

# EFFECT OF PILATES METHOD ON PHYSICAL FITNESS RELATED TO HEALTH IN THE ELDERLY: A SYSTEMATIC REVIEW



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EFEITO DO MÉTODO PILATES NA APTIDÃO FÍSICA RELACIONADA À SAÚDE DE IDOSOS:  
UMA REVISÃO SISTEMÁTICA

EFFECTO DEL MÉTODO PILATES EN LA APTITUD FÍSICA RELACIONADA A LA SALUD DE INDIVIDUOS  
DE LA TERCERA EDAD: UNA REVISIÓN SISTEMÁTICA

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## ABSTRACT

The objective of this review was to analyze the evidence of Pilates in physical fitness related to health in the elderly. The article indexing databases (Pubmed, Medline, Science Direct, Scielo, Lilacs, and Cochrane) were reviewed along with the *Pilates, elderly and aging* descriptors. A total of 41 studies with a randomized experimental and quasi-experimental design met the inclusion criteria. The selection of the studies was carried out by two researchers and the quality of the articles was assessed using the PEDro scale. Interventions ranged from 4-24 weeks with 1-3 sessions/week, and balance was the most investigated variable. The studies included in this review indicate that Pilates improves health status in the elderly, promoting gains in balance, muscle strength, flexibility, functional autonomy, muscular endurance, body composition and aerobic endurance. Despite these findings, some variables need to be further investigated. **Level of Evidence II; Systematic review.**

**Keywords:** Pilates training; Elderly; Aging.

## RESUMO

O objetivo desta revisão foi analisar as evidências do Pilates na aptidão física relacionada com a saúde de idosos. Foram revisadas as bases de indexação de artigos (Pubmed, Medline, Science Direct, Scielo, Lilacs e Cochrane), com os descritores "Método pilates, idosos e envelhecimento". Atenderam os critérios de inclusão 41 estudos com delineamento randomizado experimental e "quase experimental". A seleção dos estudos foi realizada por dois pesquisadores e a qualidade dos artigos foi avaliada pela escala PEDro. As intervenções variaram entre 4 e 24 semanas, de 1 a 3 sessões/semana e a variável mais investigada foi o equilíbrio. Os estudos incluídos nesta revisão indicam que a prática de Pilates melhora as condições de saúde dos idosos, promovendo ganhos de equilíbrio, força muscular, flexibilidade, autonomia funcional, resistência muscular, composição corporal e resistência aeróbica. Apesar destes achados, algumas variáveis precisam ser mais investigadas. **Nível de Evidência II; Revisão sistemática.**

**Descritores:** Método pilates; Idosos; Envelhecimento.

## RESUMEN

El objetivo de esta revisión fue analizar las evidencias del Pilates en la aptitud física relacionada a la salud de individuos de la tercera edad. Se revisaron las bases indexadoras de artículos (Pubmed, Medline, Science Direct, Scielo, Lilacs, y Cochrane), con los descriptores "Método pilates, ancianos y envejecimiento". Se cumplieron los criterios de inclusión 41 estudios con delineación experimental aleatorizada y "casi experimental". La selección de los estudios fue realizada por dos investigadores y la calidad de los artículos fue evaluada a través de la escala PEDro. Las intervenciones variaron entre 4-24 semanas, de 1-3 sesiones/semana y la variable más investigada fue el equilibrio. Los estudios incluidos en esta revisión indican que la práctica del Pilates mejora las condiciones de salud de los individuos de la tercera edad, promoviendo aumentos de equilibrio, fuerza muscular, flexibilidad, autonomía funcional, resistencia muscular, composición corporal y resistencia aeróbica. A pesar de estos hallazgos, algunas variables necesitan ser más investigadas. **Nível de Evidencia II; Revision sistemática.**

**Descritores:** Método pilates; Ancianos; Envejecimiento.



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## INTRODUCTION

Aging is a global phenomenon and the elderly population has the fastest growing in the world in both developed and developing countries<sup>1</sup>. In Brazil, the elderly population corresponds to 14.4% of the total population and it is estimated that in 2025 Brazil will have the sixth largest elderly population in the world<sup>2,3</sup>. Although the elderly are living more and more

it is known that most of these years are compromised by diseases and limitations. Thus, public policies are needed to promote aging with health and quality of life for the elderly and ensure adequate care for their needs.

Aging is a dynamic and progressive process in living beings, leading to the progressive losses of functional abilities of the organism and consequently leading to death<sup>4</sup>. One of the main ways to avoid and/

or minimize the physical, social and psychological decline that often accompanies aging is the regular practice of physical exercises<sup>5,6</sup>. The regular practice of physical exercises contributes to the maintenance and improvement of the physical fitness of the elderly, making them more independent<sup>7</sup>.

Physical fitness is the ability to perform day-to-day activities with the least amount of effort. Physical fitness related to health refers to the physical condition in the capacities that are related mainly to people's quality of life such as flexibility, aerobic endurance, strength and body composition<sup>8</sup>. Elderly people who perform physical exercises reduce the incidence of falls and the risk of fractures<sup>9</sup>, have a lower risk of developing depression and dementia<sup>10</sup>, and improve physical fitness<sup>11</sup>. In general, the elderly should perform moderate-intensity physical activities for at least 150 minutes/week or 75 minutes/week of vigorous activities and include flexibility, strength, and balance exercises at least two days a week in their routine<sup>7,12</sup>. In this sense, Pilates is an indicated activity for the development of flexibility, strength and balance in the elderly<sup>11,13</sup>. Pilates consists of physical exercises whose main characteristic is resistance work and dynamic stretching, performed in conjunction with breathing and respecting the principles of body control, precision, centralization, fluidity of movement and concentration<sup>14</sup>.

