



Original Article

Effect of mat Pilates exercise on postural alignment and body composition of middle-aged women

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Abstract. [Purpose] This study attempted to examine whether Pilates is an effective exercise for improving the postural alignment and health of middle-aged women. [Subjects and Methods] The participants in this study were 36 middle-aged women (20 in the experimental group, 16 in the control group). The experimental group participated in Pilates exercise sessions three times a week for 12 weeks. Body alignment and composition measurements before and after applying the Pilates exercise program were performed with a body composition analyzer and a three-dimensional scanner. [Results] Postural alignment in the sagittal and horizontal planes was enhanced in the Pilates exercise group. Trunk alignment showed correlations with body fat and muscle mass. [Conclusion] The Pilates exercises are performed symmetrically and strengthen the deep muscles. Moreover, the results showed that muscle mass was correlated with trunk postural alignment and that the proper amount of muscle is critical in maintaining trunk postural alignment.

Key words: Middle-aged women, Pilates exercise, Postural alignment

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INTRODUCTION

During middle age, women enter a stage of physiological aging, experiencing changes such as decreased muscle strength and mass, with increased body fat¹⁾. Following hormonal changes due to aging and menostasia, problems can occur not only in the cardiovascular and genitourinary systems but also in the musculoskeletal system. The physical, psychological, and mental factors of middle age directly and indirectly affect the quality of life in old age. Improperly managed middle age can cause unexpected unhappiness in old age²⁾. Thus, there is a need to develop and promote interventions that improve physical capacity and, consequently, the quality of life in elderly populations³⁾.

Pilates appeals to women as a mainstream form of exercise⁴⁾ for improving physical health (muscular strength, endurance, core stability, and breathing) and motor function (muscle control, dynamic postural control, balance, and coordination)^{5, 6)}. Currently, the Pilates method is widely applied in physiotherapy for flexibility training, stimulation of blood circulation, improvement of postural alignment, and body awareness⁷⁾. In particular, as Pilates focuses on strengthening the abdominal region, the lumbar region, and the thighs so that they are strong enough to sufficiently support the spine, it is known to be appropriate for women past middle age who cannot perform difficult exercise⁸⁾. Pilates exercise has been introduced in

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Korea, but with the heavy emphasis on its aesthetic aspects, it is commonly believed that Pilates is simply an exercise for weight loss, and it is not well known that it can improve physical structures, muscle mobilization, and postural alignment⁸⁾.

This study attempted to examine whether Pilates is an effective exercise for improving the postural alignment and health of middle-aged women.

SUBJECTS AND METHODS

The subjects of this study included 20 middle-aged women who were taking Pilates classes at the Pilates Center, located in Gyeongju, Republic of Korea, and a control group of 20 middle-aged women with no previous experience with this type of exercise. The control group did not participate in any specific exercise program in daily life, and those who joined certain exercise programs during the research period were excluded from the sample. However, strolling or stretching in daily life was not restricted. The subjects were members of a community culture center and either participated in the Pilates program or in the general cultural program. The study objectives and procedures were explained to the study subjects, and they voluntarily agreed to participate. The ethics committee of Kangwon National University's institutional review board approved the study (KWNUIRB-2014-09-004).

Those with neurologic or cardiovascular disease or previous experience with Pilates were excluded from the sample. Based on similar previous studies, each group had a standard sample size of 20, with a total of 23 subjects collected for the experimental group and 20 in the control group. Those in the experimental group who did not participate in the exercise sessions more than three times during the total period of 12 weeks were excluded from the results analysis, which resulted in there ultimately being 20 subjects in the experimental group. Participants in the control group who participated in other exercise programs or experienced any significant changes during the research period were excluded, so ultimately 16 control subjects were included in the final results analysis.

For the Pilates program, exercises that included warm-up and stretching were performed. The warm-up exercises were performed for approximately 10–15 minutes, the main exercises were done for approximately 20–40 minutes depending on the exercises performed, and the wrap-up exercises were done for approximately 10–15 minutes. The 12-week period was divided into the adaptive period (weeks 1–3), the development period (weeks 4–10), and the maintenance period (weeks 11–12). The intensity of the Pilates exercises was controlled at level 11 on the Rating of Perceived Exertion (RPE) scale and at a percentage of maximal heart rate (%HRmax) of 40%.

