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# The Behavior of Maximal Respiratory Pressures, Peak Expiratory Flow and Functional Capacity Between Pilates Method Practitioners

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## Abstract

**Introduction:** The Pilates method is a strategy with positive effects not only on the balance and quality of life of its practitioners, but also on respiratory muscle strength and functional capacity. The aim of this study was to assess respiratory muscle strength and functional capacity among individuals practicing the Pilates method and compare them with the values predicted for the Brazilian population.

**Methods:** This is a cross-sectional, observational study carried out among Pilates practitioners (N=30) of both genders, aged between 20 and 66 years, with at least 4 weeks of practice in the modality under study. Measures of lung function (peak expiratory flow) and strength (maximum respiratory pressures) were analyzed, as well as functional capacity using the step test, which were compared with normal values for the study population. The significance level adopted was  $p < 0.05$ . **Results:** the mean maximum respiratory pressures obtained were lower than those predicted for the Brazilian population. On the other hand, the average number of ascents obtained in the 6-minute step test was significantly higher than the predicted average. No statistically significant difference was found for PEF ( $p=0.687$ ).

**Conclusion:** The Pilates method did not influence the maintenance of maximum respiratory pressures or PEF measurements in its practitioners. On the other hand, this modern form of physical activity promoted an effective increase in functional capacity, as measured by the step test.

## Introduction

The Pilates method was created by Joseph Pilates in the mid-20th century with the aim of promoting better body balance by adjusting the posture of the head, spine, hips and limbs, resulting in harmonious work between strength and flexibility, and not just muscle hypertrophy [1,2]. The practice of the method has gained followers around the world and in the United States alone there were approximately 10 million practitioners in 2004 [3].

It is believed that the method contributes to greater muscle protein synthesis, increased muscle mass, better bone absorption, greater energy expenditure and higher quality of life indices among practitioners [4]. Patients with lung disease often benefit from the Pilates method because, by stabilizing the spine during the exercises, it promotes intense recruitment of the transverse abdominis muscle, especially when respiratory control is associated with trunk flexion. This pattern, known as "lateral breathing", prevents the abdominal region from expanding, favoring

the difference in pleural pressure, which results in greater efficiency of the diaphragm muscle [5]. For Martins et al. [6], its practice can even increase respiratory muscle strength, generating significant gains in  $VO_2$  max. And according to Wu et al. [3] there can also be significant gains in  $VO_2$  and in functional capacity tests when a sample is submitted to Pilates sessions and associated aerobic training.

It is understood, however, that the effects of the Pilates strategy vary according to the frequency, duration and intensity of the sessions [7].

Although there are many studies evaluating the behavior of pulmonary variables through physical activity, there are few focused on investigating the Pilates method, especially in Brazilian samples. Therefore, this study aimed to evaluate and compare measures of strength (maximum respiratory pressures) and lung function (peak expiratory flow), as well as functional capacity (from the 6-minute step test), correlating these findings with variables such as gender, age and length of physical activity.

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## Methods

This is a cross-sectional observational study carried out among Pilates practitioners (N=30) of both genders and ages ranging from 20 to 66 years. The study took place between September and October 2022 in two cities in the Serra Gaúcha (Parobé and Rolante) and was approved by the FACCAT Research Ethics Committee under opinion no. 5.657.184.

The inclusion criteria were: volunteers enrolled in the program, with a minimum duration of physical activity of four weeks, with no physical deficit that prevented them from carrying out the tests and who fully completed the socio-epidemiological questionnaire. Volunteers with colds, respiratory infections, asthma in the last month, recent thoracic-abdominal surgery (up to three months), who did not achieve a minimum of three reproducible measurements in the pulmonary function tests and users of lower limb orthoses for whom the functional capacity test needed to be adapted were not included. The sample was selected for convenience, according to local demands and provided they met the inclusion and exclusion criteria described above. The appointments were scheduled on days and times previously arranged and guidance on the procedures was provided before the test was carried out.

Peak expiratory flow (PEF) measurements were taken using the Peak Flow Meter and the patient was instructed to take maximum breaths (at the level of vital capacity), followed by an inspiratory pause and forced expiration, following the recommendations of Conceição et al.<sup>7</sup> Three measurements were taken and the one with the highest value was considered for recording purposes.

To measure maximum inspiratory pressure (MIP), the volunteer was instructed to perform a forced exhalation, place the device in their mouth and then perform a slow, deep inhalation (at the level of vital capacity), with an inspiratory pause of 2 to 3 seconds to record the measurement achieved. To measure maximum expiratory pressure (MEP), the volunteer was instructed to perform 2 to 3 ventilations at tidal volume followed by a slow, deep inhalation and, finally, a maximum, sustained exhalation. For both measurements, a Murenas analog manometer was used, calibrated at -150cm H<sub>2</sub>O to +150cm H<sub>2</sub>O and a nose clip. The position adopted for all measurements was sitting, with the legs uncrossed and the patient resting for at least 10 minutes before starting the assessments. The procedures and values obtained were compared with those considered normal for the Brazilian population, according to a study by Pereira [8].