Pilates is a rising activity, so studies that investigated the effects of Pilates among the elderly are recent and the evidence is limited. Thus, the present study aims to conduct a systematic review of the literature on the effects of Pilates on physical fitness related to health in the elderly.

## METHOD

The present systematic review was elaborated from a search of quantitative studies in the following periodicals: *Pubmed*, *Medline*, *Science Direct*, *Scielo*, *Web of Science* and *Scopus*. The terms *Pilates*, *elderly*, *aging* and *aged* were used as descriptors. The search comprised the entire period of existence of the bases until November 2017 and was carried out with the descriptors in English. The review was carried out in four stages of evaluation that included the search of articles and the reading of titles, abstracts and full texts. These evaluation stages were carried out by two researchers independently and when there was divergence between them a third researcher was called.

Included in the review there were articles that filled in the following criteria: a) analyzed the effect of Pilates on the physical fitness related to the health of apparently healthy elderly; b) included in the sample individuals aged  $\geq 60$  years; c) studies written in English or Portuguese and d) experimental or quasi-experimental studies. Studies with children, adolescents and adults as well as book chapters, theses, dissertations, review articles, case studies, editorials and other theoretical articles were excluded from the analysis.

The quality of the articles was analyzed using the PEDro scale<sup>15</sup>, which was used in similar studies<sup>16,17</sup>. This scale consists of analyzing, through 11 items, two characteristics related to the quality of the articles, that are the internal validity and if the study presents enough statistical information that makes it comprehensible. Scale scores range from 0 to 10 (the first item on the list is not counted), and studies with a score greater than 5 are considered high quality<sup>16,17</sup>.

## RESULTS

The articles were published as of 2007, with the majority coming from Brazil (n=20, 48.8%). The sample size ranged from 8 to 303 individuals. As for sex, women were included in all studies, while 17 (41.46%) included both sexes. The most investigated variable was the balance (n=22, 53.6%), followed by muscle strength (n=16, 39%), functional autonomy (n=9, 21.9%), flexibility (n=8, 19.5%), body composition (n=5, 12.2%),

muscular endurance (n=2, 4.9%) and aerobic resistance (n=2, 4.9%). The intervention period varied from 4 to 24 weeks, with the majority of programs lasting 12 weeks (n=15, 36.6%), performed from 1 to 3 sessions/week, with 50-60 minutes/session. Some studies have not reported the attendance of the elderly in class, as well as the level of intensity and the description of the exercises. The quality of the articles included in the systematic review was analyzed using the PEDro scale, reaching the average score of 3.9. Thirteen articles (31.7%) scored higher than 5 points on the PEDro scale, indicating a high methodological quality of the article. Other characteristics about the studies are shown in Appendix 1. A total of 41 articles were included in this systematic review. The titles, abstracts and full texts were read during each stage, repeated articles and those that did not fit the study inclusion criteria were excluded (Figure 1).

## DISCUSSION

This systematic review was conducted with the objective of analyzing evidence on the effect of Pilates on the physical fitness related to the health of apparently healthy elderly. It is believed that Pilates exercises can bring health benefits to the elderly, as it has been reported in studies with adults<sup>16,18,19</sup>, but some variables have been little investigated and need to be better evaluated in order to reach a conclusion. Most of the articles included in this review are recent, which shows that Pilates is being increasingly disseminated and practiced among the elderly. Consequently, there is a greater interest from part of the researchers in investigating more about the effects of the modality in this population. The studies were composed, predominantly, by women, and there was no study with a sample composed solely of males. In fact, there is a greater demand and commitment of women to Pilates, which may explain such a finding, as well as the fact that women are more concerned about taking care of their health<sup>20</sup>. Regarding the methodological quality of the studies, the average score was 3.9 and was below the average of the indexed articles in PEDro, which is 5.1<sup>21</sup>. Only 17% (n=7) of the studies included in this review were classified as high methodological quality, so some factors such as statistical information and internal validity should be analyzed with caution.

Although studies have shown a positive relationship between Pilates and physical fitness it is not clear how much time it takes for these benefits to be achieved, it was observed that some variables need more time than others to take effect. Regarding the number of sessions, a large variation was observed among the reviewed studies, with most of the studies opting for a 12-week intervention.

## Balance

Of the 22 articles that analyzed the effect of balance after Pilates practice on the elderly only 6 did not find positive results. According to the results of this review, there is strong evidence that Pilates improves the balance of the elderly, both static and dynamic. Hyun et al. (2014)<sup>22</sup> and Barker et al. (2015)<sup>23</sup> assessed several aspects of balance and found improvements in dynamic and static balance after 12 weeks of Pilates. Roller et al. (2017)<sup>24</sup> found the same positive results with a shorter practice period, 10 weeks of Pilates, only once a week. In the article by Bird et al. (2012)<sup>25</sup>, a program with 15 sessions of Pilates improved the static and dynamic balance of the participants, but although the balance improved significantly in the Pilates group there was no difference between the Pilates group and the control group. Following this study, Bird et al. (2014)<sup>26</sup> concluded that the improvement in balance remained even after one year after the intervention.

