

Pilates Exercise: Lessons From the Lab

**A new research
study examines the
effectiveness and safety
of selected
Pilates mat exercises.**

By Michele Olson, PhD, FACSM, with Carrie Myers Smith

When Joseph Pilates originally set out to teach his unique exercises to German internees during World War I, little did he know that one day hundreds of fitness professionals would teach his techniques, and infomercials would sell products based on his methods. But as popular as Pilates exercise has become over the last two decades, until now no research has been conducted to scientifically validate its effectiveness. This article will look at what the first study to date has to say about

the claims modern-day instructors make about the method. In particular, the following questions will be addressed:

- How many calories does a Pilates workout burn?
- Does Pilates exercise raise the heart rate enough to qualify as a cardiovascular fitness workout?
- Does Pilates exercise really target the core muscles? Specifically, how does it compare to the gold standard for abdominal exercise—the gym crunch?

The History

Joseph Pilates was born in a small German town in 1880. A sickly child, he sought ways to improve his health and strengthen his body, and by the age of 14, he was modeling for anatomy charts. In England at the start of World War I, he was placed in a camp for German nationals.

“A few well-designed movements, properly performed in a balanced sequence, are worth hours of doing sloppy calisthenics or forced contortion.”

—Joseph Hubertus Pilates

While there, he began teaching some of his fellow internees the methods and exercises he had developed over the years, honing them into a system that he would later call “contrology” (now referred to as “Pilates mat exercise”). After being transferred to another camp, he began working with the ill and injured internees held there, rigging up beds and springs and designing apparatus that would allow even the bedridden to perform the exercises.

Joseph Pilates eventually emigrated to the United States. In 1926 he opened a gym in New York with his wife, Clara. Because the gym shared a building with dance studios, dancers quickly became his top clientele, although he still worked with the medically challenged, including victims of polio. And so the Pilates method spread—from the medically infirm to dancers and eventually to the general exercise population.

Pilates Meets the Laboratory

I first began taking Pilates classes a few years ago. I could clearly feel the benefits of the workouts, and my body was telling me that many of the claims I had heard about Pilates exercise might be true. (For claims that are a bit sketchy, see “That’s Stretching

It!” sidebar.) But as a scientist, I wanted to take Pilates on in the lab to see if I could find real proof. So I gathered a team of researchers and hit the lab with 12 test subjects.

Feel the (Calorie) Burn

The first thing we set out to determine was how many kilocalories (kcal) a Pilates workout burns. Workouts were divided according to level and intensity (beginner, intermediate and advanced). Over the testing period, the 12 subjects completed all three workout levels in a randomized order, following prerecorded video workouts (from the STOTT PILATES™ video series), while being measured for cardiovascular output. All the routines were mat workouts that did not require any extra Pilates equipment. We used an oxygen/metabolic cart to measure caloric expenditure (1 liter of oxygen [LO₂] = 5 kcal). Both heart rate and rating of perceived exertion (RPE) were monitored.

Results indicated that Pilates workouts at the intermediate and advanced levels meet the requirements for promoting general fitness when performed with high enough frequency and duration. (See “Kcal Burned During Pilates Mat Workouts,” below.) A person wishing to improve or maintain weight and body composition through Pilates mat work would need to progress to the point of being able to do the intermediate to advanced workouts—and perform these workouts at least 4 days a week for 45–60 minutes each session, not including the warm-up and cool-down. (To attain a significant change in body weight, dietary monitoring would also be important.)

The Heart of the Matter

To determine whether a Pilates workout has cardiovascular fitness benefits, we looked at participants’ exercising heart rates and found that they varied throughout the workouts. Some moves, like the more advanced Jack-Knife and Side Lift, boosted the heart rate well into the target zone. In contrast, exercises like the Seated Twist and Leg Circles, which are performed lying down or seated, caused the heart rate to plummet. In addition, while the intermediate and advanced workouts raised heart rate significantly from resting levels—averaging around 120 and 130 beats per minute, respectively—the heart rate response was not like that seen after classic cardio activities like jogging or indoor cycling. To keep the heart pumping (and calories burning) during a Pilates workout, exercisers would need to decrease

Kcal Burned During Pilates Mat Workouts

Type of Workout	Intensity	Kcal/Minute	Comparable Exercise
basic/beginner	low-moderate	4.0	calisthenics, dynamic stretching
intermediate	moderate	6.0	low-impact aerobics, hatha yoga
advanced	moderate-high	7.5	core board exercise, power yoga

Do Pilates Exercises Work the Abs as Well as a Typical Gym Crunch Does?

Movement	Rectus Abdominis	External Obliques
Crunch (control)	100%* (55% MVC**)	100% (19% MVC)
Hundred	-33% (37% MVC)	+31% (25% MVC)
Roll-Up	+38% (75% MVC)	+245% (70% MVC)
Double Leg Stretch	100% (55% MVC)	+103% (39% MVC)
Criss-Cross	+9% (60% MVC)	+310% (79% MVC)
Teaser	+39% (76% MVC)	+266% (71% MVC)

* As the control, the gym crunch was assigned the 100% value as a basis for comparison.

