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Investigation of the Effect of Long-Term Pilates and Step Aerobic Exercises on Functional Movement Screening Scores

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Abstract

This research aimed to investigate the variation in FMS scores of women performing Pilates exercises 2 days per week, and women performing 1 day of Pilates and 1 day of step aerobic exercise per week after 8 weeks. The research included 60 sedentary female volunteers aged from 35-50 years (age range: 30.4-54.2 years, mean: 41.2 ± 6.37). Subjects in the research were tested for basic movement patterns, stabilization and mobilization. The study was planned to last 8 weeks, with 2 training sessions per week. At the end of 8 weeks, FMS tests were repeated. Statistical analyses used the SPSS program. P values of less than 0.05 were considered statistically significant. The total score in the group with 2 days Pilates per week increased from 13.08 to 17,85, while the scores for the group with 1 day Pilates and 1 day aerobic exercise rose from 13 from 15 ($p<0.05$). The control group had pre-test measurement of 13.25 and post-test measurement of 13.19, with no significant change observed ($p>0.05$). While there was no difference between the groups for preliminary FMS results, there were significant differences between the final FMS results (pre-test p: 0.92, post-test p: 0.015). In conclusion, 2 days of Pilates exercise preserved and developed functional movement, stability and mobility and reduced the risk of injury. Though one day Pilates and one day aerobic exercise improved FMS scores, it did not reduce the risk of injury.

Keywords: Pilates, step aerobic exercises**,** functional movements screen, sport injury

1. Introduction

Functional movement screening is a dynamic and practical method assessing stability, mobility and asymmetry of the body. This method identifies weaknesses in body movement patterns and estimates sporting injuries that may occur in the future. In addition to identification of sporting injuries, FMS allows the possibility of performing exercises for rehabilitation, treatment, prevention and improvement (Cook *et al*., 2006; Cook *et al*., 2010). Previous studies have reported low FMS points are a high risk for sporting injuries (Butler *et al*., 2013; Shojaedin *et al*., 2014; Kiesel *et al*., 2014). There are 7 movements in the FMS test and 21 total points can be obtained. People with points below 14 are emphasized to have higher risk of sporting injury compared to people with points of 14 or higher Minick *et al*. (2010). Additionally, the increase in FMS scores is reported to reduce the injury risk Kiesel *et al*. (2011).

Pilates exercises have begun to be intensely included in training programs in recent times. These exercises may be performed with tools and a mat, with different apparatus or body weight Fitness Trends Surveyed, (2005). Pilates exercises have been revealed in previous studies to develop strength-power, develop balance, develop cardiorespiratory resistance and muscle resistance, increase the width of joint movements and improve body composition (Siler, 2000; Schroeder, 2002; Barker *et al*., 2015; Kao *et al*., 2015; Bertoli *et al*., 2018; Bullo *et al*., 2018). Pilates exercises are also intensely used for rehabilitation of sporting injuries and treatment of some chronic disorders (Bryan & Hawson, 2003; Kalron *et al*., 2017). There is a serious reduction in chronic low back pain complaints after Pilates exercises, especially (Cruz-Díaz *et al*., 2015; Peterson & Haladay, 2018).

Step aerobics comprise dynamic movements performed using a step platform accompanied by music. These movements use the aerobic energy system and include steps from right to left, forward and backward on or beside the platform. Additionally, popularity is increasing every day due to ensuring development of physical fitness parameters while having an enjoyable time and they are frequently included in exercise programs. In these training plans, Pilates exercises are commonly performed along with step aerobic exercises in most training programs. The aim in these types of application is to increase the strength gains of the person, in addition to increasing oxygen use capacity. Step aerobics exercises performed in addition to Pilates exercises may reduce the risk of injury by increasing resistance.

There are studies investigating the effects of different types of exercises in different branches on FMS scores in the literature. Additionally, Pilates exercises have previously been studied for effects on core stability, strength development, reduced risk of injury, reduced low back pain and reduced danger of falling. However, there is no study investigating the effects of Pilates and step aerobic exercises on FMS scoring. Pilates and step aerobic exercises were shown to improve weaknesses in stability, mobility and basic movement ability and have protective effect against the risk of sporting injuries.