Some studies have investigated the balance related to falls. It is known that, in order to reduce the number of falls, the programs must be multifactorial, aiming at not only isolated equilibrium work, but also being

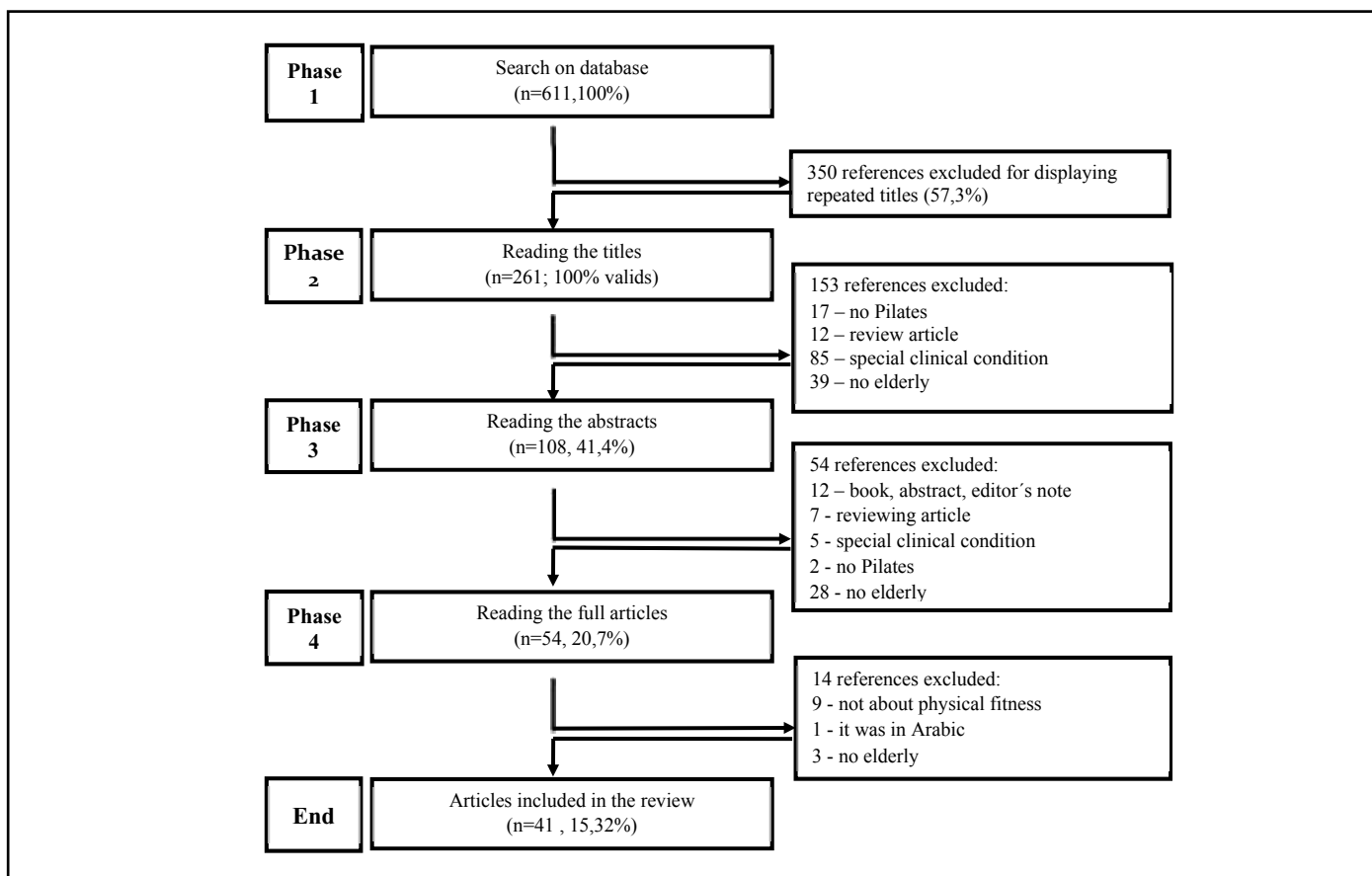


Figure 1. Flowchart of articles selection process.

associated with other variables such as strength and flexibility<sup>27</sup>. In the article by Irez et al. (2011)<sup>13</sup>, the authors conclude that the variables balance, muscle strength and reaction time, together, interfered with a reduction in the number of falls. Corroborating with Irez<sup>13</sup>, studies by Barker<sup>23</sup> and Mokhari<sup>28</sup> concluded that strength improvement, when associated with increased balance, was crucial in reducing the risk of falls in the elderly.

Gabizon et al. (2016)<sup>29</sup> after 12 weeks of Mat Pilates twice a week found no effect on balance. The authors reported that they did not perform any specific balance exercise during this intervention, which may have contributed to this finding. In addition, the study participants were healthy and independent elderly, so the lack of outcome may be due to a ceiling effect on the tests performed. On the other hand, the intervention may not have been vigorous enough to have an effect. Navega et al. (2016)<sup>30</sup> found no effect on the static balance of the elderly after Pilates practice. Like Gabizon<sup>29</sup>, he argues that in order to improve balance, specific exercises should be included for this variable and he believes that assigning the improvement of the balance to an indirect increase in muscular strength is to overestimate the results. In fact, current balance recommendations indicate specific exercises that use progressively more difficult postures with gradual reduction of the support base and dynamic movements that disturb the center of gravity, performed 2 to 3 times a week<sup>7</sup>.

### Muscle strength

several studies have investigated muscle strength and concluded that it is possible to improve this variable after the practice of Pilates. In the Barker et al. study<sup>23</sup> most of the significant changes observed at 24 weeks for the Pilates group were also significant at 12 weeks, suggesting that the changes were achieved within 12 weeks and maintained for an additional 12 weeks of observation. In the programs of Barker<sup>23</sup>, Oliveira et al. (2015)<sup>31</sup> and Oliveira et al. (2016)<sup>32</sup> the intensity with which the exercises were performed was moderate, corroborating with the

recommendations of the American College, which determines that in order to obtain benefits the elderly must practice strength exercises at least twice a week with moderate to vigorous intensity<sup>7</sup>.