Body and balance measurements before and after applying the Pilates exercise program were performed with a body composition analyzer (X-scan Plus II) and a three-dimensional (3D) scanner. The body composition analyzer can assess not only weight, BMI, body fat, and muscle mass but also obesity in the abdominal region and muscle development according to body part. For the body composition measurements, the subjects held electrode handles in both hands in a vertical position with their socks off and maintained the correct posture for approximately one minute. The 3D scanning of the subjects was done using a whole-body scanner (model WB4, Cyberware, Monterey, CA, USA). On 3D scanning of the body, a scoliosis analysis (MediCube[®]), a body mass and surface analysis (volume and surface report), and diverse skeletal muscle angle analyses (lateral, hip, and knee views) were performed. The 3D scanner consists of four vertical axes, each of which have two CCD cameras. As the cameras move from the head to the toes of the subject, information about the shape of the body is obtained, and the data, such as angles between each part of the body and the surface mass, are computed with Rapidform software. During these measurements, the subjects looked straight ahead in a standing position and maintained the correct posture until the scanning was finished.

Descriptive statistics were used for the physical characteristics of the groups and the measurement data. A paired-sample t-test was conducted to examine the difference between before and after the Pilates program. A Pearson correlation analysis was conducted to examine correlations among the variables. The statistical significance level for the measured values was set at $p < 0.05$, and the data were statistically processed using IBM SPSS Statistics version 20.0.

RESULTS

This study examined the degree to which a Pilates exercise program can improve the postural alignment and composition of middle-aged women. Markers were used to measure the body as follows, a is the out ear; b is the acromion process; c is the great trochanter, d is the fibula head and d is the lateral malleolus.

Postural alignment and body composition changes in an ordinary-routine group and a Pilates exercise group were examined and compared (Table 1). In the ordinary-routine group, no variables showed statistically significant differences between before and after the study period. In the Pilates group, all variables showed statistically significant differences during this period, except for right balance and from the acromion process to the great trochanter. Height increased and body fat decreased in the Pilates group. With regard to balance, the bias toward the left side decreased, while the pelvic angle and angle of connecting both shoulder tilt decreased. Therefore, it can be said that the postural alignment in the sagittal and horizontal planes was enhanced in the Pilates exercise group.

Correlations among the variables affecting body composition and postural alignment in the Pilates group were also investigated. The left balance difference showed a positive correlation with the body fat difference ($r=0.54$) and a negative

Table 1. Changes in postural alignment and balance before and after the exercise program

Variables	Ordinary-routine group		Pilates group	
	Before	After	Before	After
	M ± SD		M ± SD	
Height (cm)	159.82 ± 4.87	159.81 ± 4.85	157.56 ± 3.77	158.13 ± 3.85**
Weight (kg)	57.69 ± 6.33	57.71 ± 6.25	57.62 ± 7.13	57.04 ± 7.47*
Muscle mass (kg)	37.72 ± 3.12	37.71 ± 3.13	36.50 ± 2.67	36.95 ± 2.74**
Body-fat mass (kg)	16.81 ± 3.59	16.84 ± 3.62	17.81 ± 4.55	17.02 ± 4.76**
Waist-hip ratio	0.87 ± 0.06	0.88 ± 0.05	0.89 ± 0.03	0.88 ± 0.04*
Balance left	33.05 ± 14.98	33.06 ± 14.95	30.03 ± 4.37	29.12 ± 3.88*
Balance right	27.93 ± 3.52	27.99 ± 3.40	27.60 ± 3.57	27.86 ± 4.20
ab	3.37 ± 2.27	3.38 ± 2.28	4.71 ± 2.95	2.53 ± 3.79*
bc	1.19 ± 1.00	1.19 ± 0.98	1.24 ± 0.62	0.82 ± 0.94
cd	1.39 ± 1.08	1.38 ± 1.09	1.82 ± 1.53	0.84 ± 1.00**
de	1.43 ± 1.26	1.44 ± 1.24	1.60 ± 1.14	0.98 ± 0.87*
∠abc	4.38 ± 3.17	4.41 ± 3.11	5.62 ± 3.05	2.54 ± 3.57**
∠bcd	2.07 ± 2.07	2.09 ± 2.04	2.51 ± 1.62	1.52 ± 1.24**
∠cde	3.00 ± 2.75	3.02 ± 2.71	2.99 ± 1.92	1.74 ± 1.85**
Pelvic angle	3.17 ± 2.69	3.19 ± 2.67	3.27 ± 1.76	2.22 ± 1.87**
Shoulder tilt	0.97 ± 0.75	0.97 ± 0.75	1.66 ± 1.22	1.13 ± 0.89**
Scoliosis	1.39 ± 0.82	1.35 ± 0.81	2.47 ± 1.67	1.40 ± 1.12**

*p<0.05; **p<0.01. M ± SD: mean ± standard deviation; ab: distance out ear and acromion process; bc: distance acromion process and great trochanter; cd: distance great trochanter and fibula head; de: distance fibula head and lateral malleolus; ∠abc: angle ∠abc; bcd: angle ∠bcd; cde: angle cde

correlation with the right balance difference ($r=-0.79$). This implies that body fat differences decreased and right balance differences increased, with a smaller left balance difference.

