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The Effect of 8 Weeks of Barreausol Exercises on the Range of Motion, Muscular Strength, and lumbar lordosis Angle of female students

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Abstract

Background and purpose: Barasoul is a rhythmic, strength, endurance, and stretching exercise that enhances neuromuscular coordination and exercises consist of movements that are continuously performed on opposing muscle groups, engaging all involved muscles. Therefore, the aim of the present study is to investigate the effects of 8 weeks of Barreausol exercises on the range of motion, muscular strength, and lumbar lordosis angle in female students aged 15-17 years.

Materials and methods: This semi-experimental research utilized a pre-test/post-test design with 20 female students diagnosed with lumbar lordosis, divided into two experimental groups. The selection of participants was conducted randomly and observationally. The specialized training program was designed based on previous studies, lasting 8 weeks, with three sessions per week, each lasting 60 minutes under the supervision of an examiner. To measure the lordosis angle, a flexible ruler was used; the abdominal muscle strength was assessed using the sit-up test; the range of motion and flexibility of the lumbar spine were evaluated through the sit and reach test.

Results: The range of motion before the test was (28.5), and after the Barreausol exercises, it was (39.1), indicating a significant effect of the exercises. The muscle strength before the test was (22.50), and after the Barreausol exercises, it was (34.97), which also showed a significant effect of the exercises (P<0.001). The lordosis angle in the experimental group before the test was (50.30), and after the Barreausol exercises, it significantly decreased to (39.10) (P<0.001), while no significant difference was observed in the control group.

Conclusion: The results indicated that the range of motion in the lumbar region, as well as the rectus abdominis muscles, significantly increased after eight weeks of Barreausol exercises. Its strength component is attributed to the inclusion of both isometric and isotonic muscle contractions, as well as the activation of anti-gravity muscles.Additionally, the lumbar lordosis angle in the participants showed a significant decrease in the post-test.

Keywords: Barreausol, Muscle Strength, Lordosis, Range of Motion

Introduction

The human spine forms the central axis of the torso and plays a critical role, not only by protecting the spinal cord but also in facilitating movement. Any damage or deformity in the spine can disrupt bodily functions. Since various segments of the spine are interconnected through the vertebral system, a change in one region can trigger a chain reaction affecting other regions. For instance, in a chain reaction, posterior pelvic tilt can sequentially lead to a reduction in lumbar lordosis, an increase in thoracic kyphosis, and ultimately, forward head posture (1, 2).

Janda highlighted the reciprocal relationship between the skeletal-muscular and nervous systems to better understand upper quarter dysfunctions. He noted that any defect or disorder in one joint or muscle could impact the quality and functionality of other joints and muscles (3). In essence, dysfunction in one area, followed by changes in its joints and muscles, can propagate through a chain reaction, influencing other parts of the body. These chain reactions can be categorized into three types: joint-related, muscular, and neurological. Notably, these three systems interact and are not independent. Changes in the primary chain may lead to disorders in the secondary chain and vice versa (3).

Muscle imbalances arise due to factors such as postural stresses, excessive loading, repetitive movements, weakness in deep core muscles, impaired neuromuscular control, inactivity, or incomplete recovery of tissues after activity. These imbalances lead to overuse, improper joint loading, altered movement patterns, repeated microtrauma, functional disorders, and chronic injuries (4-6).

The natural alignment of the lumbar spine includes a curve. An excessive increase in this curve is termed lordosis. Due to the connection between the pelvis and the lumbar vertebrae via the sacrum, any alteration in pelvic position influences the curvature of the spine, particularly the lumbar region. Specifically, anterior or downward pelvic tilt increases lumbar curvature, while posterior or upward tilt decreases it (7). Research and investigations indicate the presence of postural abnormalities in various individuals, though these deformities are usually mild and can be corrected through a series of simple exercises(7،8).

In this study, Barre exercises were utilized to improve muscle performance. Previous studies often employed corrective exercises alone, providing limited and unreliable evidence regarding their effectiveness on postural deformities of the spine. Therefore, this research incorporates Barre exercises, which adapt standing ballet movements to a horizontal or floor-based position. Barre exercises involve continuous engagement of opposing muscle groups, engaging all muscles in the workout. These exercises promote body shaping, size reduction, and, in some cases, serve as a substitute for physiotherapy.