In the reviewed studies the intervention time ranged from 4 to 12 weeks, with 2 to 3 sessions/week, which leads to a variation of the total number of sessions between 12 and 36 sessions. The results of the studies by Bird<sup>25</sup>, with 15 sessions, and of Donath<sup>33</sup> and Kaesler<sup>34</sup>, with 16 sessions, did not present improvement of muscular strength, whose possible reason is that the little time practiced was not sufficient to promote gains in this variable. On the other hand, Pinheiro et al.<sup>35</sup>, with only 12 sessions, observed a significant improvement in paravertebral muscle strength. In spite of the relatively low number of sessions, in this specific case, the positive results are consistent due to the small sample studied. When it comes to the cases in which a larger number of sessions were recorded (24-36 sessions), there was improvement of muscle strength in all the studies. This leads us to the fact that the results should be analyzed according to the duration of each intervention, and it remains to be seen that, when close to 24 sessions, there are greater benefits in relation to practices limited to a few sessions.

### Flexibility

of the eight studies<sup>9,20,23,24,32,36-38</sup> that assessed flexibility, all found positive effects for at least a certain part of the body. Studies ranged from 8-24 weeks of intervention. The study by Guimarães et al.<sup>20</sup> investigated the flexibility of the hip and shoulder after 12 weeks of Pilates intervention in the apparatus and mat. The results showed that there was an increase in flexibility for both the hip and the shoulder, but the results were only significant for the shoulder ( $p=0.001$ ). The same happened in the study of Fourie 2013<sup>36</sup> where there was improvement of the flexibility of some parts of the body and others did not. In the study by Fourie<sup>36</sup> after 8 weeks of Mat Pilates there was gain of flexibility for shoulder and hip

flexion but not for shoulder extension and knee flexion. In that sense, it is necessary to consider whether the exercises included in the program are giving the same muscular emphasis to all the evaluated parts, besides, if the short period of the intervention was enough to cause changes in the flexibility of different parts of the body. Recommendations for flexibility suggest that any activity capable of maintaining or increasing flexibility with moderate intensity should be performed at least 2 times a week<sup>7</sup>.

In Plachy's<sup>38</sup> 24-week study of Pilates, measurements of various parts of the body were made and all of them had significant changes, suggesting that longer-lasting intervention tends to gain greater gains in flexibility for the whole body. On the other hand, the group that practiced Pilates also practiced water aerobics, so it is not known if this gain in flexibility was by Pilates, by water aerobics or by both.

### Functional autonomy

among the nine studies<sup>39-47</sup> that assessed functional autonomy, only one<sup>46</sup> did not improve after the Pilates practice. The variation in the duration of the interventions was large, between 5 and 24 weeks, and it was observed that even studies with a short period of time were efficient in increasing the functional capacity. The study by Duarte<sup>41</sup> consisted of two periods of Mat Pilates with classes twice a week, each with 5 weeks of class and an interval of 5 weeks without activity between them. Functional autonomy improved after the first period and worsened when the intervention ceased. When the second period of intervention with Pilates and the conversation circles resumed, functional autonomy improved again. Corroborating with this finding, Bertoli et al.<sup>39</sup> showed that only 6 weeks of Pilates alone were sufficient to significantly improve all variables of functional capacity assessment. The longest study was that of Filho et al.<sup>42</sup>, who evaluated and compared different exercise modalities, including pilates + water aerobics, for 24 weeks, and concluded that, at the end of this period, all modalities increased functional autonomy.

Contrary to the results, Taskiran et al.<sup>10</sup>, compared a group of elderly nursing home residents who practiced Pilates and one who practiced yoga for 8 weeks, observing improvement in strength and flexibility only in the group that practiced yoga. The authors believe that the intention-to-treat analysis may have prevented other parameters from reaching statistical significance, in addition to the small sample and the short duration of the intervention. Another possible justification is that the health condition of the population investigated was already good, so the lack of improvement.

### Muscle resistance

only two<sup>38,48</sup> studies investigated the effects of Pilates on muscle endurance. Plachy et al.<sup>38</sup> found, after 6 months of Pilates, positive results to increase muscular endurance in the elderly. The study compared individuals who practiced Pilates three times a week and subjects who practiced Pilates once a week plus twice a week water exercises. Lower limb muscle endurance was assessed through the sit-to-stand test of the Fullerton Functional Fitness Test battery. Both programs proved to be effective in increasing lower extremity muscular endurance, with the group that practiced only Pilates presenting more expressive results. However, important aspects of the practice were not clarified in the study, including whether Pilates was performed on the mat or with apparatus and also aspects of exercise intensity, load and evolution, which makes it difficult to compare with other studies.

Fourie et al.<sup>48</sup> in their study concluded that 8 weeks of Mat Pilates, 3 times a week, were sufficient to increase the muscular endurance of the elderly. The muscular resistance was measured by the number of squats that the elderly could execute without fatigue. The elderly were evaluated before and after the intervention and there was an increase of  $24.48 \pm 11.62$  repetitions to  $44.16 \pm 18.97$ ,  $p = 0.000$  after the end of the program. As in the Plachy study (38), no details of intensity, load and evolution of the exercises were reported. In both studies only women

were investigated, which prevents us from expanding the findings for both genders. Although the studies present promising results regarding the effects of Pilates on muscle endurance, the evidence is limited because, in addition to the few number of studies, both presented low methodological quality on the PEDro scale.