Thus, they have become a necessary part of programs for performance sportspeople and sedentary individuals. We think that 2 days of Pilates exercises will improve FMS scores. The research was performed with the aim of investigating the variation in FMS scores of women after 8 weeks of 2 days Pilates exercises per week or 1 day Pilates and 1 day step aerobic exercises per week.

2. Materials and Methods

2.1 Subjects

A total of 60 sedentary female volunteers aged from 35-50 years (age range: 30.4-54.2, mean: 41.2 ±6.37) participated in the research. Subjects were healthy individuals who did not perform active regular exercise. Subjects with no history of traumatic or non-traumatic injuries sustained in the last 6 months were included. The study was conducted with ethics approval from the Ethics Committee, and "informed consent" was obtained from all cases who accepted participation in the study. (Protocol no: 3670021-299-22550)

2.2 Study Design

Before beginning the study, the height and weight of all participants were measured. The basic movement pattern, stabilization and mobilization of subjects in the study were tested. The FMS scores were measured before and after 8-weeks of Pilates and step aerobic exercises with the difference between the two measurements assessed. Subjects were divided into 3 groups of 20 people each. The 1st group performed Pilates exercises 2 days per week (Group 1), the 2nd group performed the same Pilates exercises as the 1st group on 1 day and step aerobic exercises on 1 day (Group 2), and the 3rd group did not perform any exercises (control group). The study was planned for 8 weeks with 2 trainings per week. The trainings were applied as standard to all subjects by the same trainer.

2.3 FMS Test Protocol

The 7 FMS test was applied. These tests were deep squat, hurdle step, inline lunge test, shoulder mobility, active straight leg raise, trunk stability push-up and rotary stability tests Cook *et al*. (2006). The points for each test were from 0 to 3. If pain formed during the movement 0 points were given, if the movement could not be completed 1 point, if the movement was completed with deficiency 2 points and if the movement was perfect 3 points were given Smith (2016). Subjects were tested by the same researcher, with tests recorded with video camera. Points obtained by the subjects were recorded after the video camera system was checked by 3 observers.

2.4 Exercise Protocol

The group with Pilates exercises performed simple, moderate and advanced level exercises according to movement difficulty for 1-8 weeks. The repeat duration of movements and the week performed are given in detail in Table 1. The group with step aerobic exercises performed 1 set of the standard movement protocol in Table 2 for a total of 8 weeks. Before beginning exercises, each subject group had 15 minutes warm-up with 10 minutes cool-down at the end of exercising.

Table 1. 8-week Pilates training program

Exercise	Repetition	Exercise Time (week)
	Basic	
The roll down/roll up	6	1-8
The hundred	10-100 rep.	1-8
Single leg circles	5 in each direction	1-8
Rolling like a ball	6	1-8
Single leg stretch	5-10 rep.	1-8
Double leg stretch	5-10 rep.	1-8
Spine stretch forward	5	1-8
	İntermediate	
Single straight leg	10	1-8
Double straight leg	10	1-8
Saw	4	1-8
Neck roll	3 in each direction	1-8
Single leg kicks	5 in each direction	1-8
Side kick series	1 series with each leg	1-8
Criss cross	10	2-8
Corkscrew	5 in each direction	2-8
Double leg kicks	2-5 sets	2-8
Neck pull	5	3-8
Open leg rocker	6	4-8
Teaser 1	3–5 reps	4-8
Seal	6	4-8
	Advanced Level	
Wall work	1 seri	4-8
Shoulder bridge	5 with each leg	5-8
Arm weight series	1 series	5-8
Plank	3	6-8
Side plank	3 with each arm	6-8

Table 2. 8-week step aerobics training program

Exercise	Set	Exercise Time (week)
Basic step	1 set	1-8
Wide step (V step)	1 set	1-8
Tap-up-Tap down	1 set	1-8
Knee up/Knee lift	1 set	1-8
Leg curl/Heel lift	1 set	1-8
Leg lif	1 set	1-8
Kick	1 set	1-8
Straddle up-down	1 set	1-8
Turn step	1 set	1-8
Turn travel	1 set	1-8
Over the top	1 set	1-8
Across the stop	1 set	1-8
A step	1 set	1-8
Z step	1 set	1-8
L step	1 set	1-8
T step	1 set	1-8
Corner to corner	1 set	1-8
Lunge	1 set	1-8
Reverse step	1 set	1-8