The angle abc difference showed a positive correlation with muscle mass ($r=0.52$), body fat difference ($r=0.45$), waist measurement difference ($r=0.54$), and angle difference between the line connecting the internal ear to the acromion and a plumb line ($r=0.89$).

The angle bcd difference showed a negative correlation with the skeletal muscle difference ($r=-0.51$) and a positive correlation with the angle difference between the line connecting the acromion to the greater trochanter and a plumb line ($r=0.51$). The The acromion process, great trochanter, fibula head angle difference also showed a positive correlation with the difference between the line connecting the fibular head to the lateral epicondyle and a plumb line ($r=-0.47$).

The angle cde difference showed a positive correlation with the angle difference between the line connecting the acromion to the greater trochanter and a plumb line ($r=0.49$) and with the angle difference between the line connecting the fibular head to the lateral epicondyle and a plumb line ($r=0.66$).

The difference in shoulder tilt that connects the acromion on both sides showed a negative correlation with skeletal muscle ($r=-0.54$) and a positive correlation with the angle difference between the line connecting the greater trochanter to the fibular head and a plumb line ($r=0.53$). The scoliosis difference showed a positive correlation with the waist-hip ratio difference ($r=0.46$). Therefore, variables indicating trunk postural alignment showed correlations with body fat and muscle mass (Table 2).

DISCUSSION

This study attempted to examine how Pilates exercise can improve the postural alignment and body composition of middle-aged women. Pilates makes use of minor muscles that are not frequently used in daily activities, without implementing running or large movements of the body. It is an exercise that can enhance body function and muscle strength, while addressing incorrect posture, fatigue, muscle pain, low back pain, shoulder and neck pain, and stress⁹). Denise et al. argued that Pilates enhances the stability of the trunk, as it affects the joint contractions of antagonistic muscles⁹). In this study, the Pilates exercise group showed better postural arrangement on the sagittal and horizontal planes, increased muscle mass, and decreased body fat in the abdominal region. Moreover, the results indicated that problems with trunk postural alignment are closely related to skeletal muscle and body fat. Hence, proper muscle mass is one of the important factors for trunk postural alignment. Ju et al.¹⁰) reported in their study on elderly people that a group that performed Pilates showed increased walking speed compared with a group that performed exercises on unstable ground. Positive effects on chronic low back pain and

Table 2. Correlations among variables in the Pilates exercise group

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
F	0.29	-0.27	0.54*	0.11	0.21	1										
G	-0.09	0.14	-0.08	0.25	0.23	-0.79**	1									
H	0.52*	0.15	0.45*	0.44	0.54*	0.13	0.26	1								
I	0.29	0.08	0.26	0.46*	0.45*	-0.09	0.44	0.65**	1							
L	0.54*	0.15	0.49*	0.26	0.40	0.17	0.18	0.89**	0.36	-0.10	0.37	1				
M	0.11	-0.51*	0.39	-0.01	0.19	0.17	0.09	0.29	0.24	0.51*	0.47*	0.12	1			
N	-0.03	0.03	0.02	0.13	0.20	-0.21	0.31	0.14	0.49*	0.35	0.66**	-0.05	0.32	1		
O	-0.17	-0.54*	0.06	-0.06	0.06	0.12	-0.14	-0.32	-0.21	0.56**	0.14	-0.39	0.53*	0.19	1	
P	0.04	0.12	0.23	0.46*	0.31	-0.08	0.28	0.25	0.27	0.30	0.30	0.17	0.03	0.18	0.17	1