### Body composition

of the five studies<sup>46,47,49-51</sup> that investigated the effects of Pilates on body composition, three<sup>46,49,51</sup> performed their intervention programs with the same duration and weekly frequency (8 weeks, three sessions a week), using Mat Pilates. In the study by Fourie<sup>49</sup> et al. there was a decrease in the percentage of fat and increase in the percentage of lean mass. Contrary to these findings, the studies by Taskiran<sup>46</sup> and Markovic<sup>51</sup> found no change in body composition after the end of the program. Although the studies were similar in duration, details such as number of repetitions, evolution in the exercises and intensity were not reported in all studies, which makes it difficult to compare them. In addition, the form of evaluation was different between them. While Fourie<sup>49</sup> evaluated body composition through skinfold measurements, Taskiran<sup>48</sup> and Markovic<sup>51</sup> used bioimpedance, which may explain in part the differences in results. Although the two methods are widely used, there is disagreement in the literature regarding the use of skinfolds in the elderly due to thickness and elasticity of the skin and redistribution of subcutaneous fat, factors that may interfere with the accuracy of the method<sup>52</sup>.

Ruiz Montero et al.<sup>50</sup> and Vasconcellos et al.<sup>47</sup> had positive findings in their studies, but in both, Pilates was associated with other aerobic activity, which may have favored the results. Combined activities tend to produce better results than isolated training, particularly for anthropometric measurements and body composition<sup>47,53</sup>. In addition, the duration of their program was much greater than that of the others: in the study of Ruiz Montero et al.<sup>50</sup> were 24 weeks of intervention and, in the study by Vasconcellos et al.<sup>47</sup>, 16 weeks. Ruiz Montero et al.<sup>50</sup> performed a program that mixed aerobic activities and Pilates in the same class and observed that at the end of the program there was a decrease in the percentage of fat mass while the percentage of lean mass remained unchanged. Vasconcellos et al.<sup>47</sup> compared strength group, functional gymnastic group and pilates + water aerobics group, and although the three groups improved body composition and anthropometric measures, the group that practiced Pilates + water aerobics had more expressive results than the others in the loss of weight and decrease in body mass index.

### Aerobic resistance

two studies<sup>38,54</sup> investigated aerobic resistance and Pilates and the results were positive. After a 24-week Pilates program with three sessions a week Plachy et al.<sup>38</sup> observed positive results in aerobic endurance in elderly women. The aerobic endurance was measured in two moments: before and after the intervention, through the 6-min walk test. The authors justified this result as a consequence of the greater gain of muscular resistance and also of the increase of muscle control. The same result was confirmed in the study by Vieira et al.<sup>54</sup> who, after a 12-week program of Mat Pilates, recorded an increase in distance in the 6-min walk test ( $\sim 30$  m,  $p < 0.01$ ). However, the authors advert that the results need to be interpreted with caution since there was also an increase in lower limb strength in the sit-to-stand test, which may have influenced performance in the aerobic endurance test. In fact, this bias will always exist, because muscle strength is one of the variables worked on in a Pilates class. Nevertheless, the results of the studies point in a positive direction, however, the number of studies that support this evidence is reduced.

## CONCLUSION

Overall, the studies included in this review indicate that the Pilates practice improves the health conditions of the elderly, promoting gain in balance, muscle strength, flexibility, functional autonomy, muscular endurance, body composition and aerobic endurance. Despite these findings, some variables were poorly investigated, and the number of studies relating Pilates for the elderly with certain variables, such as muscular endurance and aerobics, is reduced. Thus, these variables need to be further studied to arrive at some conclusion about the benefits achieved.

The professionals in the area of physical activity can use the results of this review as a basis for preparing programs for Pilates training in the elderly. It was observed that 2-3 sessions/week, for a period between 4-24 weeks, can initiate changes that promote benefits for the physical fitness

related to the health of the elderly. Nevertheless, some limitations should be considered in relation to the studies analyzed, such as the limited time of some programs, the limited description of the interventions such as, for example, the specific exercises that were performed, intensity, number of repetitions, number of absences and training of the Pilates professional, and the existence of few studies with high methodological quality.

We emphasize that more studies are needed on the variables that were less investigated, as well as studies that promote longer interventions, with a better description of the methodological details of the program and with greater methodological rigor.

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**Appendix 1.** Description of the studies published and included in this review regarding the effects of Pilates on physical fitness related to health in the elderly.