** MVC = maximum voluntary contraction, or the percentage of the muscle's maximal output.

the number of breaks between exercises and maintain a more constant flow throughout the session.

We concluded that Pilates mat exercise, if done at an intermediate to advanced level, can provide a moderate cardio stimulus similar to that provided by some lower-impact activities like walking, but in a more interval-like way. To say that Pilates could replace higher-intensity cardio activities like running would be misleading. Even at the intermediate to advanced level, Pilates is more like flow types of yoga or circuit resistance training with light forms of resistance.

Targeting the Abs

Previous studies on the effectiveness of various abdominal exercises have provided information about the types of movements found to be most challenging to the midsection muscles (Juker et al. 1998; Willett et al. 2001). Using this information as a way to measure the effectiveness of Pilates exercises in the abdominal area, we placed electromyography (EMG) electrodes on the rectus abdominis (RA) and external obliques (EO) of the 12 test subjects and measured the amount of electrical output elicited by these muscles during 10 reps of five different Pilates exercises—the Hundred, the Double Leg Stretch, the Criss-Cross, the Roll-Up and the Teaser. (We also used EMG electrodes to measure the output elicited by the hip flexor muscle. See the next section on possible risks.) The basic gym crunch was used as the control.

RA Activity. Only the Hundred elicited less electrical intensity than the gym crunch for the RA. The Roll-Up and the Teaser produced high amounts of activity, comparable to what Willett and colleagues found for the V-sit and reverse curl; and the Dou-

ble Leg Stretch and the Criss-Cross were similar to what Juker and others measured for bent-knee sit-ups and cross curl-ups.

EO Activity. All the Pilates exercises beat out the crunch when it came to working the EO. The Roll-Up, the Teaser and the Criss-Cross really fired up these muscles, providing a challenge quite similar to what Willett and colleagues found for the crunch with a twist. The Roll-Up and the Teaser also activated the abs to the level that researchers from the University of San Diego reported for the gym crunch on the stability ball (Anders 2001). Finally, the Double Leg Stretch proved effective in challenging the obliques to the same level as the popular side bridge exercise, as reported in the Juker study.

The EMG study results clearly demonstrated that the tested Pilates exercises provide an ample challenge to the abdominal muscles. What was most impressive was the degree to which even the nonrotating Pilates exercises were found to work the obliques.

What Are the Possible Risks?

The research demonstrates that Pilates is probably on target as far as working the abdominal muscles goes, but what about the possible strain these exercises place on the hip flexors, low back and neck during some of the positions? (See “Risks for Injury Associated With Pilates,” below.)

The EMG results indicate that the Teaser is relatively tough on the hip flexors, registering three times more activity in this

Risks for Injury Associated With Pilates

- Putting Too Much Weight on the Neck.** Two at-risk exercises include the Roll-Over and the Jack-Knife. Performance of these exercises can diminish blood supply from the feet to the head and also injure the disks in the neck.
- Flexing the Back Beyond Its Proper Range of Motion.** Positions used in both the Swan Dive and Rocking can overly compress the soft tissues in the back or cause an abdominal strain.
- Overusing the Hip Flexors, Causing Malalignment of the Pelvis.** This can displace the lumbar segments and cause spinal compression in the low back. Two of the biggest offenders are the Roll-Up and the Teaser.

area than the crunch. Since the hip flexors pull on both the upper femur and the front of the pelvis, a strong contraction of the hip flexors can cause the pelvis to rotate forward, creating an increased inward arch in the low back. This puts pressure on the disks and overworks the back extensors.

In addition, some Pilates exercises can be too aggressive on the neck and low back. Classic execution of exercises like the Roll-Over and the Jack-Knife involves rolling the shoulders completely off the floor. When the moves are executed in this way, all the

body weight rests on the small cervical vertebrae of the neck, placing the disks under extreme pressure. Over time, the disks could herniate or rupture.

The posterior muscles on the back side of the neck are also overstretched in these extreme positions, and blood flow can be blocked from the jugular veins, which are pinched together like bobby pins. This is why similar moves in yoga, like the Plow, have always been reserved for experienced yoga exercisers and discouraged in general group fitness classes.

Performance Guidelines

The following guidelines should help maximize the effectiveness of selected Pilates exercises while limiting the risk of injury. Modifications are given for clients with back or neck problems.

Throughout all the exercises, keep the spine stabilized. Envision shortening the abdominal muscles (top to bottom) to the center of the navel. Think “tight and firm.” Do not tuck the pelvis under with the gluteal muscles, since this can cause more stress on the lumbar region. Instead, use the abdominal muscles to flatten the lower belly and stabilize the low back against the mat.

The Hundred

EMG Results. This isometric exercise scored a little lower than the crunch in targeting the rectus abdominis but was 31% more effective at targeting the external obliques.

