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# **Is Pilates-based Exercise Effective In Improving Balance In Healthy Adults Over The Age Of 18?**

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A SELECTIVE EVIDENCE BASED MEDICINE REVIEW

In Partial Fulfillment of the Requirements For

The Degree of Master of Science

In

Health Sciences – Physician Assistant

Department of Physician Assistant Studies  
Philadelphia College of Osteopathic Medicine  
Philadelphia, Pennsylvania

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## Abstract

Objective: The objective of this selective EBM review is to determine whether or not Pilates-based exercise is effective in improving balance in healthy adults over the age of 18.

Study Design: Review of three English language randomized controlled trials (RCTs) published in 2006, 2009 and 2012.

Data Sources: Three non-blind randomized controlled trials published in peer reviewed journals found via PubMed.

Outcome(s) Measured: Efficacy was measured with the experimental group participating in a predetermined number of Pilates classes and the control group refraining from any exercise or continuing their pre-study, non-Pilates exercise routines. Change in balance was measured using a four square step test, timed up and go test, functional reach test or the Tinetti scoring system.

Results: Pilates is a useful tool that can be incorporated into the multidisciplinary effort to improve balance in otherwise healthy adults. The three RCTs in this review prove that Pilates-based exercises improve balance compared to baselines. Bird et al found significant longitudinal changes for the timed up and go test ( $p < 0.001$ ) and the four square step test ( $p = 0.001$ ). Johnson et al found significant longitudinal changes in the experimental group ( $p = 0.01$ ), but not in the control group ( $p = 0.54$ ). Rodrigues et al also found a significant improvement in the experimental group ( $p = 0.009$ ) and no improvement in the control group ( $p = 0.084$ ).

Conclusion: Pilates-based exercise significantly improves balance in healthy adults when compared to their pre-study baselines. Future studies need to look at the consequential change in the risk of falling secondary to the improvement in balance.

Key Words: “*Pilates*,” “*balance*”

## Introduction

The loss of static and dynamic balance can represent difficulties for adults that increase considerably with age and can potentiate the incidence of traumatic falls that lead to hospitalization and decreased quality of life. Pilates-based exercises primarily focus on postural muscles to improve trunk stability. They are frequently used in a wide spectrum of environments, including rehabilitation facilities as well as in the athletic industry to improve performance.<sup>1</sup> This paper evaluates three randomized controlled trials (RCT) investigating the efficacy of Pilates-based exercises on improving static and dynamic balance in otherwise healthy adults.

The incidence of falls due to imbalance in young adults (18-45 years old) is 18%, in middle-aged adults the incidence is 21% and in adults over the age of 65 the incidence of falls secondary to imbalance is 35%.<sup>2</sup> These statistics make balance an important part of the clinician's assessment of every patient that is seen, whether it is an annual physical or a daily evaluation of an in-patient. Specifically in older adults over the age of 65, falls are the leading cause of fatal and nonfatal injuries, making balance that much more important.<sup>3</sup> Not only does balance effect morbidity and mortality, it is also a financial burden. According to a 2012 study, the direct medical costs of falls secondary to imbalance for the year were \$30 billion.<sup>4</sup> Imbalance and secondary falls in any age group was responsible for 2.4 million visits to the emergency department in 2012 and more than 722,000 hospital admissions.<sup>3</sup>

To assess a patient's balance, any medical provider must look at multiple variables including but not limited to medications, vision, central nervous system anomalies, musculoskeletal strength and psychosocial factors. In young adults (18-45 years old) the most common etiology of imbalance and subsequent falling is athletic in nature and typically not related to a disease process.<sup>3</sup> In middle-aged adults (45-60 years old) the incidence of imbalance

and falling due to a physiological process increases, and 1 in 4 adults are reported to have an injury-sustaining fall in the last 2 years.<sup>3</sup> In older adults over the age of 65, the incidence of balance-related falls is 35%, giving them the highest risk of sustaining injuries that require medical attention.<sup>3</sup> Currently it is unknown if core strengthening exercises, such as Pilates, can help improve balance in adults and prevent falls.<sup>2</sup>