Author, Year (Country) PEDro Scale	Sex, N, Age	Study design (use of control group)	Objective	Intervention	Variables / tests	Results
Barker et al, 2015 (Australia) 6/11	MF, 53, 61-84	Randomized controlled trial (Y)	To evaluate the feasibility of Pilates exercise in older people to decrease falls risk and inform a larger trial.	PG: Pilates equipment, 12 weeks, 2 sessions/week, 60 min +20 min home exercise (balance and strengthening exercises performed in a standing position). Exercises were individually tailored to participants' needs and ability but were intended to be '7 out of 10 difficulty' for balance (0-10 scale) and were progressive. Exercise progressions included sensory challenges with eyes closed, head turns or unstable surfaces; dual tasking and narrowing the base of support. CG: continued to receive standard care from their primary healthcare practitioners + 20 min home exercise (same program of PG).	Balance: step test, functional reach, lateral reach, timed up and go, timed tandem stance and dynamic gait index, four square step test. Muscle Strength- timed sit to stand. Flexibility- straight leg raise and knee-to-wall test.	There were significant improvements (p < 0.05) in the PG compared with the CG for five standing balance measures: step test, functional reach, timed up and go (fast), timed tandem stance on foam with eyes closed and dynamic gait index. Lower-limb strength improved significantly (P = 0.012) improved in PG compared with the CG at the 24-week follow-up. There were significant improvements (P = 0.05) in the PG relative to the CG in lower limb flexibility (straight leg raise), while both groups improved in the knee-to-wall test (P = 0.001) without a significant difference between groups (P = 0.144).
Bertoli et al, 2017a (Brazil) 2/11	F, 14, 62±3	Experimental (Y)	To analyze the effects of Mat Pilates on isokinetic torque of the lower limbs in elderly women.	The investigation had two periods: control and intervention. The control period consisted of the first 4 weeks of the study, where no Mat Pilates exercises were performed and the participants continued with their normal activities. The intervention period consisted of Mat Pilates and accessories, 12 weeks, 3 sessions/week, 60 min. Exercises were performed in 3 sets, the number of repetitions increased every 4 weeks and the difficulty level progressed from beginner to intermediate and then advanced.	Muscle Strength - isokinetic dynamometer.	The results showed significant improvements (p < 0.05) in concentric and eccentric peak torque of knee flexors muscles, hip flexor and extensor muscles after 12 weeks. Mechanical work showed significant improvement (p < 0.05) for knee extensor muscles during eccentric contractions after week 12, for hip extensor muscles during concentric contractions week 12, and for flexor muscles during concentric and eccentric contractions after week 12.
Bertoli et al, 2017b (Brazil) 2/11	F,18, 62.3 ±2.3	Experimental (Y)	To evaluate the effect of Mat Pilates on the functional capacity of elderly women before and after six weeks of intervention.	The investigation had two periods: control and intervention. The control period consisted of the first 4 weeks of the study, where no Mat Pilates exercises were performed and the participants continued with their normal activities without any kind of physical activity intervention. The intervention period consisted of Mat Pilates, 6 weeks, 3 session/week, 60 min. Over the weeks, difficulty and the number of repetitions was increased, starting at beginner and reaching the intermediate level.	Functional capacity- Timed Up and Go test, Timed Up Stairs, Timed Down Stairs, 30-s Chair Stand, Chair Sit-and Reach and Back Scratch	Six weeks of Mat Pilates intervention were enough to improve significantly all functional capacity assessment variables (P < 0.05)
Bird et al., 2012 (Australia) 6/11	F/M, 32, 67.3± 6.5	Randomized controlled trial (Y)	To evaluate effects of a Pilates intervention on balance and function in community-dwelling older adults.	PG: Circuit style session of Pilates reformer and mat-based exercises, 5 weeks, 2 sessions/week, 60min + 1 session/week mat pilates at home (they received a diary with exercise description). Progression occurred whenever possible through increased load and repetition. CG: did not receive treatment and were instructed to maintain their current activities.	Static and dynamic balance- mediolateral sway range, Four Square Step Test, Timed Up and Go Test. Strength- was measured for both legs by using a spring-based measurement system developed as part of a battery of fall risk assessment tests.	PG: There were significant improvements in all dependent static and dynamic balance variables (p < 0.001), but not for lower-limb strength (knee extensor strength, P<.396; ankle dorsiflexor strength, P<.356). CG: no changes. There were no significant differences between the PG and CG for any measured variables (P<.05).
Author, Year (Country) PEDro Scale	Sex, N, Age	Study Design (use of control group)	Objective	Intervention	Variables / tests	Results
Curi et al, 2017 (Brazil) 3/11	F, 61, 64,5	Randomized controlled trial (Y)	To determine the effects of Pilates-based mat exercises on functional autonomy and life satisfaction among elderly women.	PG: Mat Pilates , 16 weeks, 2 sessions/week, 60 min. Started with exercises for beginners in the first 2 weeks and progressed to intermediate, the number of repetitions varied between 3-10 repetitions depending on the exercise. CG: did not receive treatment.	Functional Autonomy- Senior Fitness Test.	There was a significant improvement (p <0.005) in all variables analyzed for PG. There was no improvement for CG.
Donath et al, 2016 (Switzerland) 5/11	F/M,48, >60	Randomized controlled trial (Y)	To examine effects of traditional balance vs. Mat-based Pilates training on balance and trunk strength in healthy community dwellers.	PG: Mat Pilates, 8 weeks, 2 sessions/week. Six to 12 repetitions were performed during each exercise. Training progression was guaranteed within the 8 weeks by modifications and increased repetitions. BG: same frequency of PG, the main part was conducted in standing position. Training progression was ensured by reducing the base of support, sensory input and additional tasks. CG: followed their regular daily activity schemes.	Static and dynamic balance- force plate (single limb stance, perturbed kneeling and Y-balance test). Trunk strength- Curl up test.	The PG did not have significant changes in the variables investigated, while the BC significantly improved the balance and trunk strength.

