



## EFFECTS OF AN ELEVEN-WEEK PILATES EXERCISE PROGRAM ON PROGRESSIVE-SPEED WALKING CAPACITY IN SEDENTARY YOUNG WOMEN: A PILOT STUDY

doi: 10.1515/humo-2016-0011

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### ABSTRACT

**Purpose.** To assess the effects of an 11-week Pilates exercise program on the functional capacity of young sedentary women. **Methods.** Ten subjects underwent the shuttle walking test. A portable metabolic system was used during the shuttle walking test to measure the maximum heart rate and  $\text{VO}_2$  max. The heart rate recovery and the predicted maximal heart rate were also assessed. **Results.** The findings showed increased walking distance, maximum heart rate and heart rate recovery after completing the protocol. The peak of  $\text{VO}_2$  was not significantly different but showed a tendency to increase, being significantly correlated with the covered distance. **Conclusions.** The current results suggest that Pilates exercises significantly improve walking functional capacity.

**Key words:** heart rate, functional capacity, peak of  $\text{VO}_2$ , recovery

### Introduction

Pilates exercises are performed on a mat or using Pilates equipment to assist the subject to practice the exercises properly [1]. Pilates exercises include controlled breathing, concentration, and precision of the movement, tightening the core muscles including the abdominals, the lumbar multifidus and the pelvic floor muscles. The core muscles are responsible for static and dynamic stabilization, and are associated with breath control [2, 3]. The core muscles support the diaphragmatic function by activating the abdominals, and helping to increase lung volume and capacity [4].

A recent review found contradictory or inconclusive results on the effects of Pilates exercise on pain, quality of life and lower extremity endurance in women [3]. On the other hand, another review found strong evidence to support the use of Pilates exercises to improve flexibility and dynamic balance [5]. Recent studies found increased muscular endurance among subjects who started to practice Pilates exercises compared to inactive subjects and with subjects who maintained their normal activity routine [6, 7]. Also, some improvements in lower limb strength and muscle endurance were found in older adults and patients with fibromyalgia [8, 9]. Nevertheless, the effectiveness of Pilates exercises on increasing progressive-speed walking capacity needs to be further evaluated. Cardiopulmonary exercise (e.g. fast

walking) capacity can be used for exercise prescription [10]. The shuttle walking test can be used to evaluate the functional walking capacity of healthy and unhealthy subjects [11, 12]. This low-cost/easily administered test imposes a cardiopulmonary challenge; the information on change in walking speed is communicated to the participants using an audio signal for progressive effort to assess their functional walking capacity [10–13].

Pilates exercises are often used by health professionals (e.g. physical therapists) to treat patients, but further studies are needed to evaluate the benefits claimed by Pilates himself, including its potential effects on functional walking capacity [14]. Therefore, the aim of the study was to assess the effects of an 11-week Pilates exercise program on the functional capacity of young sedentary women. The hypothesis was that the Pilates exercises would increase the functional capacity of young sedentary women.

### Material and methods

#### Participants

A sample of ten healthy but sedentary young women participated in this study (Table 1). Subjects were recruited through public call at the city of Diamantina, Minas Gerais, Brazil. Inclusion criteria were: age between 18 and 21 years of age, weight between 50 and 70 kg, International Physical Activity Questionnaire – IPAQ [15] score classification as inactive or minimally active (sedentary lifestyle). The subjects were assessed by a trained physical therapist, and the exclusion criteria were: leg

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Table 1. Participants’ characteristics

Characteristics	Mean ± SD
Age (years)	23 ± 2
Height (cm)	163 ± 6
Weight (kg)	62 ± 13
Body mass index (kg/m <sup>2</sup> )	23 ± 4
Resting Heart Rate (bpm)	85 ± 13

length discrepancy, pregnancy, ankylosing spondylitis, shoulder impingement, paresthesia, and absence of tendon reflexes. The local ethics committee for human research approved the study protocol, and all subjects signed an informed consent form prior to participation (Protocol 531.995/CEP-UFVJM).