2.5 Statistical Analysis

Statistical analysis was completed using the SPSS program. Descriptive features of subjects are given as minimum, maximum, mean and standard deviation. The Shapiro-Wilk and Kolmogorov-Smirnov tests were used to determine whether the groups had normal distribution or not. As the pre-test and post-test differences in the groups did not have normal distribution, the Wilcoxon test was used. The Kruskal-Wallis test was used to assess the difference in FMS means in the exercise groups. P values of less than 0.05 were considered statistically significant.

3. Results

The mean age of all cases (n=60) was 41.2 (35-50) years. The mean weight and height of all cases (n=60) were 70.8 (54.10-90.50) kilograms and 1.62 (1.48-1.82) meters, respectively.

Table 3. Difference in pre-test and post-test FMS measurements in the Pilates group

N=20	Mean	Standard Deviation	Minimum	Maximum	z	p
Deep squat pre test	1,75	0,62	1,00	3,00		
Deep squat post test	2,75	0,45	2,00	3,00	-2,972b	,003
Hurdle Step pre test	2,16	,71	1,00	3,00		
Hurdle Step post test	2,75	,45	2,00	3,00	-2,333b	,020
Lunge pre test	1,67	0,89	0,00	3,00		
Lunge post test	2,08	0,79	1,00	3,00	-2,236b	,025
Shoulder Mobility pre test	2,50	0,80	1,00	3,00		
Shoulder Mobility post test	2,58	0,51	2,00	3,00	-,577b	,564
Active Leg Raise pre test	2,50	0,52	2,00	3,00		
Active Leg Raise post test	2,92	0,29	2,00	3,00	-2,236b	,025
Trunk Stability pre test	1,33	0,78	0,00	2,00		
Trunk Stability post test	2,17	0,72	1,00	3,00	-2,887b	,004
Rotary Stabiliy pre test	1,17	0,39	1,00	2,00		
Rotary Stabiliy post test	2,33	0,65	1,00	3,00	-3,071b	,002
FMS pre test	13,08	2,97	6,00	18,00		
FMS post test	17,58	2,54	13,00	21,00	-2,952b	,003

When the pre-test and post-test results of the groups are examined, Group 1 had pre-test results of FMS total score 13.08 ± 2.96 (deep squat 1.75 ± 0.62, hurdle step, 2.16 ± 0.71, inline lunge 1.66 ± 0.88, shoulder mobility 2.5 ± 0.79, active leg raise 2,5 ± 0,52, trunk stability 1,33 ± 0,77, rotary stability 1.16 ± 0.38) and post-test results of FMS total score 17.58 ± 2.53 (deep squat 2.75 ± 0.45, hurdle step, 2.66 ± 0.41, inline lunge 1,08 ± 0,79, shoulder mobility 2,58 ± 0,51, active leg raise 2.91 ± 0.28, trunk stability 2.16 ± 0.71, rotary stability 2.3 ± 0.65). Apart from FMS shoulder mobility, there were significant increases for all tests and total scores (deep squat z: -2.972b, p: 0.003, hurdle step, -2.333b, p: 0.02, inline lunge z: -2.236b, p: 0.025, shoulder mobility z: -.577b, p: 0.565, active leg raise -2.236b, p: 0.025, trunk stability z: -2.887b, p: 0.004, rotary stability z: -3.071b, p: 0.002, FMS total score z: -2.952b, p: 0.003) (Table 3).

Table 4. Difference in pre-test and post-test FMS measurements in the Pilates and step aerobic group

