

# The effects of the Pilates exercises on rectus abdominis thickness and balance in healthy female health worker: prospective, single blind study with controlled group

## Abstract

**Objective:** To evaluate the effects of the Pilates exercises on rectus abdominis thickness (RAMT), balance and depression in female health worker.

**Design:** 40 healthy female health-workers were included to the study. Group-1 joined the Pilates exercises for first 8 weeks, whereas Group-2 (control group) waited without joining Pilates exercises or any other exercise group, during that time. Falling index (FI) was evaluated with a system to test balance and stability by a trained researcher. All participants were instructed to follow a 45-min programme for three times a week, for eight weeks.

**Results:** Age, BMI and marital status scales were not significantly different among the two groups. In group-1, RAMT values were significantly increased in rest and contracted position at the end of eight weeks of Pilate's session. BDS and FI were significantly decreased in Group-1 after 8 weeks. Interestingly, body weight mean value was higher after the Pilates exercises, but there was no significant difference. Group-2 showed that RAMT values were not significantly different in rest or in contracted position at the beginning and the 8th week.

**Conclusion:** The results of the present study led us to conclude that Pilate's exercises have positive effects on RAMT and fall index.

**Keywords:** pilates training, exercise, postural balance, rectus abdominis, ultrasound, accidental falls

Volume 2 Issue 4 - 2017

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**Received:** September 09, 2017 | **Published:** December 13, 2017

## Introduction

Pilate's exercises were originally designed for and used by performance artists, but have enjoyed wider popularity in recent years.<sup>1</sup> Joseph H. Pilates developed a comprehensive program known as the Pilates method in the 1920's. Over the last decade, the popularity of this set of exercises has grown and Pilates is now used as a form of fitness and holistic health.<sup>2</sup> The Pilates method can offer significant improvement in personal autonomy, static balance and quality of life in elderly females.<sup>3</sup> The abdominal muscles flex the lumbar spine, where rectus abdominis is particularly powerful muscle. Acting collectively, the abdominal muscles not only increase intra-abdominal pressure but also affect forced expiration, sneezing and coughing.<sup>4</sup> Rectus abdominis muscle is one of the anterior abdominal muscles. This muscle is originated from pubic crest and pubic symphysis and inserted in xiphoid process and costal cartilages 5-7. It is innervated by intercostal nerve (T7-T11) and subcostal nerve (T12). Function of rectus abdominis is to depress ribs and flex trunk.<sup>5</sup>

Ultrasound imaging was performed to determine the thickness of the abdominal muscle and to measure the effect of rehabilitation<sup>6</sup>. Measuring the thickness of rectus abdominis by Ultrasound imaging is an easy way for the clinician to follow the patient. Pilates exercises on deep abdominal muscle thickness increased significantly higher

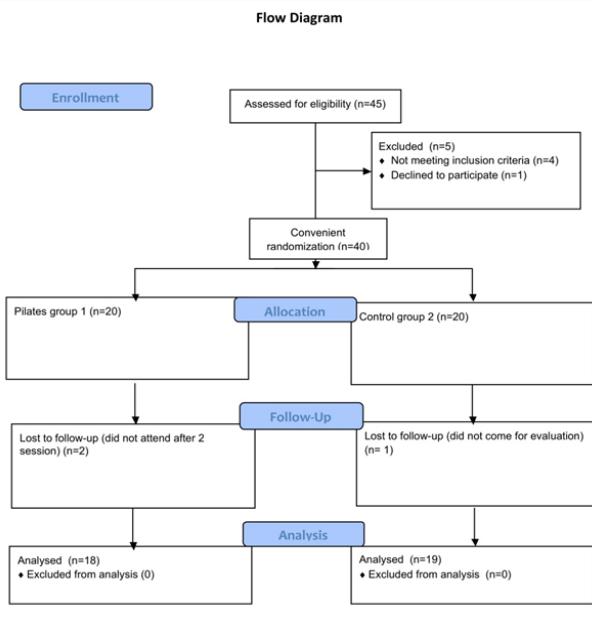
compared to resistance exercises.<sup>7</sup> We need to investigate short time (8 weeks) effect of Pilates exercise on the important abdominal muscle rectus abdominis. In this way we have an idea of cost and time effect of Pilates exercise to plan new study. We tried to show that following the patient's rectus abdominis by ultrasound imaging is a practical way. Our study aimed to evaluate the effects of the Pilates exercises on rectus abdominis muscle thickness (RAMT) with a control group without any exercise and to investigate Pilate's exercises on balance and depression.