Functional capacity was assessed using the 6-minute step test (ST6'): the volunteer was instructed to go up and down a step at their own pace and at the highest speed possible for 6 minutes, as recommended by Ritt et al. [9]. The value obtained was then compared with the predicted value using the following formula: 'ST6' = 348.4 + 48.48 x Sex (men=1, women=0) -1.29 x Age (years) -0.98 x Height (cm), as recommended by Arcuri [10]. The step used was one sold on the fitness market, made from EVA and 25cm high.

The results obtained were stored in a table in the Excel program. The normality of parametric data was tested using the Kolmogorov-Smirnov test. For the comparative analyses of lung strength and function, as well as functional capacity, Student's one-sample t-test was used. Pearson's correlation test was used to analyze the correlation between gender, age and activity time with the variables under study.

## Results

The study involved 30 volunteers who practiced Pilates, 86.67% of whom were female and most of whom had a high school education, as shown in Table 1.

**Table 1.** Sample of size.

|                           |               |
|---------------------------|---------------|
| Female                    | 86,67%        |
| Age (years)               | 48,06 ± 12,21 |
| Medium level of education | 56,67%        |
| Pilates 1x/week           | 60%           |
| Married                   | 76,67%        |
| Total                     | 100%          |

The mean maximal respiratory pressures obtained in the sample were lower than those predicted for the Brazilian population, emphasizing that Pilates practice had no influence on ventilatory muscle strength variables in this sample. It was also not possible to observe that the Pilates method influenced PEF measurements (p=0.687). On the other hand, the average number of ascents obtained in the assessment of the functional capacity test adopted in the study was significantly higher than the expected average, proving the effectiveness of Pilates in improving the functional capacity of the sample (see Table 2).

**Table 2.** Comparison of the mean values obtained and predicted for pulmonary function and functional capacity measurements.

|                           | Value obtained | Expected value | p       |
|---------------------------|----------------|----------------|---------|
| PEF (L/min)               | 425 ± 105,37   | 434,55 ± 71,54 | 0,687   |
| MIP (cm H <sub>2</sub> O) | 76,20 ± 22,66  | 93,39 ± 16     | 0,001*  |
| MEP (cm H <sub>2</sub> O) | 110,51 ± 26,62 | 142,66 ± 10,04 | 0,003*  |
| ST6'                      | 204,62 ± 45,10 | 137,97 ± 45,10 | 0,0001* |

PEF (peak expiratory flow); MIP (maximum inspiratory pressure); MEP (maximum expiratory pressure); ST6' (6-minute step test). \* statistical significance p < 0.05

When correlating the primary outcomes, namely: PEF, MIP, MEP and ST6' with variables such as gender, age and length of physical activity, a moderate influence of gender on maximum respiratory pressures was observed, as well as age on PEF and ST6'. There was also a strong correlation between gender and PEF and ST6'. Time spent in physical activity, on the other hand, was unable to influence the outcome variables adopted in the study, as shown in Table 3.

**Table 3.** Correlation of pulmonary function variables and functional capacity for Pilates practitioners.

|                    | PFE (L/min) | MIP (cm H <sub>2</sub> O) | MEP (cm H <sub>2</sub> O) | ST6'    |
|--------------------|-------------|---------------------------|---------------------------|---------|
| Gender             | -0,735+     | -0,526*                   | -0,472*                   | -0,763+ |
| Age                | -0,440*     | -0,544                    | -0,139                    | -0,532* |
| Activity frequency | -0,168      | -0,232                    | -0,149                    | 0,187   |

PEF (peak expiratory flow); MIP (maximum inspiratory pressure); MEP (maximum expiratory pressure); ST6' (6-minute step test).

\*Moderate correlation; +Strong correlation

## Discussion

This study included volunteers of both sexes, the majority were female (86.67%), half the sample was over 51 years old and 60% practiced the study modality once a week (Table 1).

The Pilates method is one of the modern forms of physical activity, which involves mental and musculoskeletal health in the same proposal and is practiced mostly by individuals over the age of fifty [3], as also evidenced in this study and mentioned above. For Cronin et al. [11], Pilates is a body and mind program, capable of bringing benefits to muscle strength, postural control, balance, proprioception and coordination. Other authors point to the population's concern about the long-term effects of ageing, the aim of which would be to improve flexibility, reduce the loss of muscle strength and endurance, increase cardiorespiratory capacity and combat the progressive decline in motor skills [12,13].