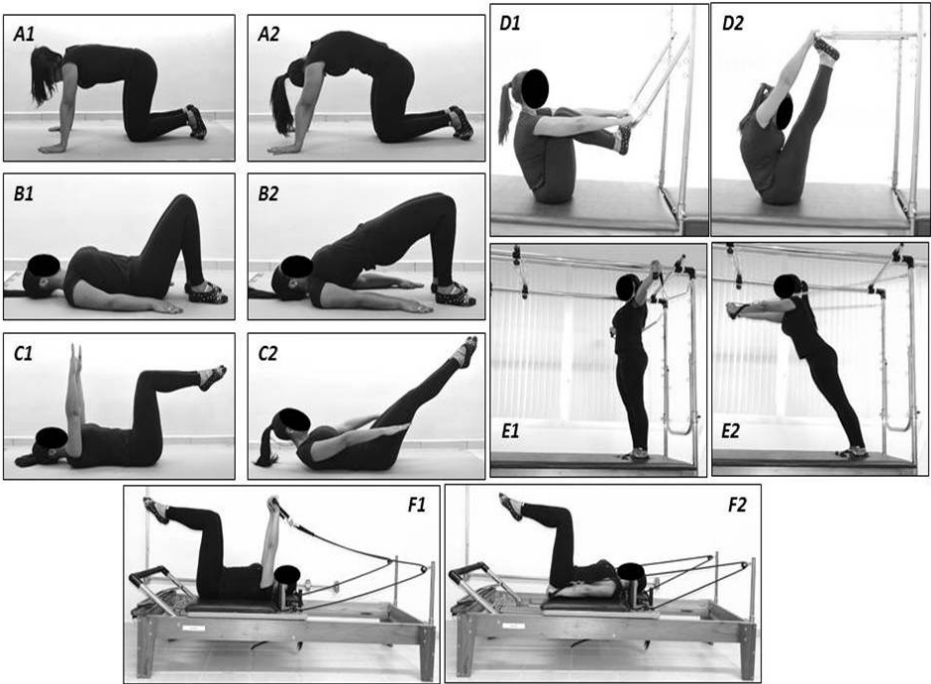


Figure 1. Pilates method exercises: (1) initial position, (2) final position; (A) the cat, (B) the bridge, (C) the hundred, (D) Monkey, (E) Standing on Floor, (F) Arms up and down

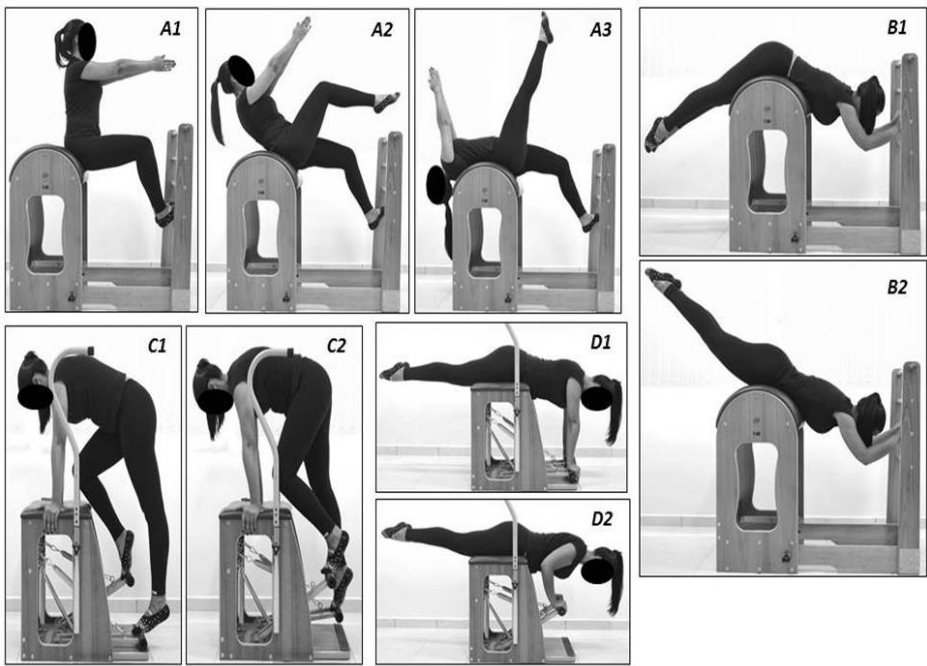


Figure 2. Pilates method exercises: (1) initial position, (2) final position; (A) Climb a Tree, (B) Leg Extension, (D) Step Down, (E) Swan Front