## Method

### Participants

Obtaining an ethical approval by the Hospital Ethics Committee and having provided written informed consent, 40 healthy female health-workers were included to the study. Exclusion criteria were having cardiac and pulmonary problem, being under eighteen years old, having had spinal or abdominal surgery at any time, having back pain in the last two years, having visible scoliosis, neuromuscular disorders, pregnancy or having previous Pilates training. Study took place in Istanbul Physical Therapy and Rehabilitation Training and Research Hospital between September-October 2010. This study was implemented as a part of an already existing Pilates exercise

organization for the health workers, by convenience sampling and evaluation consents. Forty women participated to the study after the exclusion process. These individuals were separated into two groups according to their availability from working time, which resulted in equally sized populations in each group by polyclinic secretary who was blinded to the study. One of the researchers recorded two groups informed participants. Flow chart of this study is shown in Figure 1.



**Figure 1** Flow chart of Pilate exercise from 1 to 8 weeks.

Group-1 (to be mentioned as the Pilates group) joined the Pilates exercises for first 8 weeks, whereas Group-2 (to be mentioned as the control group) waited without joining Pilate's exercises or any other exercise group, during that time. Group-2 joined the exercise sessions after the 9th week of the study but their measurements were not recorded following their Pilates periods. Three sessions in one week were performed. Every session was 45minutes 8 repetitions of each exercise from Table 1. First three weeks some participants were let 4 -8 repetitions for each exercise. By definition, a "successful" participant is the one who completes at least 22 of 24 possible exercise sessions.

## Data collection

Demographic data, Beck Depression Scale (BDS) for each participant were recorded before randomization by one of the researcher<sup>8,9</sup>. BDS was developed by Beck and coll and Turkish validation was performed.<sup>9,10</sup> Schober test is used to measure the lumbar range of motion in centimeter. Ultrasound measurements were made at the beginning and at the eighth week of the study by a researcher who is blind to the randomization.

**Table 1** List of Pilates exercises used in the study

Warm up	Hundred Roll Up One Leg Circle Rolling Like a Ball Single leg stretch Double leg stretch Scissors Double straight leg Spine stretch forward Open leg rocker Corkscrew Saw Ski Ramp Flight
Abdominals	Swan series Side kick series Teaser group Mermaid to push Rup
Swan series	Swan dive Rest position Shoulder bridge Front & back Up & down Small circles Inner thigh lifts & circles Beats on belly One leg teaser Swimming Leg pull front Mermaid stretch Seal Push Rup series
Side kick series	
Teaser group	
Mermaid to push Rup	

## Ultrasound and falling index measurement

Measurements are taken by placing the ultrasound transducer perpendicular to the abdominal wall, 5cm lateral to the umbilicus.<sup>11</sup> First, muscle thickness measurements were obtained by resting supine flexing knee and hip. Then, participants were instructed to flex their head and shoulder and contract their abdomen (resulting in 45 degree angle lean without back support) for the second measurement set. The USG study was performed using a General Electric Logic P5 apparatus preliminarily covered with ultrasound transmission gel.

All USG! Measurements were performed by physiatrist who

were certificated for muscle USG and blind with respect to the participants' group. Falling index (FI) was evaluated with a system to test balance and stability (Tetrax) by a trained researcher. Tetrax is a noninvasive posturography tool to evaluate balance and to provide balance training. This device can save the data digitally from different measurement platforms simultaneously and document them as visual and numerical values. The patients were tested with eyes opened and closed in different oscillations of the device.<sup>12</sup>

### Outcome measure

All participants were instructed to follow a 45-min programme for three times a week, for eight weeks. Sessions were supervised by a Pilate's instructor, who graduated from a Sports Academy holding a peak Pilate's certification. In addition to that, one of researcher followed the study. According to the literature, there are two styles of Pilates, the repertory approach (traditional) and modern Pilates.<sup>13</sup> Present study uses the traditional method having the list of Pilate's exercises given in Table 1. Prior to recruitment, a sample size calculation was performed, based on the results from Critchley et al.,<sup>4</sup> who reported mean (standard deviation) difference of 1.95 (0.80) mm in Obliquus Internus (OI) thickness, between pre and post Pilates exercises. In a two-group design, 40 total participants are required to detect such difference at 5% level of significance with 80% power. Mann-Whitney U tests were utilized for comparison of mean differences between Group-1 and Group-2 and one-tailed Wilcoxon tests were employed for comparison of mean differences between pre and post-intervention. Statistical significance of the tests was assumed to be lower than 0.05 ( $P<0.05$ ).