Barre is a rhythmic, strength-based, endurance, and stretching workout that enhances neuromuscular coordination. Its strength-building aspect stems from incorporating isometric and isotonic muscle contractions as well as engagement of anti-gravity muscles. Additionally, the exercises are designed to align with proper biomechanics, ensuring that correct execution does not harm the musculoskeletal structure and can even replace some physiotherapy movements. The primary focus of these exercises is on the lower back and lower body, emphasizing consistent strength and stretching movements targeting adductor and abductor muscles (8). Therefore, familiarity with corrective exercise science appears essential for individuals with physical abnormalities or postural deformities. Corrective exercises, after a thorough assessment and identification of the causes and contributing factors of different postural deviations—preferably diagnosed by specialists in corrective exercise and movement therapy—are prescribed to individuals with physical and postural weaknesses for correction, prevention, and treatment.

Considering previous studies have reported limitations such as insufficient training duration, lack of variety in corrective exercises, absence of combined stretching and strengthening exercises, and inadequate supervision of corrective programs, many prior studies have also localized their corrective exercise interventions, potentially reducing their overall effectiveness.

Given the increasing importance of preventing and managing musculoskeletal disorders in the country and the undeniable role of exercise in fostering recovery and control of these issues, this study aims to evaluate the effects of Barre exercises. If proven effective, this novel training method could be introduced as an appropriate corrective approach for addressing certain postural problems.

The primary aim of this research is to assess the impact of an 8-week Barre training program on the range of motion, muscular strength, and lumbar lordosis angle in female students aged 15-17. Based on this, the researcher posits the following hypotheses:Does the Barre training method improve the lumbar lordosis angle in students?Does the Barre training method enhance muscular strength in students?Does the Barre training method increase the range of motion in students?

The results of this study could not only contribute to the rehabilitation and treatment of individuals with lordosis but also support its use as a preventive measure against pain and postural deformities.

Materials and Methods

This semi-experimental study employed a pretest-posttest design. The study population included 20 adolescent girls diagnosed with lumbar lordosis. Sample size determination was based on similar prior studies and statistical formulas (9). A confidence level of 95% and a test power of 80% were considered (10).

Participants were purposefully selected from high school students aged 15 to 17 years in Khomeinishahr and randomly divided into two groups. The angle of lordosis was assessed using a flexible ruler, and participants were randomly assigned to groups using a simple randomization method (lottery). The control group (age: 16.4 ± 1.02 years, height: 1.60 ± 0.25 m, weight: 63 ± 5.5 kg) and the experimental group (age: 16.9 ± 1.2 years, height: 1.60 ± 0.52 m, weight: 60.1 ± 9.9 kg) voluntarily participated in the study. Inclusion criteria included willingness to participate in the study, absence of musculoskeletal disorders, no history of limb abnormalities, cardiovascular diseases, or contagious diseases such as certain skin conditions, age range of 15-17 years, and female gender. Exclusion criteria included pathological symptoms related to previous fractures, surgeries, or joint diseases of the spine, irregular attendance in training sessions, failure to complete study assessments, congenital abnormalities, and inability to complete the intervention program.

Before the formal participation, candidates underwent verbal interviews to ensure activity levels and willingness to participate. Written consent and a personal information questionnaire were then distributed, and participants were familiarized with the study design, training protocols, and measurement methods. General information and personal characteristics were recorded using a questionnaire, and participants' weight and height were measured. Missing two consecutive training sessions or a total of three sessions led to exclusion from the study. Similarly, any fractures or neuromuscular complications during the study resulted in removal.

It is noteworthy that the inclusion and exclusion criteria were determined through self-reporting by the research participants, parental inquiries, and, when available, a review of their medical records. Subsequently, physical examinations were conducted to assess the presence of postural abnormalities. These examinations were performed by two examiners who were proficient in assessment methods (including the grid method and landmark identification) and were graduates in sports injury rehabilitation and corrective exercise.