N=20	Mean	Standard Deviation	Minimum	Maximum	z	p
Deep squat pre test	1,42	1,00	0,00	3,00		
Deep squat post test	1,83	1,03	0,00	3,00	-1,633[b]	,102
Hurdle Step pre test	2,42	0,51	2,00	3,00		
Hurdle Step post test	2,75	0,45	2,00	3,00	-2,000[b]	,046
Lunge pre test	1,58	0,90	0,00	3,00		
Lunge post test	1,83	0,83	0,00	3,00	-1,732[b]	,083
Shoulder Mobility pre test	2,25	0,75	1,00	3,00	-1,000[b]	,317
Shoulder Mobility post test	2,42	0,67	1,00	3,00		
Active Leg Raise pre test	2,58	0,67	1,00	3,00	-1,732[b]	,083
Active Leg Raise post test	2,83	0,39	2,00	3,00		
Trunk Stability pre test	1,17	0,83	0,00	3,00	-2,121[b]	,034
Trunk Stability post test	1,67	0,98	0,00	3,00		
Rotary Stabiliy pre test	1,33	0,78	0,00	3,00	-2,000[b]	,046
Rotary Stabiliy post test	1,67	0,65	1,00	3,00		
FMS pre test	13,00	3,88	8,00	20,00		
FMS post test	15,00	3,44	9,00	21,00	-2,701[b]	,007

Group 2 had pre-test results of FMS total score 13 ±3.88 (deep squat 1.41 ±0.99, hurdle step 2.41 ±0.51, inline lunge 1.58 ±0.90, shoulder mobility 2.25 ±0.75, active leg raise 2.58 ±0.66, trunk stability 1.16 ±0.83, rotary stability 1.33 ±0.77) and post-test results of FMS total score 15 ±3.43 (deep squat 1.83 ±0.29, hurdle step 2.75 ±0.45, inline lunge 1.83 ±0.83, shoulder mobility 2.41 ±0.66, active leg raise 2.83 ±0.38, trunk stability 1.66 ±0.98, rotary stability 1.66 ±0.65). The FMS scores did not have a significant increase for deep squat, inline lunge, shoulder mobility and active leg raise results, while there were significant increases in hurdle step, trunk stability, rotary stability and total FMS scores (deep squat z: -1.633b, p: 0.102, hurdle step, -2.000b, p: 0.42, inline lunge z: -1.732b, p: 0.083, shoulder mobility -1.000b, p: 0.317, active leg raise -1.732b, p: 0.083, trunk stability -2.121b, p: 0.034, rotary stability z: --2.000b, p: 0.046, FMS total score -2.701b, p: 0.007) (Table 4).

Table 5. Difference in pre-test and post-test FMS measurements in the control group

N=20	Mean	Standard Deviation	Minimum	Maximum	z	p
Deep squat pre test	2,00	0,60	1,00	3,00	-1,000[c]	0,317
Deep squat post test	2,1	1,03	1,00	3,00		
Hurdle Step pre test	2,50	0,52	2,00	3,00	-1,000[c]	0,447
Hurdle Step post test	2,40	0,55	2,00	3,00		
Lunge pre test	1,67	0,49	1,00	2,00	-1,000[c]	0,317
Lunge post test	1,63	0,55	1,00	2,00		
Shoulder Mobility pre test	1,85	0,75	1,00	3,00	-1,000[c]	0,344
Shoulder Mobility post test	1,83	0,94	1,00	3,00		
Active Leg Raise pre test	2,40	0,79	1,00	3,00	,000[b]	1
Active Leg Raise post test	2,42	0,79	1,00	3,00		
Trunk Stability pre test	1,42	0,72	0,00	3,00	-1,000[c]	0,632
Trunk Stability post test	1,40	0,98	0,00	3,00		
Rotary Stabiliy pre test	1,42	1,00	0,00	3,00	,000[b]	1
Rotary Stabiliy post test	1,41	1,00	0,00	3,00		
FMS pre test	13,25	3,65	8,00	19,00	-1,000[d]	0,755
FMS post test	13,19	3,44	8,00	19,00		

The control group had pre-test FMS total score 13.27 ±3.88 (deep squat 2.1 ±0.60, hurdle step 2.45 ±0.52, inline lunge 1.66 ±0.49, shoulder mobility 1.83 ±0.69, active leg raise 2.41 ±0.79, trunk stability 1.41 ±0.83, rotary stability 1.41 ±0.77) and post-test FMS total score 13.28 ±3.80 (deep squat 2.1 ±0.49, hurdle step 2.46 ±0.35, inline lunge 1.65 ± 0.49, shoulder mobility 1.83 ±0.34, active leg raise 2.40 ±0.72, trunk stability 1.42 ±0.63, rotary stability 1.40±0.57). There was no significant change in the results (deep squat z:-1.000c, p:0.317, hurdle step, z:-1.000d, p:0.516, inline lunge z: -1.000d, p:0.652, shoulder mobility z:-1.000c, p:0311, active leg raise z:-1.000c, p:0.483, trunk stability z:-1.000c, p: 0.324, rotary stability z:-1.000c, p: 0.46, FMS total score z:-1.000c, p:0.315) (Table 5). While there was no significant difference between the pre-test total FMS scores in the groups, there was a significant difference in post-test results (pre-test p: 0.92, post-test p: 0.015) (Figure 1).