Get It Right. Lie on the back, feet off the floor, knees bent to 90 degrees so that the shins are parallel to the floor (this is called “tabletop” position). Arms are resting at the sides. Lift the head and shoulders, and extend the knees so that the legs are at a 45-degree angle to the floor. Inhale and pump the arms, palms down, 3–4 inches off the floor, 5 times. Exhale and pump the arms 5 more times. This is 1 breath cycle (or 1 rep). Repeat until you have completed 10 breath cycles.

Modification Tip. Instead of extending the legs at a 45-degree angle, point them straight up to the ceiling, keeping the hips at a 90-degree angle.

The Roll-Up

EMG Results. Compared to the crunch, the Roll-Up was 38% more effective at targeting the rectus abdominis and 245% more effective at targeting the external obliques.

Get It Right. Lie on the back with legs straight and arms reaching diagonally backward above the head. Tighten the abs, then inhale while bringing the arms forward, parallel to the chin. Nod the head forward and try to hit each vertebra as you coil the body up and forward in the shape of the letter C. Exhale and continue to coil forward from the hips, arms extending toward the feet, eyes gazing downward toward the toes. Inhale as you pre-

pare to roll back, and exhale as the back contacts the mat, one vertebra at a time. Perform 5–10 reps.

Modification Tip. Place a small, folded towel under the low back to provide support as you learn the exercise (or if you have a stiff back).

The Double Leg Stretch

EMG Results. The Double Leg Stretch was similar to the crunch in targeting the rectus abdominis and 103% more effective at targeting the external obliques.

Get It Right. Lie on the back, head lifted, feet up, knees bent with toes pointing down, and hands touching the outer shins. Inhale and simultaneously extend both legs to a 45-degree angle while reaching the arms up and back until they are parallel with the ears. Exhale and circle the arms out and around in order to “cup” the lower legs as they bend in back to the start position. Repeat for a total of 5–10 breath cycles.

Modification Tip. Place a large medicine ball under the upper back—just below the neck—for support, but keep contracting the abs to avoid actually resting on the ball.

The Criss-Cross

EMG Results. Compared to the crunch, this exercise was 9% more effective at targeting the rectus abdominis and 310% more effective at targeting the external obliques.

Get It Right. Lie on the back, legs in the tabletop position, hands behind the ears. Lift the head and shoulders off the floor. Twist the trunk, bringing the right shoulder toward the left hip, with the left knee flexing inward. Extend the right leg up and out at a 45-degree angle. Repeat on the other side, bringing the left shoulder toward the right hip, etc. Exhale each time you rotate; inhale between repetitions. Repeat for a total of 10 reps each side.

Modification Tip. Keep both knees bent in the tabletop position. This will give the back extra support and help target the obliques as you progress to the classic style.

The Teaser

EMG Results. Compared to the crunch, the Teaser was 39% more effective at targeting the rectus abdominis and 266% more effective at targeting the external obliques.

Get It Right. Lie on the back, legs in the tabletop position. Place the hands above the head, pointing at the ceiling. Inhale. Exhale, roll through the spine and extend the legs until you sit up to a V-sit position. Arms should be parallel to the legs. Hold and inhale. Then exhale and slowly roll the upper body back down, one vertebra at a time, keeping the legs in the air. Return the arms and legs to the start position. Perform 5–10 reps.

Modification Tip. The Teaser is very advanced and is heavy on hip flexor activity. Working on the “balance” point by rocking back slightly and holding the parallel position with knees flexed will help you achieve better control when trying to master the entire movement.

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That’s Stretching It!

Q. Does Pilates exercise create longer muscles?

- A. Muscles cannot grow longer, but Pilates exercise can improve flexibility in the back, hip and hamstring areas by making the connective tissues (i.e., ligaments) more pliable.

Q. Will Pilates mat exercise create bulky muscles in the way that weight training does?

- A. First, this question makes the false assumption that everyone gets bulky muscles from resistance exercise. The fact is, the overwhelming majority of women have a difficult time “bulking up” because of their low levels of testosterone and high percentage of aerobic muscle fibers. Second, Pilates mat exercise will probably not dramatically increase muscle size because so many of the exercises are performed using a low load, much like yoga, and each repetition is performed under control and precision versus under the resistance of heavy dumbbells or weights.

Q. Does Pilates create lean muscle?

- A. Muscle is already lean tissue. In order to get leaner, you have to add more muscle. (The leanest people in the world have the most muscle mass, as well as very little body fat.) In addition, people who stand tall with an excellent carriage look more elongated, so they may appear to be leaner. This is due to a combination of improved flexibility and increased abdominal and back strength, which Pilates can provide.

Q. Is Pilates effective for healing back pain?

- A. The effectiveness of Pilates for treating back pain has yet to be clearly proven. However, many—though not all—Pilates exercises are similar to those prescribed by physical therapists for rehabilitating people with low-back problems. A study of 22 adults conducted at Florida Atlantic University found that Pilates reduced back pain following a 12-week program (Graves et al. 2005). More studies need to be conducted in controlled, randomized settings before any strong claims can be made regarding the role of Pilates in promoting back health.