## Results

Demographic features of all the participants are given in Table 2. Mean age of the participants was 33.3 years and Body Mass Index (BMI) mean was 23.15kg/m<sup>2</sup>. Age, Body mass index (BMI) and marital status scales were not significantly different in two groups ( $P>0.05$ ), as shown in Table 3. In Group-1, RAMT values were significantly increased in rest and contracted position at the end of eight weeks of Pilates session ( $P1=0.001$   $P2=0.003$ ). At the same time, as shown in Table 4, BDS and FI were significantly decreased in Group-1 after 8 weeks of Pilate's exercises. However, Schober improvement was not statistically significant in Group-1. Investigation of control group (Group-2) showed that RAMT values were not significantly different in rest or in contracted position at the beginning and the 8th week of the study. Body weight, BDS and FI values were not significantly improved either, as summarized in Table 5.

**Table 2** Demographic characteristics of subjects

Age	33.26±7.898 (25R45)
Height(m)	162.53±4.888
Weight (kg)	61.43±10.437
Body mass index	23.15
	Physician=10
	Nurse=13
Occupation	Technician=7
	Representative=1
	Medical secretary=3
Marital status: married/single	18/16

**Table 3** Comparison of demographic features

	Pilates group (n=18)	Control group(n=19)	P value
Age	31.7±7.06	34.8±8.5	0.238
Height(cm)	162.5±4.88	162.8±5.7	0.908
Weight(kg)	63.7±13.13	59.2±	0.219
BMI	23.98	22.31	0.181
Marital status	9-Aug	9-Aug	1

**Table 4** Pilates group parameter before and after Pilates exercise

Pilates group	Before pilates	After pilates (8 <sup>th</sup> week)	P R value
RA thickness R rest(mm)	79.33±12.982	88.56±10.366	0.002*
RA thickness R contracted(mm)	100.60±11.599	117.63±18.701	0.005*
Schober(cm)	5.21±1.091	5.44±0.750	0.532
Weight(kg)	63.7±13.13	64.1±13.30	0.172
Fall index%	29.7±16.94	24.6±19.38	0.036*
Beck Depression Scale	10.5±5.17	5.9±5.442	0.001*

\* $p<0.05$

**Table 5** Control group at the beginning and after 8 weeks

Control group	At the beginning	After 8 <sup>th</sup> week	P value
RA thickness R rest(mm)	82.88±12.92	83.94±11.89	0.811
RA thickness R contracted(mm)	107.47±12.75	108.59±10.67	0.48
Schober(cm)	4.79±1.100	4.91±0.98	0.465
Weight(kg)	59.21±14.08	58.91±13.75	0.217
Fall index%	26.47±17.27	27.29±18.08	0.92
Beck Depression Scale	9.41±4.98	9.59±5.40	0.441

## Discussion

The effects of Pilates exercises were investigated in the literature for many illnesses.<sup>14-17</sup> In chronic low back pain disability scores improvement were reported by Donazelli et al.<sup>14</sup> and by Rydeard et al.<sup>15</sup> Emery et al.<sup>16</sup> reported that Pilates training program was effective in improving core strength and posture as well as certain aspects of scapula and upper trunk displacement during a shoulder flexion task.<sup>16</sup> They reported that their results could support the use of the Pilates method in the prevention of neck–shoulder disorders. King et al reported that some Pilate's exercises improved the form of each subcomponent of the movements in Parkinson patients.<sup>17</sup> There are a few prospective studies about the effects of Pilate's exercises on abdominal muscles.<sup>18</sup>

Dorado et al.<sup>17</sup> analyzed the effects of Pilates on the volume of the rectus abdominis, obliques and transversus abdominis muscles using magnetic resonance imaging. Menacho et al.<sup>18</sup> reported significant increase in total volume of rectus abdominis muscle. Similar to our study, participants were healthy women but their Pilates practices were twice a week for 9 months. As a contrast to that study, our intention was to investigate the short-term effects, which resulted

in 8 weeks of exercise. Menacho et al.<sup>18</sup> found a significant increase in electromyographic activity in back extensor muscles.<sup>19</sup> They investigated healthy women and used traditional mat Pilates exercises similar to this study.

