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The effects of an 8-week Pilates program on physical fitness and spinal posture in adult women

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This study analyzed the effects of an 8-week Pilates exercise program on health-related physical fitness and spinal morphology in female college students. As a result of performing 8 weeks of Pilates exercise program, there was a significant difference in flexibility and muscular endurance in the experimental group. In addition, there was a significant difference in lateral deviation after performing 8 weeks of Pilates exercise program. Therefore, it is expected that consistent participation in Pilates exercise will lead to improvements in flexibility, endurance, and lateral deviation. Pilates requires professional and systematic theoretical establishment, and therefore, future research requires more specific qualitative studies on Pilates exercise.

Keywords: Pilates exercise, Flexibility, Muscular endurance, Lateral deviation

INTRODUCTION

Modern society has reduced exercise, leading to poor posture in many people. A closer look reveals a significant number of people with hunched posture, uneven shoulder height, and asymmetrical posture. Prolonged posture can damage bones, cartilage, and ligaments in areas where weight is concentrated, causing pain. Muscle tension can also worsen posture. Repeated lifestyle habits can lead to complications such as spinal problems and knee or ankle joint problems. Furthermore, spinal deformities are the most common orthopedic deformity in children and adolescents (Dayer et al., 2013; Trobisch et al., 2010).

Pilates exercise was invented by Joseph Hubertus Pilates. The characteristic of this exercise is that it strengthens and softens all the muscles deep inside the body that are necessary for smooth movement of the body, and it is very effective in rehabilitation treatment (de Oliveira et al., 2019; Fernández-Rodríguez et al., 2022). It is a flexible and balanced exercise, corrects bad posture, and is very effective in rehabilitation treatment. In addition, it is an effective exercise that maintains the body's balance and improves control by focusing on exercising the three abdominal muscles that support the spine and pelvis. In particular, it is an exercise that focuses on strengthening the abdomen so that it can support the lumbar region, thighs, and spine without straining the body, and is effective even for adults who have difficulty with strenuous exercise (de Oliveira et al., 2019; Fernández-Rodríguez et al., 2022). Pilates is a mind-body workout that focuses on strength, core stability, flexibility, muscle control, posture, and breathing (Wells et al., 2012). Most clinical trials using Pilates as a rehabilitation tool have shown that it is effective in achieving desired outcomes, particularly in reducing pain and disability (Byrnes et al., 2018).

Although most exercise interventions were effective in managing pain and disability in patients with chronic low back pain, the most effective program was Pilates (Fernández-Rodríguez et al., 2022). People who have been trained in Pilates appear to be better able to contract the transverse abdominis and maintain lumbosacral stability than those who do regular abdominal curls or no abdominal exercises at all (Herrington and Davies, 2005). Strength training for older adults can prevent functional decline, and Pilates exercises, which focus on proper body mechanics and posture, can improve safety (Mallery et al., 2003).

Maintaining proper muscle strength is crucial for maintaining

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proper posture. Previous studies examining the effects of Pilates on the body have reported that Pilates is effective in improving body composition, flexibility, and muscle strength (Herrington and Davies, 2005; Mallery et al., 2003; Segal et al., 2004). A representative disease of lateral deviation of the spine is scoliosis, and the possibility that exercise can correct scoliosis has been suggested (Kim, 2022). Existing research on spinal morphology changes through Pilates exercise is lacking. Therefore, this study aimed to investigate the effects of 8 weeks of Pilates exercise on physical health and spinal changes, thereby providing basic data on these changes.

MATERIALS AND METHODS

Study subjects

The study included 14 female college students who expressed interest in participating in a Pilates exercise program. Prior to the experiment, the subjects received a thorough explanation of the study's purpose and procedures and signed a consent form. This study was approved by Eulji University, and the approval number is 2025-3-17.

Measurement items

Strength (abdominal strength)

Using a digital abdominal dynamometer, stand with your feet apart for approximately one second, grasp the handles, tilt your upper body forward 30°, and slowly and forcefully pull the abdominal dynamometer handle. The test was performed twice, measuring in 0.1-kg increments. The best result was recorded.