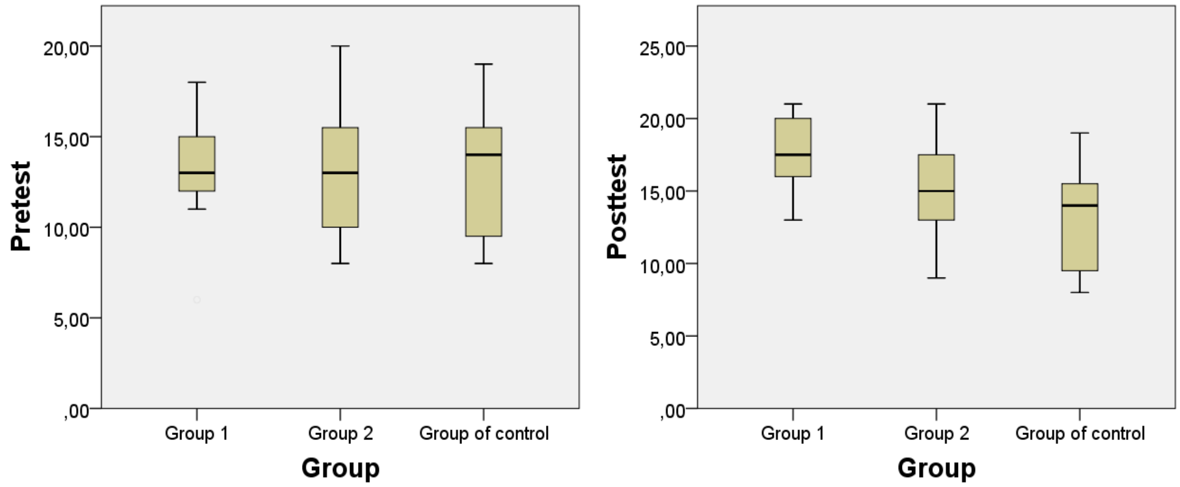

Figure 1. Pre-test and post-test FMS measurement results in the groups

4. Discussion

Previous research has dealt with topics like the effects of long-term Pilates exercises on mobility, stabilization and balance parameters, and rehabilitation after low back pain and sporting injuries (Bryan & Hawson, 2003; Phrompaet *et al*., 2011; Pata *et al*., 2014; Cruz-Díaz *et al*., 2015; Kalron *et al*., 2017; Peterson & Haladay, 2018). Acute studies have compared the FMS scores of different ages and groups with swimming, gymnastics, football and sedentary activity (Bond *et al*., 2017; Sahin *et al*., 2017; DORREL *et al*., 2018). The effect of Pilates exercises and Pilates exercises combined with step aerobic exercises on functional movement scores has not been studied previously. This research performed 2 days Pilates exercises per week and one day Pilates and one day step aerobic exercises with the aim of investigating the effect on functional movement scores. According to the results of the study, the Pilates group developed all FMS scores, apart from shoulder mobility. Additionally, the total FMS score rose from 13.08 to 17.58. The group with one day Pilates and one day step aerobics had an increase in hurdle step, trunk stability, and rotary stability tests, with no variation for the other 4 tests. In this group the total FMS score increased from 13 to 15. The control group had no significant changes in results. In the control group pre-test FMS score was 13.25, post-test FMS score of 13.19 with no change in FMS total scores. The Pilates group received more than 2 points for every test and were not in the risk group for sporting injury. The group with 1 day Pilates and 1 day step aerobics did not receive more than 2 points for the deep squat, inline lunge, rotary stability and trunk stability tests and remained in the injury risk group. The test values in the control group did not change, they did not fulfil the necessary 14-point criteria and did not receive 2 points from each test and remained in the injury risk group.