Measurement of Lumbar Lordosis Angle

A flexible ruler was used to measure the lumbar lordosis angle. Two reference points, the 12th thoracic vertebra (T12) and the 2nd sacral vertebra (S2), were identified. Participants stood naturally without upper body garments in a relaxed posture. T12 was located as previously described, while S2 was determined at the level of dimples overlying the posterior superior iliac spine (PSIS). The flexible ruler was aligned with the lumbar curve, ensuring no gap between the ruler and the skin. The curvature was traced onto an A3 paper, and the angle of lordosis was calculated using trigonometric formulas based on measured length (L) and height (H) (11).

Evaluation of Abdominal Muscle Strength

Abdominal muscle strength was assessed with participants lying supine, knees bent, and feet flat on the ground. Hands were crossed over the chest, and a partner held the feet steady. The number of sit-ups performed within one minute was recorded (12).

Range of Motion Assessment

The flexibility of the lumbar spine was measured using the sit-and-reach test (13).

Training Program Protocol

The training program lasted 8 weeks, with three sessions per week. Initial instructions and clarifications were provided, emphasizing that missing two consecutive sessions or a total of three sessions would lead to exclusion. The program focused on correcting lumbar lordosis by stretching the hip flexors and lumbar extensors while strengthening abdominal and hip extensor muscles. Sessions lasted 30-60 minutes, supervised by the investigator (Table 1).

Exercises progressed from simple to complex, considering participants' abilities. Training principles, including intensity, gradual progression, duration, and overload, were incorporated. Early sessions included simpler exercises with lower intensity and fewer repetitions, while subsequent sessions gradually increased difficulty and intensity.

Each session began and ended with 5-10 minutes of warm-up and cool-down exercises.

Table 1: Training Protocol

Exercise Name	Description
Upper Body Stretch	Sitting cross-legged, leaning forward, stretching arms and upper body.
Abdominal Contraction	Sitting cross-legged, contracting the abdomen with forward-stretched arms.
Leg Side Opening	Sitting while holding feet, rotating and opening legs to the sides.
Hip and Knee Flexion	Supine position, hip and knee flexion with single or double leg movements.
L Movement	Supine position, hip flexion with dynamic and static stretches of hip flexors.
Knee to Chest	Supine, abdominal contraction, and knee flexion towards the chest.
Four-Count Crunch	Supine position, alternating between sit-ups and lower back flexion.
Two-Count Crunch	Standard sit-ups with a 4-second pause.
Camel-Cat Stretch	On hands and knees, alternating between arching and hollowing the back.
Single-Leg Camel-Cat	Similar to Camel-Cat but with single-leg movement, including PNF technique.
Hip Extensor Stretch	On hands and knees, extending one leg upwards.
Back Plank	Prone position, lifting abdomen and lower back off the ground.
Side Plank	Lying sideways, lifting abdomen and lower back off the ground.

Results

For data analysis, statistical methods were used at two levels: descriptive and inferential. Regarding the changes in lordosis, descriptive statistics (mean and standard deviation) were used, and inferential statistics (ANOVA test) was applied. Data analysis was conducted using SPSS version 25, and a confidence level of 0.05 ($P < 0.05$) was considered.

Table 2: Physical and Physiological Characteristics of the Participants

Statistic	Group	Number	Age (Years)	Height (m)	Weight (kg)
	Barassel	10	16.3 ± 1.62	1.26 ± 0.61	67.59 ± 10.2
	Control	10	16.6 ± 0.67	1.59 ± 0.69	61.27 ± 11.6

The results of the ANOVA test showed that the range of motion in the lumbar spine in 15-17-year-old female students improved significantly over the eight-week Barassel exercise program (P = 0.001).

This table(3) shows that there were significant differences between the groups during two rounds of testing ($P \leq 0.05$). It is important to note that in ANOVA for repeated measures, the means of pre- and post-test scores are compared. A summary of the changes in within-group and between-group static balance is shown in Figure 4-1.