Flexibility (front flexion)

Flexibility was measured by sitting and bending forward. Sit with your legs together, heels together, and hands together to push the dial forward. Read the number on the dial at the point where you can no longer push. Do not bend your knees. Hold the bend as far forward as possible for 3 sec, and then measure your force in centimeters.

Muscular endurance (sit-ups)

Muscular endurance was measured with modified sit-ups. The subject was asked to lie down, knees straight, and hands clasped behind the head. One repetition was recorded: raising the upper body from the supine position, bringing the elbows to the knees, then the shoulders to the ground, and then returning to the prone position. Movements involving both hands or bouncing were excluded from the recording. The number of sit-ups completed in 60 sec was recorded.

Three dimensions spinal scan

The spinal scan utilized three dimensions imaging equipment to calculate posture, spinal deformation, vertebral rotation angle, pelvic condition, and pelvic torsion. After removing their upper clothing, the subject stood on a simulation platform, facing the camera with their back straight, legs extended, and their arms relaxed. Measurements were taken with the sacrum point visible. The capture time was 0.04 sec, and the images were analyzed automatically.

Pilates exercise

Pilates exercise was performed twice a week for 60 min. The intensity was divided into stages: stage 1 (2 weeks), stage 2 (3 weeks), and stage 3 (3 weeks), for a total of 8 weeks.

Data analysis

Descriptive statistics (mean±standard error) were calculated using SPSS ver. 12.0 (SPSS Inc., Chicago, IL, USA) for the data collected through the experiment. A large-sample *t*-test was conducted to compare the mean values before and after the 8-week Pilates exercise program. All statistical significance levels were set at $P < 0.05$.

RESULTS

The results of an analysis of changes in muscle strength (abdominal strength), flexibility, and muscular endurance following an 8-week Pilates exercise program are shown in Table 1.

The control group showed no significant difference in muscle strength before and after the Pilates exercise program, while the experimental group showed no significant difference before and after the Pilates exercise program. The control group showed no significant difference in flexibility before and after the Pilates exercise program, but the experimental group showed a significant increase after the Pilates exercise program ($P < 0.01$). The control group showed no significant difference in muscular endurance before and after the Pilates exercise program, but the experimental group showed a significant increase after the Pilates exercise program ($P < 0.01$).

As a result of comparing the differences in trunk inclination, the control group showed no significant difference from pretest (8.42°±5.22°) to posttest (13.71°±9.97°), and the experimental

Table 1. Changes of physical fitness

Variable	Group	Pre-exercise	Postexercise	*P*-value
Strength (abdominal strength) (kg)	Control	55.55±7.85	53.28±7.28	0.287
	Experimental	53.64±9.46	56.75±5.81	0.529
Flexibility (front flexion) (cm)	Control	13.06±12.80	14.67±9.84	0.407
	Experimental	10.55±7.54	16.95±6.62	0.006
Muscular endurance (sit-ups) (n)	Control	24.42±1.93	24.14±2.54	0.840
	Experimental	22.00±6.40	31.00±7.68	0.008

Values are presented as mean±standard deviation.

Table 2. Lateral deviation

Variable	Group	Pre-exercise	Postexercise	*P*-value
Lateral deviation (°)	Control	2.85±1.67	5.00±4.39	0.251
	Experimental	2.14±0.69	3.85±1.21	0.017

Values are presented as mean±standard deviation.