In the study which investigated the effects of Pilates exercise on the thickness of transversus abdominis (TrA) and obliquus internus (OI) muscles, there were no differences in TrA thickness between Pilates exercising group and strength training group, before and after intervention. However, in terms of both simplicity and accuracy of the measurements, we used RAMT and found a statistically significant increase.<sup>14</sup> In this study, control group (Group-2) did not have any exercises and this may have caused us to find different results than the ones given in reference. Culligan et al.<sup>19</sup> compared a standardized physical therapy-based pelvic floor muscles training program with a standardized Pilates program in regards to improvement of pelvic floor muscle strength. They reported that both groups demonstrated improved strength at the end of the study.<sup>20</sup>

Despite the fact that Pilates in general focuses on improving flexibility, this results show that there was no significant difference in Schober measurements. We did not use any other different scale for flexibility, since aim of this study was not to investigate flexibility. This study differs from these aforementioned ones in the sense that the effect of Pilates exercises on the development of the rectus abdominis muscle thickness and balance in healthy women are investigated with objective parameters. In the literature, Pilates exercise effects on the risk of falling in the elderly population were evaluated and significant improvement was seen. The risk of falling was an important parameter among the elderly population, osteoporotic population and the patients with balance problems.<sup>21</sup> Improving the quality of life and decreasing the cost of health, importance of the falling risk should be emphasized. This study focused on this parameter and found significant improvement even for healthy individuals in the test group.

There was no significant difference in body weight in Group-1 after the end of all Pilate's sessions. A review on this subject was parallel to this study stating that, BMI generally does not change significantly. There was only one study, which reported a significant reduction in BMI.<sup>22</sup> However, a study on teenage girls, who had 8 weeks of Pilates exercises, showed that there was no change in BMI after the end of all sessions. Yet, there was a significant decrease in BMI percentile.<sup>23</sup> As opposed to that study, a significant reduction in BMI was detected in a study on obese women.<sup>24</sup> Information about positive effects of Pilates exercises on depression is available in the literature<sup>25</sup> giving seemingly parallel results to this study. Nevertheless, BDS scores of the participants of Group-1 varied from mild-depression state to no-depression state during the period of Pilate's exercises.

## Limitations

Only the RA muscle was evaluated in our study TrA and OI were evaluated in the literature.<sup>14</sup> Participants could be followed up long time period. This was another limitation Healthy worker women were assessed. So the participants were aware of benefit of exercise and their muscles. This might increase concordance to the study and decrease drop out.

## Conclusion

The results of the present study led us to conclude that Pilate's

exercises have positive effects on RAMT and fall index. Pilate's exercises should not only be used by healthy women but also by individuals who have disorders needing strengthening and balance improvement. Besides this study states once more that Ultrasound imaging is a practical way to follow the thickness of rectus abdominis of the patients.

There are two points which were known already:

- i. Ultrasonography is a noninvasive and easy way to evaluate muscle thickness .USG was used in different body position of the patient in this study.
- ii. Fall index as a balance parameter is very important in much neuromuscular and locomotor system disease.
- iii. This study adds:
- iv. USG can be used widely in assessment of muscle thickness for evaluating outcomes of sports and exercise therapy according to the aim.
- v. Significant improvement was found in fall index parameter in Pilates exercise group. Thus Pilates exercise is an important choice for improving balance in many diseases with balance problems.
- vi. Also group exercise can save time instead of individual exercise we can recommend group exercise.

## Acknowledgements

This research received no specific grant from any funding agency in the public, commercial or not for profit sectors.

## Ethical approval

This study was approved by Istanbul Physical Therapy and Rehabilitation Training and Research Hospital Committee.

## Conflict of interest

The author declares there is no conflict of interest.

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