Table 3: Between-group Comparison Results

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F Value	Significance
Intersection	273.13	1	273.13	338.6	0.001
Group	526.3	1	526.3	6.5	0.019
Error	1613.2	25	50.65		

Table 4: Results of ANOVA with within subject (range of motion)

Group	Number	Pre-test	Post-test
Barassel	10	28.5±0.77	39.1±0.66
Control	10	25.8±0.29	25.6±0.59

The initial range of motion of the lumbar spine in both groups is similar. In repeated measures ANOVA, the most important action is comparing the slope of the change lines of the research groups. In Figure 1, it is clearly observed that the slope of the control group's line is completely different from the experimental group, with a significant difference (P = 0.001, F = 53.8 for degrees 1 and 25). Statistically, it is said that the two groups have an interaction. As seen, in the post-test, the control group clearly has lower records. Generally, in the post-test, the slope of the line in the control group remains almost constant, while in the experimental group, in contrast to the control group, it improves significantly. These changes result in a complete differentiation between the two groups in terms of the lumbar spine range of motion.

Table 5: Results of ANOVA with within subject (abdominal muscle strength)

Group	Number	Pre-test	Post-test
Barassel	10	22.5±1.71	34.0±1.62
Control	10	25.4±1.23	25.6±1.51

The results of the ANOVA test showed that the abdominal muscle strength in 15-17-year-old female students significantly improved over the eight-week Barassel exercise program (P = 0.001).

The results of the statistical analysis of within-group effects were significant (P = 0.001, F = 27.1 for degrees 1 and 25). In the between-group comparison, the pre- and post-test mean scores of the experimental group were compared with the pre- and post-test mean scores of the control group. The results of the between-group analysis were not significant (P = 0.5, F = 0.43 for degrees 1 and 25).

In the interaction comparison, the within-group changes for each group were considered separately, and more clearly, the slope of the change lines between the two groups was compared. For abdominal muscle strength, the interaction or pattern of changes within the experimental and control groups was significantly different (P = 0.001, F = 25.3 for degrees 1 and 25).

Table 6: Results of ANOVA with within subject (angle of lordosis)

Group	Number	Pre-test	Post-test
Barassel	10	50.3±1.35	39.1±1.42
Control	10	46.9±1.12	47.0±1.18

The angle of lordosis in female students aged 15-17 improved significantly during the eight-week Barasell exercise program (P = 0.001).

For this variable, all three effects were significant: within-group effects (P = 0.00, F = 60.4), between-group effects (P = 0.001, F = 22.1), and interaction effects (P = 0.001, F = 60.3). The significant interaction between the groups indicates that the changes were significantly in favor of the experimental group, with differences observed between the two groups. As shown in Figure 5, the slope of the line in the exercise group is different and increasing, meaning that the experimental group showed significant changes in the post-test compared to the pre-test, in contrast to the control group.

Discussion

The present study aimed to evaluate the impact of the Barasell exercise program on spinal range of motion, abdominal and gluteus strength, and lumbar lordosis angle in female students aged 15-17. The results of this study showed a significant increase in range of motion, abdominal muscle strength, and gluteus strength in the experimental group following the exercise program, while no significant changes were observed in the control group. Additionally, the lumbar lordosis angle significantly decreased in the experimental group, while no significant change was observed in the control group. These findings confirm the effect of the Barasell exercise program on range of motion, muscle strength, and lumbar lordosis angle.

The findings of the present study indicated that the Barasell exercises, which were performed three times a week for 8 weeks, each session lasting about one hour on mats, had a significant effect on the range of motion of the subjects. Based on the findings, it can be concluded that 8 weeks of Barasell exercises significantly improved range of motion. In a study by Amini et al. (2019), it was shown that Barasell and Pilates exercises could improve the quality of life in women with chronic low back pain, thus potentially being recommended as a useful modality for rehabilitation and enhancing the quality of life for women with chronic low back pain (14).

Mirzaei et al. (2017) found that Barasell exercises were effective on the spinal alignment of female students (15). Afravandeh et al. (2016) concluded that both traditional corrective exercises and Pilates can be used effectively to treat lumbar lordosis, with no significant advantage of one over the other. Both methods increase the flexibility of back muscles and the quadriceps and strengthen the abdominal and hamstring muscles to correct this anomaly (13). In a study by Saraj et al. (2012), the effects of Barasell exercises on body composition and flexibility were examined. The results showed that Barasell exercises did not significantly affect body composition in non-athletic women, but had a significant effect on improving range of motion (7).

