-pelvic area. To this end, William recommended these exercises for patients with low back and lower back pain [\[30\]](#).

During the pelvic tilt movement in the Williams exercise protocol, the abdominal muscles and by lifting the pelvis, the serine muscles come into action to create a force pair in the direction of the tilt, backward the pelvis and flattening the lumbar spine arch [\[30\]](#). According to William, in performing these two exercises simultaneously, the first goal is to straighten the arch of the spine [\[30\]](#). This is followed by movements, such as bringing the knee to the chest, incomplete sitting, stretching the muscles behind the thighs, squatting, and stretching the anterior muscles to reduce the extent of the lumbar arch [\[30\]](#).

Shields and Heiss documented that the abdominal muscles are active during incomplete sitting exercises. Even the activity of the internal and external oblique muscles of the abdomen can be detected. The involvement of these muscles controls pelvic tilt, increases abdominal muscle strength, and supports the trunk [\[31\]](#). Moving two kneeling to the chest in the Williams set of movements specifically emphasizes the stretching of the back, thigh, pelvic, and back thigh muscles. According to William, the weakness of the abdominal muscles is an essential risk factor for low back pain; thus, with incomplete sitting exercise, the abdominal muscles are strengthened and increase the strength and stability of the trunk [\[31\]](#). As strength enhances, some stretching is applied to the trunk extensor muscles during incomplete sitting exercise.

Stretching the muscles of the back of the trunk and strengthening the muscles of the front of the trunk

increases the stability of the trunk. In the stretching movement of the muscles in the back of the thigh, the Williams set of movements emphasizes the increase of muscle flexibility, especially the hamstring muscles [31]. Williams believes that the flexion of the torso and lumbar spine requires flexibility in muscles, such as the serine, hamstrings, and torso extensions where one can lift the object off the ground [31].

In the traction movement of the anterior thigh muscles, the emphasis is on stretching the muscles of the spine, thighs, pelvis, knees, hamstrings, quadriceps, back muscles of the legs, and ankles. In squatting, the goal is to strengthen the quadriceps muscle, i.e., achieved by performing the aforementioned flexible exercises [3]. Moving two kneeling to the chest in the Williams set of movements specifically emphasizes the stretching of the back, thigh, pelvic, and back thigh muscles. According to William, the weakness of the abdominal muscles is an important risk factor for low back pain. Therefore, with incomplete sitting exercise, the abdominal muscles are strengthened and increase the strength and stability of the trunk. As strength increases, some stretching is applied to the trunk extensor muscles during incomplete sitting exercise; stretching the muscles of the back of the torso and strengthening the muscles of the front of the torso increases the stability of the torso. In the stretching movement of the muscles behind the thigh, from the Williams set of movements, further emphasis is placed on increasing the flexibility of the muscles, especially the hamstring muscles. Williams believes that flexion of muscles, such as the serine, hamstring, and torso extension is required for full flexion of the torso and lumbar spine [32].

Accordingly, an individual can lift the object off the ground. In the exercise of stretching the anterior thigh muscles, the emphasis is on stretching the muscles of the spine, thighs, pelvis, knees, hamstrings, quadriceps, back muscles of the legs, and ankles. In squatting, the goal is to strengthen the quadriceps muscle, i.e., achieved by performing the aforementioned flexible exercises [32].

By performing a set of Williams's movements and achieving the stated goals, pain and disability in patients with low back pain will be reduced. The present study data specifically signified the beneficial effects of this exercise method in reducing pain and increasing the efficiency of women with chronic low back pain. This point has been mentioned in other research studies. Komantakis et al. stated that general training increases strength and thus increases performance [33]. Elnaggar et al. determined a greater increase in spinal mobility in flexor exercises, compared to extensor exercises [34].

By performing Williams flexion exercises, increasing the strength and flexibility gained may have been effective in improving low back pain and function in women with chronic low back pain. Donelson et al., in their study of patients with low back and lower back pain, found that pain became central in 87% of patients after exercise. In other words, after exercising, the pain is concentrated from the lower extremities to the lower back. The centralization of pain is a sign of improvement and the effect of exercise. He considers the centralization of pain as a sign of a good prognosis and the lack of need for surgery. Besides, if the pain is not centralized, surgery is required [35]. Snook et al. also revealed that flexural exercise can reduce and centralize low back pain [36]. Furthermore, conducting Williams's movements improves posture, especially the lumbar arch, and can improve back pain and centralize pain [37].

Williams exercise has been touted as a treatment program to increase balance. Although the association of low back pain with leg problems and balance seems far-fetched, recognizing that each leg component plays a role in body balance, and balance is directly related to muscle cooperation [37]. Therefore, any changes in the components of the leg and imbalance in the body can somehow affect the forces acting on the muscles and cause a change in the muscles, and a change in the muscles involved in the balance is among these changes [37]. Williams' training program could increase the strength of the lumbar stabilizing muscles by affecting the muscles involved in balance. Moreover, this type of exercise program could probably prevent the deviation of the center of gravity out of the level of reliance and reduce the dynamic balance by strengthening the central and small muscles connected to the spine. The lack of core stability of the spine is a contributing factor to low back pain [38].

Core stability exercises are essential components in maximizing balance and function in individuals with low back pain in upper and lower limb movements. Maintaining balance creates a complex interaction between internal characteristics (sensory sense, auditory sense, & vision) and muscular factors [38]. These markers interact with the neural network and motor feedback [38]. The factors affecting the maintenance of natural balance are summarized as follows: A- Sufficient strength in the muscles of the lower limbs and trunk to maintain an upright position; B- Situational sensitivity to the transmission of information about the situation; C- Receiving natural impulses from the atrial labyrinth about the condition of the body; D. The normal functioning of the central coordinating mechanism, the main part of which is located in the cer-

ebellar vermis; E- The activity of higher centers involved in the voluntary maintenance of the situation. These 5 parts play a major role in maintaining balance [39].