In a study of 35 elderly sedentary individuals, Pata administered 8 weeks of chair Pilates exercises with each training lasting 40 minutes. At the end of the study, subjects had developed mobility, postural stability and balance characteristics and these results were emphasized to reduce the injury risk (Pata *et al*., 2014). Keays in a study of women with chest cancer found that Pilates exercises increased the shoulder mobility of women (Keays 2008). Rogers found 8 weeks of mat Pilates increased the shoulder and low back *et al*., flexibility of recreationally-active young adults (Rogers & Gibson, 2009). Mokhtari in a study of 30 elderly females stated that 12 weeks of mat Pilates exercises developed balance features and reduced the risk of falling in the elderly (Mokhtari *et al*., 2013). Kalron performed 12 weeks of Pilates exercises with 45 multiple sclerosis patients and found the physical fitness parameters of balance and flexibility had developed at the end of 12 weeks (Kalron *et al*., 2017). In our study, 2 days per week Pilates exercise developed all parameters apart from shoulder mobility. We think the reason for the lack of increase in shoulder mobility is the fact that shoulder mobility in the groups was already high.

There are studies stating Pilates exercises have a role in physical rehabilitation of some injuries and a protective role against injury, in addition to features like flexibility, balance and strength. Bryan in a study of elderly males with chronic low back pain observed 85.1% reduction in low back pain after Pilates exercises and an 87.7% improvement in functional disabilities and emphasized the importance of Pilates in physical rehabilitation (Bryan & Hawson, 2003). Cruz in a study of 65-year old females found that 6-weeks of Pilates exercises reduced low back pain (Cruz-Díaz *et al*., 2015). These results show that Pilates improves spine stabilization and core stabilization. In this research, the group performing 2 days Pilates developed stabilization, while the group with 1 day Pilates and 1 day step aerobics did not have sufficient development. As a result, Pilates can be recommended at least 2 days per week.

Most of the time Pilates exercises are performed with aerobic exercises. In the literature, different training types have been applied under the heading of aerobic exercises. These include aerobic endurance exercises like running, walking, swimming, cycling, step aerobics and dance, etc. Aerobic exercises reduce body fat and weight and may reduce risk of injury. Öksüz applied clinical Pilates exercises with aerobic exercises to ankylosing spondylitis patients and found more effective improvement of spinal mobility, upper extremity flexibility, dynamic balance, forced vital capacity, quality of life and tiredness severity (Öksüz, 2017). Kraemer et al. researched the effects of different training groups on physical and physiologic performance in women and divided the women into 3 different groups. These performed 25 minutes step aerobics in the 1st group, combination of step aerobics and lower-upper body resistance exercise in the 2nd group and 40 minutes step aerobics in the 3rd group. The results of the study recorded reductions of 5-6% body fat in all exercise groups (Kraemer et al., 2001). Özdemir applied 8 weeks of step aerobics exercises combined with Pilates exercises to young women and found fat and body weights reduced, with no significant reduction in middle-aged women (Özdemir 2014). In our study, body fat and weight reduced in both groups. However, the FMS scores were better in Group 1. Basic movement and mobility features like deep squat and inline lunge were not developed in Group 2. These results show that Pilates and step aerobic exercises hare equally effective on body composition; however, Pilates exercises have more effect on FMS scores. Additionally, the variations in Group 2 may be due to the 1 day of Pilates exercises they performed.

There are some limitations to the research. The first is that the study included female groups. It is unknown what the results of the study would be with the male gender. The study included a sedentary group. The test results were not assessed in different populations. Additionally, the low number of subjects is another limitation. Additionally, the study did not include a group performing step aerobics alone, so the direct effect of step aerobic exercises on FMS values cannot be understood; only the results with Pilates movements were found.

In conclusion, 2 days of Pilates exercise preserved and developed functional movement, stability and mobility and reduced the risk of injury. Though one day Pilates and one day step aerobics developed FMS scores, the risk of injury was not reduced. It is clear that sedentary lifestyle carries risk of injury. At least 2 days of Pilates exercises per week may be recommended to preserve functional movement abilities.

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