In regards to balance and subsequent falls, the most important goal of medical intervention should be prevention of such events, especially in aging patients who will have a longer recovery and higher morbidity and mortality. Nonetheless, the same methods to prevent falls are also used after an injury-sustaining fall to rehabilitate the patient back to a better baseline of health and to prevent future injury. The methods that are commonly implemented include exercises focusing on leg strength, Tai Chi, modification of medications such as beta blockers and diphenhydramine, routine neurologic and eye exams with up to date corrective lenses and eliminating tripping hazards at home.<sup>3</sup>

Improving balance is multi-disciplinary and physical activity is at the center of it. Tai Chi, among other disciplines focus on leg strength. Pilates focuses on the transverse abdominis, internal oblique and external oblique muscles that are crucial for trunk stability and may help improve balance by virtue of center of gravity.<sup>5</sup>

### **Objective**

The objective of this selective evidence-based medicine review is to determine whether or not Pilates-based exercise is effective in improving balance in healthy adults over the age of 18.

### **Methods**

The process of selecting studies to analyze required following certain criteria. The population in question includes otherwise healthy adults over the age of 18. Each of the three

studies evaluated an interventional group that attended serial class-based Pilates sessions for up to 8 weeks. The experimental groups were compared to the control groups that consistently received no intervention. The outcomes measured were the effects of Pilates on static and dynamic balance using a four square step test, timed up and go test, functional reach test and Tinetti test, all of which will be discussed later in this paper. The three studies included were all randomized controlled trials.

During research and study selection, key words used were “Pilates” and “balance”. All of the articles are written in English and are published in peer reviewed journals, including Journal of Bodywork and Movement Therapies and Archives of Physical Medicine and Rehabilitation. These articles were researched and selected based on their relevance to the clinical question and if they included patient oriented outcomes (POEM). These studies are randomized controlled trials published after 1999. Any studies of patients under the age of 18 were excluded from the selection. All statistics reported were achieved with p-values, ANOVA, and independent T-tests.

Table 1: Demographics and Characteristics of Included Studies

Study	Type	# Pts	Age (yrs)	Inclusion Criteria	Exclusion Criteria	W/D	Interventions
Bird <sup>6</sup> (2012)	RCT	32	67.3 +/- 6.5 years old	> 60 yo, Independently living and ambulatory, If any medical conditions, they were controlled and stable.	Currently have or recently had an acute medical condition.	5	2- 1h group sessions of Pilates / week for 5 weeks. 1 independent session of Pilates at home / week for 5 weeks with diary of exercises
Johnson <sup>5</sup> (2006)	RCT	40	> 18 years old	> 18 years old	Any medical condition that would impair	6	Ten 1-hour Pilates sessions

					balance, any heart-related conditions that would have prevented them from exercise, Had previously participated in a Pilates-based exercise program, Begun a new exercise program within previous 6 months.		over 5 weeks
Rodrigues <sup>7</sup> (2009)	RCT	52	66 +/- 4 years old	Capacity to carry out ADLs without physical support, physical aptitude for the practice of Pilates exercises, no practice of any other type of physical activity during study period.	Pathologies that could cause physical limitations or that interfered with the functions of attention, understanding and cognition, Use of medication for the treatment of bone, muscle or joint injuries	0	1 hour community-based Pilates session twice every week for 8 weeks.

### Outcomes Measured

The outcome measured in these articles was the change, if any, in static and dynamic balance. Collectively, these articles used a four square step test (FSST)<sup>6</sup>, timed up and go test (TUG)<sup>6</sup>, functional reach test (FRT)<sup>5</sup> and Tinetti scoring<sup>7</sup>. The four square step test is setup with two pieces of tape crossing on the floor making four squares. The patient starts in the back left square (square 1) and faces square 2. They are then instructed to step in boxes 2, 3, 4, 1, 4, 3, 2, 1 with both feet making contact on the floor in all boxes, while facing the same direction. The fastest time from two trials is their score.<sup>6</sup>

The timed up and go test involves a patient seated in a chair with a line on the floor 10 feet away. They are to stand up, walk to the line, walk back to the chair and sit down again. The time begins when you say “Go” and stops when they are seated once again. A patient with a time greater than 12 seconds is considered a high risk for falling.<sup>6</sup>