The results of this study are not consistent with those of Pereira et al. (2012). The discrepancy between the findings of the present study and those of Pereira et al. could be attributed to differences in participant age, number of intervention sessions, and the sample size (16).

Barasell exercise gently and painlessly improves spinal flexibility as the movements are based on body physiology. When performed on the floor, gravity does not put pressure on the back. It protects the back while strengthening its muscles. Arm movements (such as raising the hands) stretch the body, strengthening the back and arms. The method used in this study is Barasell, which involves transitioning movements from a standing to a horizontal position on the floor, performed in a stretching manner in seated, supine, or prone positions. This increases flexibility, especially in the lower body muscle groups. Barasell can be effective for the following reasons: it gently and painlessly increases spinal flexibility, as the movements are based on body physiology, and gravity does not exert pressure on the back. The main focus of Barasell exercise is on the abdomen, sides, and thighs, greatly helping to strengthen the muscles in these areas (17). Barasell exercises, focusing on the back and lower body muscles, improve neuromuscular coordination and, when performed in proper biomechanics, help prevent injury to the musculoskeletal structures (7, 8).

The spinal column is the body's axis, providing two major mechanical needs: strength and flexibility. Its strength is provided by the muscles and ligaments of the region, while its flexibility is due to the slight movements in each vertebra, which collectively enable larger movements. Mobility and flexibility of the soft tissues around joints are important in preventing injury or re-injury of soft tissues. Adequate joint movement is necessary to achieve the required flexibility. A deficiency or excess in flexibility can lead to stiffness and instability in movable parts, affecting posture and alignment (18).

Bone structure may limit the final movement range of a joint. Fat may also limit the ability of a joint to move through its full range. A person with excessive abdominal fat may face significant limitations when attempting to bend forward and touch their toes. Fat can also act as a barrier between the lever arms, restricting their movement during the motion. Muscles, tendons, and their surrounding fasciae often limit the range of motion. Stretching exercises aim to enhance the extraordinary elasticity of a muscle. These exercises can increase the extensibility or length a muscle can stretch. The connective tissues around joints, such as the ligaments in the joint capsule, can resist muscle stretching. Although ligaments and joint capsules are somewhat elastic, if a joint remains immobile for a period, these structures lose some of their elasticity and effectively shorten. Barasell exercises, which combine ballet moves, are more effectively performed on the floor. These exercises not only reduce body size but also improve spinal alignment, helping to alleviate many bone issues, including upper limb pain. Additionally, these exercises have positive effects on soft tissues and muscles. Given the factors mentioned, the effect of these exercises on the natural range of motion seems plausible and explainable. One factor influencing the reduction in lumbar curvature is the strengthening of weak muscles. Studies have shown that weakness in the gluteal and abdominal muscles contributes to the development of lumbar lordosis. The significant improvement in the strength of these muscles, as discussed in the previous hypothesis, can be linked to the reduction in lumbar curvature. Muscle strength is the ability that increases the overall capability of the body. Muscle strength plays a role in maintaining balance and posture. In some cases, increasing muscle strength can reduce the risk of injury, improve posture, enhance physical performance, and improve body composition. One of the potential mechanisms for muscle degeneration in adulthood is participating in general training programs such as Pilates or Barasell exercises (19).

Limitations of the present study include the small sample size, all participants being from one city, and the lack of control over psychological factors. Future studies are needed to examine the impact of these exercises with different protocols, duration, and frequency on other participants to reach more comprehensive conclusions about the use of corrective exercises in combination with other therapeutic interventions.

Conclusion

Based on the obtained results, it can be concluded that Barasell exercises are effective in improving the strength of the abdominal and enhancing the flexibility of the lumbar vertebrae. Furthermore, performing these exercises leads to a reduction in the lumbar lordosis angle, which helps prevent postural abnormalities. Additionally, by improving lumbar lordosis, these exercises can prevent chronic back pain in later ages. Barasell exercises are a new form of training that can be used to improve physical fitness factors such as flexibility, strength, and endurance in students. Moreover, when performed correctly, these exercises do not cause any harm to the musculoskeletal structure. Besides addressing physical issues, these exercises may also help alleviate some of the psychological and emotional problems that students face.

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