## Procedures

The following sequence of Pilates exercises was performed twice a week, in non-consecutive days (~ 45 minutes/session), during the 11-week protocol (22 sessions): Mat Pilates: “the cat”, “the bridge” and “the hundred”. Exercises on the Cadillac (Pilates exercise equipment): “Monkey” and “Standing on Floor”; on the Reformer: “Arms up and down” (Figure 1); on the Chair: “Step Down” and “Swan Front”; on the Barrel: “Climb a Tree” and “Leg Extension” (Figure 2). All the exercises were performed using the basic Pilates breathing technique that consists of (1) deep exhalation through the mouth – with the lips slightly pursed, (2) inhalation through the nose before the movement and (3) deep exhalation through the mouth – with the lips slightly pursed – during the movement [1].

## Outcome measurements

The shuttle walking test was performed in a 10 m course marked by two cones placed 0.5 m from each end point. Participants went from walking to running around the 10 m course according to the speed communicated by an audio signal. The initial walking cadence was 0.5 m/s increased by 0.17 m/s each minute. The cadence increment was always indicated by a triple audio signal. All tests were administered by the same trained physical therapist and all explanations were standardized.

The shuttle walking test was interrupted when participants became unable to maintain the required speed due to dyspnea or fatigue, or if the subject failed to complete the course within the specified time twice. The therapists approached the subject with a chair and recorded the total distance walked. The number of turns was counted, and a digital chronometer AK71® (AKSO®, St. Leopoldo, RS, Brazil) was used to measure the time. The reduction in heart rate (heart rate recovery) during a 1-minute long rest immediately after completion of the test was recorded [16], and the predicted maximal heart rate was calculated as 220 minus age (in years). A portable metabolic system (VO2000®, MedGraphics®, St. Paul, MN, USA) including a metabolic unit, a battery pack, a harness, a heart rate monitor, a face mask, and a breathing valve was used during the shuttle walking test to measure the peak heart rate and peak of  $\text{VO}_2$  [17].

The reference values for the shuttle walking test in women is largely explained by gender, age and BMI using the following equation [10]:  $\text{SWT}_{\text{pred}} = 1449.7 - (11.7 \times \text{age}) + (241.9 \times \text{gender}) - (5.7 \times \text{BMI})$ ; where male gender = 1 and female gender = 0. Based on the sample demographics, the  $\text{SWT}_{\text{pred}}$  was 1049 m.

## Statistical analysis

BioEstat 5.3 software (Belém, PA, Brazil) was used for statistical analyses. Descriptive statistics were calcu-

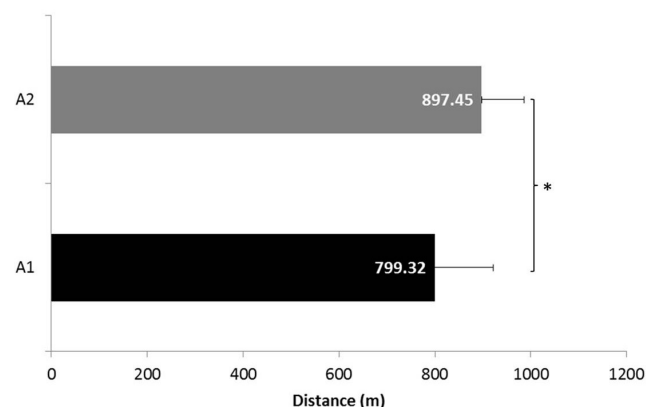


Figure 3. Shuttle walking test distance. A1 – 1<sup>st</sup> assessment; A2 – 2<sup>nd</sup> assessment; \*  $p < 0.05$

lated for the participants' characteristics. The Shapiro Wilk test was performed to evaluate the Gaussian distribution of the data. Paired  $t$ -tests were used to compare differences between assessments (before vs. after). Correlations were calculated using Pearson's correlation coefficient. All were conducted with a significance level set at  $\alpha = 0.05$ .