group showed no significant difference from pretest (11.00°±8.40°) to posttest (16.42°±18.28°). As a result of comparing the differences in pelvic tilt, the control group showed no significant difference from pretest (4.00°±3.10°) to posttest (2.42°±2.07°), and the experimental group showed no significant difference from pretest (7.85°±3.43°) to posttest (8.28°±6.21°). As a result of comparing the differences in pelvic rotation (pelvis torsion), the control group showed no significant difference from pretest (2.00°±0.91°) to posttest (1.71°±1.38°), and the experimental group showed no significant difference from pretest (2.57°±1.61°) to posttest (1.71°±0.76°). As a result of comparing the differences in lateral deviation, the control group showed no significant difference before and after Pilates exercise program, while the experimental group showed a significant difference after Pilates exercise program ($P<0.05$) (Table 2). As a result of comparing the difference in the posterior angle, the control group showed no significant difference from the pretest (30.42°±6.82°) to the posttest (32.71°±4.49°), and the experimental group showed no significant difference from the pretest (35.14°±7.98°) to the posttest (37.85°±10.68°). As a result of comparing the difference in the anterior angle, the control group showed no significant difference from the pretest (31.28°±5.76°) to the posttest (32.00°±5.85°), and the experimental group showed no significant difference from the pretest (33.14°±3.80°) to the posttest (37.00°±9.52°).

DISCUSSION

Pilates began with posture correction, but it also uses a lot of static muscle strength to perform movements, and is performed while sitting or lying down. Most movements are performed centered on the spine, and it is an exercise that stimulates and strengthens the upper limbs and lumbar muscles, as well as the erector spinae, to maintain posture during movements (Byrnes et al., 2018; Wells et al., 2012). These Pilates exercises are important as a treatment because they align and balance the imbalances of the body, and always consider the curvature of the spine, the balance of the head, upper and lower body weight (Byrnes et al., 2018; Wells et al., 2012). Segal et al. (2004) reported that Pilates training may help improve flexibility, but its effects on body composition, health status, and posture are limited, and its effectiveness may be difficult to prove. Although both Pilates and aerobic exercise have the potential to reduce pain and, consequently, improve balance and function in older adults with chronic low back pain, Pilates may be more effective because it targets the trunk stabilizing muscles more intensively (de Oliveira et al., 2019).

Scoliosis in children over school age primarily affects girls, and the goal of treatment in children is to prevent progression. Treatment for adult scoliosis is determined by the individual patient's condition, with physical therapy and braces playing a relatively supportive role. For adults (including the elderly) with scoliosis and sagittal imbalance, surgical treatment may be the most effective option (Trobisch et al., 2010). Although patients with scoliosis are often asymptomatic, the resulting abnormalities of the spinal surface can negatively impact adolescent patients, and the increasing spinal curvature can pose health risks in adulthood (Sud and Tsirikos, 2013). Despite numerous potential etiologies for idiopathic scoliosis, the primary etiology of adolescent idiopathic scoliosis remains unknown. Beyond identifying the etiology, iden-

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tifying prognostic factors for adolescent idiopathic scoliosis progression is expected to be increasingly important in clinical practice. This could reduce treatment costs associated with repeated radiation exposure, unnecessary bracing, psychological issues, and follow-up care in low-risk patients (Dayer et al., 2013).

Conservative treatment for adolescent idiopathic scoliosis (CONTRAIS), which included physical therapy, exercise therapy, manual therapy, and home exercise, resulted in a decrease in the Cobb angle. In other words, CONTRAIS, which included physical therapy, exercise therapy, manual therapy, and home exercise, was reported to successfully correct scoliosis (Kim, 2022). CONTRAIS may be helpful in adolescents with scoliosis who have poor quality of life and low self-esteem, and when physicians are considering more aggressive treatment (Dufvenberg et al., 2021). Surgical treatment for adolescent idiopathic scoliosis presents the following challenges: Postoperative pain is severe in young patients, and most patients visit hospitals for pain management due to unresolved postoperative pain (Kwan et al., 2020; Roye et al., 2022).

In this study, an 8-week Pilates exercise program targeting female college students did not show a significant difference in muscle strength between the experimental group, but showed a significant difference in flexibility and muscular endurance. In addition, this study did not show a significant difference in trunk tilt, pelvic tilt, pelvic rotation, kyphosis angle, and lordosis angle when female college students performed Pilates exercise for 8 weeks, but it was confirmed that there was a significant difference in lateral deviation. Future research requires more specific qualitative studies of Pilates exercise.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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