Author, Year (Country) PEDro Scale	Sex, N, Age	Study design (use of control group)	Objective	Intervention	Variables / tests	Results
Duarte et al, 2017 (Brazil) 2/11	F/M, 24, >60	Quasi-Experimental (N)	To verify the effect of an intervention protocol using Pilates and conversation circles on the functional autonomy and quality of life of older adults.	Mat Pilates, 20 sessions (2 periods of 5 weeks of class). Each period was composed of 2 sessions / week, 45-50 min + conversation circle about health and life. The same sequence of exercises was maintained throughout the intervention and each exercise was carried out with 5-10 repetitions. The progression of the exercises was not reported.	Functional Autonomy-GDLAM	After 20 weeks the GDLAM index obtained 16% reduction in the average time of tests, from 32.5 to 27.3 seconds (p<0,001). In the first 10 weeks, reduction was greater (14%) than in the last 10 weeks (11%) of intervention. The 10-m walking test improved from weak to good. The time of standing from a sitting position test was weak in the first baseline and after 20 weeks showed good classification. The standing from the prone position and standing from a chair and move around the house tests improved from weak to regular, as well as the GDLAM index.
Filho et al, 2016 (Brazil) 4/11	F, 114, 64.21 ± 3.17	Randomized controlled trial (Y)	To evaluate different modalities of physical exercises on elderly women's muscular strength and functional autonomy.	All groups practiced exercise for 24 weeks, 3 sessions/ week, 60 min, 5-7 points of intensity on the Borg scale. PG: Pilates in the apparatus, 2-3 sets of 10 repetitions, the intensity was controlled by the springs which was adjusted individually and were replaced by other ones of greater intensity according to the evolution of each participant. STG: alternating exercises by segments, 3 sets, 8-12 repetitions, 1-2 minutes of interval between sets. WG: stretching exercises, localized (with and without accessories) and aerobics. GG: resistance, flexibility, balance and agility exercises with the use of dumbbells, shin guards, rods and cones. CG: unspecified	Functional Autonomy-Senior Fitness Test	All modalities proved to be efficient in increasing muscle strength and functional autonomy. However, strength training stood out as other modalities in increasing muscle strength and transferring this physical capacity to functional autonomy (p <0.05).
Author, Year (Country) PEDro Scale	Sex, N, Age	Study Design (use of control group)	Objective	Intervention	Variables / tests	Results
Fourie et al, 2012 (South Africa) 4/11	F, 50, > 60	Randomized controlled trial (Y)	To determine the effects of Mat Pilates on muscular strength and endurance in elderly women.	PG: Mat Pilates, 8 weeks, 3 sessions/ week, 60 min. The intensity and progression of the exercises were not reported. CG: did not receive treatment.	Upper-body muscular strength- arm curl test (SFT) Lower-body muscular strength- sit to stand test (SFT). Muscular Endurance- was measured by the number of squats the subject was able to perform until fatigued.	There was significant improvements in upper-body muscular strength (from 19,12±5,13 repetitions (reps) to 27,84±5,68 (reps); p=0,000); lower-body muscular strength (from 13,24±3,23 reps to 17,52±3,81 reps; p=0,000) and muscular endurance (from 24,48±11,62 reps to 44,16±18,97; p=0,000).
Fourie et al, 2013a (South Africa) 4/11	F, 50, > 60	Randomized controlled trial (Y)	To determine the effects of a mat Pilates program on body fat in elderly women.	PG: Mat Pilates, 8 weeks, 3 sessions/ week, 60 min. Intensity and progression were not reported. CG: did not receive treatment.	Body composition- skinfolds of triceps, biceps, subscapular and iliac crest (equations of Durnin and Womersley).	PG: demonstrated a significant (p ≥ 0.05) decrease in body fat (p = 0.016) and fat mass (p = 0.038), with a significant increase in lean body mass (p = 0.006), while not showing any significant changes (p ≥ 0.05) in body mass (p = 0.979) and body mass index (p = 0.992). CG: did not produce any significant (p ≥ 0.05) changes in any of the tests anthropometric variables.
Fourie et al, 2013b (South Africa) 4/11	F, 50, > 60	Randomized controlled trial (Y)	To determine the effects of mat Pilates on flexibility in elderly women.	PG: Mat Pilates, 8 weeks, 3 sessions/ week, 60 min. Intensity and progression were not reported. CG: did not receive treatment.	Flexibility- gravity based Leighton Flexometer).	PG: demonstrated a significant (p ≤ 0.05) improvements in shoulder flexion (from 152,84±21.32 degrees to 179,60±10.53 degrees; P=0.000) and hip flexion (from 74.36±13.07 degrees to 82.60±16.40 degrees; P=0.002), but not shoulder extension (from 54.80±24.03 to 61.20±9.99 P=0.184) or knee flexion (from 79.20±10.48 degrees to 82.60±16.40 degrees; P=0.371). CG: No significant differences was found in shoulder flexion (P=0.165), hip flexion (P=0.583) and knee flexion (P=0.349) from pre - to post - test. However, shoulder extension did significantly (P=0.000) increase from pre- to post-test.
Gabizon et al, 2016 (Israel) 5/11	F/M, 88, 71 ± 4	Randomized controlled trial (Y)	To evaluate the effect of a group-based Pilates training program on balance control and health status in healthy older adults.	PG: Mat Pilates, 12 weeks, 3 sessions/ week. The progression of the exercises were made through the use of swiss ball and thera band, the exercises were tailored to each subject's ability. CG: did not receive treatment.	Postural control and balance: postural stability examination (force platform) and BBS.	There were no significant group-by-time interactions for any measure of balance control. However, there were significant main effects for time for the BBS and postural stability parameters. PG did not improves balance control when compared with a control group.