*p<0.05; **p<0.01. A: muscle mass difference; B: skeletal muscle difference; C: body fat difference; D: waist-hip ratio difference; E: waist measurement difference; F: left balance difference; G: right balance difference; H: angle difference between the line connecting the outer ear to the acromion and plumb line; I: angle difference between the line connecting the acromion to the greater trochanter and plumb line; J: angle difference between the line connecting the greater trochanter to the fibular head and plumb line; K: difference between the line connecting the fibular head to the lateral malleolus and plumb line; L: $\angle abc$ angle difference; M: $\angle bcd$ angle difference; N: $\angle cde$ angle difference; O: shoulder-tilt angle difference; P: scoliosis difference

balance among working women were also confirmed¹¹⁾. Moreover, Pilates results in improved muscle strength and balance of the lower limbs, as well as improved quality of life¹²⁾. Pilates exercise, which was created by Joseph Pilates, is a form of exercise that relaxes body tension and strengthens deep muscles by using the body weight of the participant. This kind of Pilates program is known to be useful in enhancing lower limb function in stroke patients¹³⁾. In Korea, Pilates began to receive attention after a female celebrity released a fitness video using this technique. However, this has caused Pilates to be known in Korea as an exercise with aesthetic purposes. However, as studies on diverse age groups with various purposes continue to be performed, Pilates is now becoming known as an effective and moderate form of exercise.

The present study confirms that Pilates has a positive impact on trunk postural alignment in middle-aged women, which can be attributed to the fact that Pilates exercises are performed symmetrically and strengthen the deep muscles. Moreover, the results showed that muscle mass was correlated with trunk postural alignment, and that the amount of body fat had a negative correlation with balance, indicating that the proper amount of muscle is critical in maintaining trunk postural alignment. The actions of the muscles should come first in order to maintain the skeletal form and the postural alignment, not only on the left and right, but also at the front and back.

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REFERENCES

- Kim MH: Effect of resistance training on immune function in middle aged women. *Kore J Physic Edu*, 2000, 39: 402–413.
- Lee SH, Seo BD, Chung SM: The effect of walking exercise on physical fitness and serum lipids in obese middle-aged women. *J Phys Ther Sci*, 2013, 25: 1533–1536. [[Medline](#)] [[CrossRef](#)]
- Bullo V, Bergamin M, Gobbo S, et al.: The effects of Pilates exercise training on physical fitness and wellbeing in the elderly: a systematic review for future exercise prescription. *Prev Med*, 2015, 75: 1–11. [[Medline](#)] [[CrossRef](#)]
- Eyigor S, Karapolat H, Yesil H, et al.: Effects of pilates exercises on functional capacity, flexibility, fatigue, depression and quality of life in female breast cancer patients: a randomized controlled study. *Eur J Phys Rehabil Med*, 2010, 46: 481–487. [[Medline](#)]
- Latey P: The Pilates method: history and philosophy. *J Bodyw Mov Ther*, 2001, 5: 275–282. [[CrossRef](#)]
- Lange C, Unnithan VB, Larkam E, et al.: Maximizing the benefits of Pilates-inspired exercise for learning functional motor skills. *J Bodyw Mov Ther*, 2000, 4: 99–108. [[CrossRef](#)]
- Muscolino JE, Cipriani S: Pilates and the power house-II. *J Bodyw Mov Ther*, 2004, 8: 122–130. [[CrossRef](#)]
- Mazzarino M, Kerr D, Wajswelner H, et al.: Pilates method for women's health: systematic review of randomized controlled trials. *Arch Phys Med Rehabil*, 2015, 96: 2231–2242. [[Medline](#)] [[CrossRef](#)]
- Rossi DM, Morcelli MH, Marques NR, et al.: Antagonist coactivation of trunk stabilizer muscles during Pilates exercises. *J Bodyw Mov Ther*, 2014, 18: 34–41. [[Medline](#)] [[CrossRef](#)]
- Hyun J, Hwangbo K, Lee CW: The effects of pilates mat exercise on the balance ability of elderly females. *J Phys Ther Sci*, 2014, 26: 291–293. [[Medline](#)] [[CrossRef](#)]

- 11) Lee CW, Hyun J, Kim SG: Influence of pilates mat and apparatus exercises on pain and balance of businesswomen with chronic low back pain. *J Phys Ther Sci*, 2014, 26: 475–477. [[Medline](#)] [[CrossRef](#)]
- 12) Campos de Oliveira L, Gonçalves de Oliveira R, Pires-Oliveira DA: Effects of Pilates on muscle strength, postural balance and quality of life of older adults: a randomized, controlled, clinical trial. *J Phys Ther Sci*, 2015, 27: 871–876. [[Medline](#)] [[CrossRef](#)]
- 13) Shea S, Moriello G: Feasibility and outcomes of a classical Pilates program on lower extremity strength, posture, balance, gait, and quality of life in someone with impairments due to a stroke. *J Bodyw Mov Ther*, 2014, 18: 332–360. [[Medline](#)] [[CrossRef](#)]