With regard to aspects of ventilation, according to Jesus et al. [5], the improvement in lung mechanics through the Pilates method is achieved by stabilizing the spine during the exercises through intense recruitment of the transverse abdominis muscle, especially when respiratory control is associated with trunk flexion, thus favoring the difference in pleural pressure and improving diaphragmatic efficiency. According to Oliveira et al. [14], the method also promotes increases in circulation and cardiorespiratory capacity.

Despite what recent scientific literature states, this study did not observe any improvement in the ventilatory mechanics of Pilates practitioners, since the means obtained were lower than those predicted for MIP and MEP measurements (Table 2). Contrary to our findings, Santos et al. [15] observed a statistically significant increase in maximum respiratory pressures among 19 elderly women treated with the Pilates solo method. Fernández-Rodríguez et al. [16], on the other hand, stated that the Pilates method, in addition to its positive effects on balance, quality of life and general physical performance, was also able to exert a strong influence on respiratory muscle strength, a fact that was not evidenced in our study. For Tolves et al. [17], the Pilates method also promoted improvements in the cardiorespiratory function of normal individuals and increases in the functional capacity of elderly women with type II diabetes.

Although our study did not observe any influence of the Pilates method on the maximum respiratory pressures of adults, the authors would like to point out that this strategy can be successful in children, as observed in the study by Leiria et al. [2] which was carried out among children with suspected asthma, treated with Pilates sessions, and who showed normal values of maximum respiratory pressures at the end of the intervention.

About lung function, measured by PEF, this study found no statistically significant difference between the means obtained and those predicted ( $p=0.687$ ). This result was expected for volunteers over 60 years of age, as demonstrated by De Vrieze et al. [18], who pointed out that PEF values tend to decrease over time, probably due to the decline in the ability and capacity for forced expiration in the elderly. Furthermore, in the study by Alvarenga et al. [1], whose sample consisted of 12 elderly people treated with the method for three months, only MIP showed a significant improvement among the pulmonary assessment measures, a fact not demonstrated in the present study.

With regard to functional capacity, it is known that the 6-minute walk test (6MWT) is considered the gold standard

for evaluation in different populations; however, the 6-minute step test (ST6') is attracting increasing interest in the scientific community, as it shows a strong correlation with the expected values for the 6-minute walk test [16]. In our study, we observed a statistically significant difference when comparing the means of the predicted and obtained values for this variable (Table 2). This corroborates the findings of Tolves et al. [17], who treated 14 individuals with the Pilates method and observed an increase in the distance covered in the 6MWT. Finally, when correlation tests were applied to the ST6' performance, our study showed a strong influence of both gender and age (Table 3) for this outcome variable.

In our study, 60% of the sample did physical activity only once a week, a frequency that could be responsible for the unsatisfactory effect on maintaining maximum respiratory pressures. According to Eliks et al. [19], an effective Pilates program should be individualized, last at least 8 weeks, preferably performed three times a week and last between 40 and 60 minutes. In our study, the length of time the Pilates program was carried out had no influence on any of the outcome variables (Table 3).

Physical activity in the Pilates modality is so important that studies such as that by Martins et al. [6], carried out among 68 women who practiced Pilates and those who were sedentary, concluded that even the short period of sessions (16 sessions) was able to promote an improvement in functional capacity and quality of life indices. Similar results were obtained by Ribeiro et al. [20], who treated 33 elderly women in 36 sessions and observed an improvement in both physical activity limitations and pain complaints. On the other hand, fibromyalgia patients treated with Pilates over 15 sessions did not show a statistically significant improvement in functional capacity [21], which leads us to believe that the treatment time needs to be extended for this population.

In our sample, we didn't find any volunteers with a serious illness; however, it is our duty as health workers to alert the population that a physical activity routine can prevent cardiovascular events and reduce morbidity and mortality [22]. In serious diseases such as Chronic Obstructive Pulmonary Disease (COPD), it was possible to recognize significant increases in MIP, MEP and PEF, even though the sample was treated in a relatively short time with the Pilates method [23]. Finally, according to Leiria et al. [2], performing the exercises and postures offered in the Pilates method can have a positive impact on the functioning of the respiratory muscles, resulting in significant increases in ventilatory capacity in both healthy adults and children.

For the authors of the present research, although Pilates is widely used as a form of treatment for various diseases, its results published in reliable scientific media are still scarce, which is one of the limitations for discussing our results. The other limitations of this study refer to age heterogeneity (relevant to spontaneous demand research) and, finally, the small number of participants, making it impossible to randomize the sample.

## Conclusion

The Pilates method was unable to influence the maintenance of maximum respiratory pressures or PEF measurements in its practitioners. On the other hand, this modern form of physical activity promoted an effective increase in functional capacity, as measured by the 6-minute step test.

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