The functional reach test is performed with the patient standing with one shoulder next to a wall. They then flex this shoulder to 90 degrees and make a fist. Standing straight, a yardstick is used to measure at the head of their third metacarpal. The patient is then instructed to “reach forward as far as you can without taking a step.” The third metacarpal is recorded again. There are three trials that are averaged together to make their functional reach test score.<sup>5</sup>

The Tinetti test is a task performance exam that measures balance and gait by asking the patient to perform a variety of chair-based and standing-based movements. Each movement is scored 0-2, zero represents the most impairment and two represents complete independence. The maximum score for gait is 12 and for balance is 16, the maximum combined score is 28. Any patient with a total score less than 19 is at high risk of falls. A score of 19-24 is at risk of falls.<sup>7</sup>

## **Results**

The three randomized controlled trials included in this review evaluated the efficacy of Pilates on static and dynamic balance in healthy adults. Each study contained continuous data that could not be converted to dichotomous data. Therefore, the analysis of risk reduction (RRR), absolute risk reduction (ARR) and numbers needed to treat (NNT) could not be calculated.

In the study conducted by Bird et al 27 adults over the age of 60 completed the randomized crossover trial. The population was divided into two groups that were randomized by a computer generator. The first intervention phase was a 5-week period when one group participated in 2 one-hour Pilates classes every week, along with an independent one-hour Pilates

session every week. During this time, the control group was instructed to continue usual exercise regimens. The next phase was a 6-week wash-out period, in which both groups were instructed to continue usual exercise regimens. After the wash-out period, the control group became the experimental group and was held to the same schedule of Pilates classes, while the initial experimental group became the control. The two variables measured in this study were the TUG test and the FSST.

An ANOVA was used to assess any differences between the groups. The authors concluded there were no significant differences by the end of this crossover study. However, there were significant pre-Pilates and post-Pilates differences for both the TUG test ( $p < 0.001$ ) and FSST ( $p = 0.001$ ), while using a confidence interval of 95%. Table 2 summarizes the results.

Table 2: Change in Variables During Pilates and Control Phases

Variable	Pre-Pilates	Mean Difference From Baseline	Pre-Control	Mean Difference From Baseline	Difference Between Change in Pilates and Change in Control
TUG Test (seconds)	6.26 (5.97 to 6.72)	-0.41 (-0.61 to 0.21)	6.02 (5.55 to 6.48)	-0.14 (-0.46 to 0.18)	-0.20 (-0.62 to 0.10)
FSST (seconds)	7.86 (7.30 to 8.42)	-0.57 (-0.91 to 0.23)	7.58 (7.07 to 8.09)	-0.34 (-0.76 to 0.07)	-0.23 (-0.72 to 0.26)

In the study conducted by Johnson et al 34 adults over the age of 18 completed the trial after being randomly divided into an exercise group ( $n=17$ ) and control group ( $n=17$ ). The exercise group completed 10 Pilates sessions in a 5-week phase while the control group was instructed to refrain from Pilates or from starting a new exercise regimen. A Functional Reach Test (FRT) was used before and after the 5 weeks by a researcher who was blind to the groups. A two-way ANOVA was then used to compare the FRT between the two groups and to compare the before and after measurements. A paired t-test was used to compare the mean change and determine the effect of the Pilates classes.

There was no statistical difference in pre-study FRT scores ( $p = 0.09$ ). There was a significant improvement in the exercise group. The mean pre-Pilates FRT was 13.61 inches and the mean post-Pilates FRT was 14.84 inches ( $p = 0.01$ ); with a 1.23 inch change from baseline. The mean pre-test FRT for the control group was 15.10 inches and the post-test FRT was 14.79 ( $p = 0.54$ ); with a loss of 0.31 inches from the baseline. Table 3 summarizes the results.

Table 3: Functional Reach Test scores (in.)