Core stability exercises further focus on the small, deep, and posterior muscles of the spine and try to maintain and stabilize the correct body position by re-examining and increasing the strength and endurance of these muscles; they also play a role in improving low back pain by stabilizing the spinal [40].

Core stability exercises are a major part of rehabilitation programs for individuals with low back pain. Therefore, the role of some trunk muscles in the stability of the lumbar region has been proven. Research revealed that in individuals with a history of low back pain, the pain is associated with weakness of the transverse abdominal and lumbar muscles [41]. McGill argued that performing strength, flexibility, and endurance exercises increases the odds of spinal stability; thus, it improves balance and reduces the risk of injury [10]. Frank et al. compared central stability training and general training and concluded that both training methods improved low back pain [42].

Hesari et al. explored the effect of 8 weeks of central stability exercises on balance, a dynamic balance was significantly increased as a result of central stability exercises in four directions (internal, internal posterior, posterior external) [43]. According to the contents, the muscles of the central region of the body may provide a stable level of movement for the body by producing more inertia against the turbulence of the body, and the muscles of the central region of the body, including the transverse abdominal muscle, internal and external oblique, and lumbar muscles integrated. They have acted as a coordinated structure to ensure the stability of the spine, thus providing a strong level of support for body movements [43]. When the transverse abdominal muscle contracts, the internal oblique muscle pressure increases, causing the lumbar dorsal nodule to tighten. These contractions occur from the beginning of the movement of the limbs to allow the limbs to have a stable surface for movement and muscle activation. Furthermore, the right abdominal muscle and the oblique abdominal muscles are activated in specific patterns to the movement of the limb that provides the support of the stature [43].

However, the results of Piegato [44] and Sato and Mocha [45] were inconsistent with those of this study. The central stability training program with the mechanism presented above could strengthen the muscles effective in maintaining and stabilizing the pelvis and back. It could

also stimulate the deep muscles of this area of the body while facilitating the recall process and the integration of systems involved in balance, improving the dynamic balance of the participants in this training program.

Considering the mechanism of the effect of core stability training programs on strengthening and stabilizing the muscles supporting the spine and stimulating these muscles, performing a core stability training program seemed to have resulted in strengthening and interaction of the muscular system with other systems involved in balance. It has prevented pressure on the lumbar vertebrae or at least could reduce the pressure on the nervous system and reduce the irritability of the lumbar nerves to transmit the pain message. Furthermore, individuals' participation in this exercise program may have increased the feeling of vitality and happiness. Moreover, following various central stability programs might increase body temperature and blood flow, followed by stimulating the release of hormones, such as dopamine and serotonin. It sends pain messages to the brain and its processing is, therefore, reduced. There was no statistically significant difference between Williams training and central stability methods in the rate of improvement of the study participants' low back pain. However, there was a statistically significant difference in dynamic balance.

Considering that both training methods presented a significant effect on the recovery rate of low back pain and the proximity of the mean posttest of the two groups in the recovery rate of low back pain, it seems that both training groups were in one direction. This difference has occurred and this has caused no statistically significant difference between the experimental groups. Possibly, these two training methods could reduce the extent of pressure on the neural circuits that trigger back pain in the same proportion; consequently, the rate of improvement was very close in the experimental groups. Additionally, strengthening the lumbar-pelvic muscles and anti-gravity muscles, and increasing the release of hormones, such as serotonin and dopamine, has reduced the extent of pain.

Considering the pretest and posttest scores of the training groups in dynamic balance, it was found that the effectiveness of the core stability training program was greater than the Williams movement training program. The core stability program has axial muscles and supports the spine and pelvis in its effectiveness. Moreover, the mechanism of action of this type of exercise program is mentioned in the above discussions. Accordingly, it could perform better on this group of muscles. Additionally, this exercise program affects most of the

anti-gravity muscles; therefore, it could further improve the dynamic balance of the participants, compared to Williams' exercise program, which focuses on flexor movements of the trunk. This exercise program might have also caused the systems involved in balance to pay more attention to the information sent from the deep receptors and the inner ear; with this approach, the study participants presented a better performance in dynamic balance without consciously paying attention to the movement.

The lack of control over physiological characteristics (menstruation period) of individuals as well as the lack of control over nutrition and side physical activity were among the study limitations.

Conclusion

The present study data revealed that core stability training and the Williams method significantly impacted the rate of recovery of chronic low back pain and dynamic balance of the study participants. There was a difference between the training methods in dynamic balance and the effect of the core stability training program was greater. In contrast, there was no statistically significant difference between the training methods in improving low back pain. According to the reported findings, the implementation of these training methods to improve and reduce pain and increase the dynamic balance of women with chronic low back pain are recommended; considering the low cost and ability to perform in a minimum of space without the need for special facilities. Furthermore, the effectiveness of the core stability training program was greater in dynamic balance; thus, using this training program and its special charms and the development of lumbar-pelvic muscle strength and endurance for the target community are recommended.

Ethical Considerations

Compliance with ethical guidelines

All research processes and methods was approved by the Institutional Review Board of Islamic Azad University Najafabad branch.

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Authors' contributions

All authors equally contributed to preparing this article.

Conflict of interest

The authors declared no conflict of interest

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