## Results

Figure 3 shows the increased walking distance after completing the Pilates exercise program (mean difference 95% CI = 29 to 167 m,  $p = 0.005$ ). The peak heart rate also increased after completing the Pilates exercise program ( $180 \pm 17$  bpm before vs.  $194 \pm 10$  bpm after, mean difference 95% CI = 5 to 22,  $p = 0.003$ ), and the heart rate recovery increased from  $27 \pm 12$  bpm before to  $42 \pm 12$  bpm after (mean difference 95% CI = 0.7 to 29,  $p = 0.021$ ).

Peak  $\text{VO}_2$  tended to increase, but the differences were not statistically significant ( $30 \pm 4$  mL/kg/min before vs.  $32 \pm 4$  mL/kg/min after). Peak  $\text{VO}_2$  was also significantly correlated with covered distance ( $r = 0.63$ ,  $p = 0.048$ , 95% CI = 0.01 to 0.90).

## Discussion

There were no adverse effects and all subjects stated no difficulties and a very satisfying experience in completing the Pilates exercise program. There was an improvement in heart rate recovery after the Pilates exercises protocol. Faster heart rate recovery was also found in aerobically trained subjects [18, 19]. Type of exercise is an important determinant of the post-exercise autonomic recovery and also of the effects of interaction between sympathetic withdrawal and parasympathetic activation [20]. On the other hand, a recent study found no difference between cardiac autonomic recovery after continuous and intermittent maximal exercise [21].

Guimarães et al. [22] assessed heart failure patients randomly assigned to either a 16-week Pilates exercise



program or conventional cardiac rehabilitation and, consistently with the trends observed in this study, they found increased ventilation, peak  $\text{VO}_2$  and  $\text{O}_2$  saturation only for the Pilates exercise group. Jürgensen et al. [23] reported that healthy subjects reached 78% of their maximal predicted heart rate when performing the shuttle walking test, while Probst et al. [10] reported that subjects reached 99% of their maximal predicted heart rate. Similarly to the latter, in the current study, subjects reached 98% of their maximal predicted heart rate. Additionally, heart rate recovery was found to be faster in groups with progressive training load, independently of the  $\text{VO}_{2\text{max}}$  level [24].

Pilates exercises characteristics might be beneficial to pulmonary function and functional capacity [4]. The increased recruitment of the abdominal, gluteal and lumbar muscles and breathing technique results in increased blood flow and  $\text{O}_2$  consumption. Aerobic training at intense levels (as opposed to moderate) also increases heart rate recovery [25]. However, the Pilates exercises prescribed during the 11-week protocol were not an intense routine, as classified by the participants. The findings showed changes in heart rate recovery due to a moderate level of Pilates exercise. Another important finding is that the subjects progressively needed less time to complete the exercise sequence. Until the 6<sup>th</sup> week, the average time to complete the sequence was 45 minutes; afterwards the average time was 35 minutes.

Some limitations of this study can be addressed. The sample size of the current study was small, so larger studies are encouraged including the evaluations of different populations and people with different demographics because we only assessed young sedentary women. Also, more parameters need to be assessed including gait characteristics and muscle activation. Furthermore, a control group would strengthen the design of future studies. However, the significantly longer distance covered after the protocol reinforces the hypothesis of improvement in the functional walking capacity. Subjects were closer to reach the predicted shuttle walking test distance ( $\text{SWT}_{\text{pred}} = 1049 \text{ m}$ ) after (actual distance = 81% of  $\text{SWT}_{\text{pred}}$ ) than before completing the program (actual distance = 76% of  $\text{SWT}_{\text{pred}}$ ). A study compared breast cancer subjects who completed an 8-week Pilates exercise protocol along with home exercises with subjects that just did the home exercises and also found that the group that also did Pilates exercises had significantly larger improvements, among others, in walking distance [26].

## Conclusions

Pilates exercises may significantly improve walking functional capacity including walking distance/speed, peak heart rate and heart rate recovery (cardiopulmonary function).

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Paper received by the Editor: January 4, 2016

Paper accepted for publication: May 25, 2016

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