	Pre-test mean	Post-test mean	P-value
Exercise (n=17)	13.61	14.84	0.01
Control (n=17)	15.10	14.79	0.54

In the study conducted by Rodrigues et al, 52 women over the age of 60 were randomly divided into a Pilates group (n=27) and a control group (n=25). The study analyzed personal autonomy, static balance and quality of life. For the purpose of this review, only static balance will be discussed. Over the course of 8 weeks, the Pilates group participated in 1-hour community-based Pilates classes twice each week. The control group was instructed to continue usual exercise regimens. The Tinetti test was used to assess the groups' progress.

An ANOVA was used to compare variables between the two groups and a student t-test was used to compare results within the same group. Before the study, the Pilates and control groups had Tinetti scores that were not significantly different (23.85 and 22.04 respectively). The post-test score for the Pilates group was 24.88, which was significant ( $p = 0.009$ ). They are also no longer considered "at risk". The control group had a post-test Tinetti score of 22.36 ( $p = 0.084$ ). Table 4 summarizes the results that describe the effect on static balance.

Table 4: Comparison of pre-test and post-test Tinetti scores

		Average +/- SD	p-value
Pilates group	Pre	23.85 +/- 1.49	0.009
	Post	24.88 +/- 1.07	
Control group	Pre	22.04 +/- 2.89	0.084
	Post	22.36 +/- 2.63	

## Discussion

The efficacy of Pilates-based exercises in improving balance in otherwise healthy adults is an area that these three studies attempted to shed more light on. Already recognized methods of improving balance include leg strengthening exercises, Tai Chi, modification of medication and routinely correcting visual defects. Pilates-based exercise has the potential to become a part of a multi-dimensional approach to improving balance and preventing injury-sustaining falls.

Bird et al found significantly improved TUG and FSST scores from pre-Pilates tests to post-Pilates tests ( $p < 0.001$  and  $p = 0.001$  respectively), however there was no difference between groups at the conclusion of this crossover study. Johnson et al used a functional reach test to measure change within each group throughout the study. They found that there was a significant difference in scores in the Pilates group from beginning to conclusion ( $p = 0.01$ ). Rodrigues et al used the Tinetti test to compare the Pilates group to the control. They found that the Pilates group had significant improvement in scores from pre-study to post-study ( $p = 0.009$ ), while the control group had insignificant improvement ( $p = 0.084$ ).

Although the post-study inter-group comparisons are unclear in the articles, it can be said that the experimental groups showed more improvement compared to the controls. This is because each study displayed no difference in pre-study scores between groups, but the

experimental groups consistently had significant longitudinal changes, and the controls did not. The randomized controlled trials discussed in this review share common findings and prove that Pilates-based exercise improves balance compared to no exercise at all, or continuation of a person's usual non-Pilates exercise.

There were several limitations to the studies in this review. Sample size was a limiting factor across the board. Rodrigues et al studied 52 subjects, Johnson et al initially had 40 subjects, with only 34 completing the program, and Bird et al began with 32 subjects with only 27 completing. In the future, larger study populations will be able to refine the findings and be more comprehensive.

Bird et al used a crossover RCT to study the efficacy of Pilates on balance. The design of the study is not the best when answering this type of question. The experimental group from the first phase may have had neuromuscular adaptations that were retained throughout their control period after the "wash out". In other words, they attained muscle memory from their Pilates classes that were never lost during the second half of the study. This negates the controlled aspect of their control phase and alters the results.

Another limitation was the populations studied. Bird et al and Rodrigues et al studied the effects of Pilates on a population that was specifically over the age of 60, and Rodrigues et al only used female subjects. Though these authors used sub-populations of the one in question, their specificity skews the conclusion of this review and raises questions that could be the topic of future studies.

## **Conclusion**

This systematic review of three randomized controlled trials proves that Pilates-based exercise does significantly improve balance in healthy adults when compared to their pre-study

baselines. Future studies should pay more attention to the sample size and length of the study to better refine the results and come to a more precise conclusion. Also, crossover designs should be avoided in this type of study because of the neuromuscular adaptations that are likely to occur. Now that Pilates is shown to improve balance, future studies can focus on consequential change in the risk of falling secondary to the improvement in balance. Studies can also focus on Pilates specifically in a young adult population and the ability to maintain core strength as opposed to what is commonly seen in the elderly population, regaining what is already lost.

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