Author, Year (Country) PEDro Scale	Sex, N, Age	Study Design (use of control group)	Objective	Intervention	Variables / tests	Results
Geremia et al, 2015 (Brazil) 1/11	F/M, 20,70 ± 4	Quasi-experimental (N)	To evaluate the effects of physical training using the Pilates method on body flexibility of elderly individuals.	Mat Pilates, 10 weeks, 3 sessions/week, 60 min. 8 to 10 repetitions were performed for each exercise, according to their level of difficulty. The exercise order was maintained throughout the protocol. The Borg Rating of Perceived Exertion (6–20 point scale) was used to monitor training intensity. The rating score was 12 for the first 5 weeks and 14 for the remaining 5 weeks of the training program.	Flexibility- flexometer	Cervical spine: There were increases in flexion (22.86 %; p < 0.001), extension (10.49 %; p = 0.036), and left rotation movements (20.45 %; p = 0.019). There were no changes in right and left tilt and in right rotation movements. Thoracolumbar spine: Increases could be observed in all variables evaluated, with greater magnitude in right (39.52 %; p < 0.001) and left tilt (38.02 %; p = 0.001), right and left rotation (24.85 and 24.24 %, respectively; p < 0.001 for both directions), and, finally, flexion (16.45 %; p < 0.001) and extension (23.74 %; p = 0.006). Glenohumeral joint: In both joints increases could be observed in the ranges of motion for flexion (right— 8.80 %, p = 0.034; left—7.03 %, p = 0.050), abduction (right—20.69 %, p < 0.001; left—16.26 %, p = 0.005) and lateral rotation (right—116.07 % and left—143 %; p < 0.001 for both directions). There were no changes in the ranges of joint motion for right and left shoulder extension or in medial rotation in both directions. Hip joint: Increased flexibility was observed only in hip flexion (right—15.83 %, p = 0.050; left—9.55 %, p = 0.047). There were no changes in extension, abduction in either direction, adduction in either direction, and lateral and medial rotation. Knee joint- Both the right (14.20 %; p = 0.006) and the left knees (15.20 %; p = 0.017) exhibited increased flexion movement.
Guimarães et al, 2014 (Brazil) 2/11	F/M, 60, 68 ± 5.1	Randomized controlled trial (Y)	To evaluate the effect of the Pilates method on the hip and shoulder girdle flexibility levels in the elderly.	GP: Pilates machine, mat and with accessories, 12 weeks, 2 sessions/week, 60 min. The intensity of the exercises was moderate, 10 to 12 repetitions for each exercise. GC: were instructed to not practiced any kind of physical activity during the intervention period.	Hip Flexibility- sit and reach test. Shoulder Flexibility -behind the back reach test	PG: concerning hip flexibility, 60% was considered normal, this percentage raised to 66,7% in the retest. In the superior classification we had 10% and there was a rise of 33.3% in the retest, however not having significance between the variables (p = 0.180). On shoulder girdle flexibility, 63.3% were classified under normal, and 16.7% on superior flexibility, changing this number to 46.7% in normal classification, and to 33.3% on the superior classification on the retest, within an increase of 16.6% for the superior variant on the retest, with significant difference between the variables (p = 0,001). CG: no changes between test and retest.
Author, Year (Country) PEDro Scale	Sex, N, Age	Study design (use of control group)	Objective	Intervention	Variables / tests	Results
Hyun et al, 2014 (Republic of Korea) 2/11	F,40, ≥65	Quasi-Experimental (N)	To compare the effects of Pilates exercise on a mat and balance exercise for trunk stability on the balance ability of elderly female subjects.	PG and USSG: 12 weeks, 3 sessions/week, 40 min. PG: Mat Pilates, 1-2 sets of 2-10 repetitions. USSG: balancing exercises on an unstable platform.	Static balance- Romberg's test Dynamic balance- TUG	After the intervention, sway length, sway speed and TUG time had significantly decreased (p < 0.05) in both groups. A comparison of sway speed after the intervention between the two groups revealed that the PME group showed a larger decrease than the USSG group (p < 0.05).
Irez et al., 2011 (Turkey) 8/11	F, 30, ≥65	Randomized controlled trial (Y)	To determine if Pilates exercise could improve dynamic balance, flexibility, reaction time and muscle strength in order to reduce the number of falls among older women.	PG: Pilates-based mat exercises, theraband exercises and Pilates ball exercises, 12 weeks, 3 sessions/week, 60 min. The program was divided into three parts: mat exercises (1 <sup>st</sup> month), theraband elastic resistance exercises (2 <sup>nd</sup> month) and Pilates ball exercises for beginners (3 <sup>rd</sup> month). CG: did not receive treatment and were instructed to maintain their current activities.	Dynamic balance- force platform. Muscle Strength- Muscle Manual Tester (Lafayette Company, Model 01160 Nicholas Manual Muscle Tester MMT). Flexibility- sit and reach test .	The PG improved all the variables analyzed between the pre and post test when compared to the CG (p <0.05).
Irez et al., 2014 (Turkey) 4/11	F/M, 45, ≥65	Randomized controlled trial (Y)	To compare the effects of Pilates and a walking exercise program on dynamic balance, flexibility, and muscle strength, fear of falling and falling risk among an elderly population.	PG and WG: 12 weeks, 3 sessions/week, 60 min. PG: Pilates-based mat exercises, theraband exercises and Pilates ball exercises for beginners, low and moderate intensity. WG: low and moderate intensity. CG: did not receive treatment.	Balance-Berg Balance e ABC Scale . Muscle strength- muscle tester (Lafayette Company, Model 01160 Nicholas Manual Muscle Tester MMT).	Significant differences (p <0.05) were found in all PG variables and in WG flexibility, no differences were found in CG.



Author, Year (Country) PEDro Scale	Sex, N, Age	Study design (use of control group)	Objective	Intervention	Variables / tests	Results
Josephs et al., 2016 (United States) 4/11	F/M, 30, ≥65	Quasi-Experimental (N)	To determine whether Pilates is more effective than traditional strength and balance exercises for improving balance measures, balance confidence and reducing falls in community dwelling older adults with fall risk.	PG and TEG: 12 weeks, 2 sessions/ week, 60 min + 15-20 min home exercise (strength and balance exercises) on non-program days and daily following discharge from the program (the same program for both groups). All patients were asked to work at level 12-14 on the Borg Perceived Exertion Scale (6-20). PG: Pilates apparatus (Reformer, Chair and Cadillac), 12 weeks, 2 sessions/ week, 60 min. Exercises were individually made more challenging by altering spring tension, reducing base of support, adding complexity to the exercise and altering surface stability. Each exercise was performed for 10 repetitions. TEG: Elastic resistance bands, ankle weights, foam balance pads, boxes of varying heights and half foam rollers were props that were used with the traditional group. Repetitions of the resistance exercises were progressed individually. When the patient could perform 20 repetitions, the resistance was increased: elastic resistance bands were progressed to the next color; ankle weights were progressed by 0.5 pounds; box heights were progressed by 2 inches.	Balance- Fullerton Advanced Balance Scale (FAB), Berg Balance Scale, TUG, ABC Scale.	In the TEG, there was a significant difference (mean difference = 7.45, p= .01) between the pre-test and post-test scores of the FAB. In the PG there was a significant difference in the pre-test and post-test scores of the FAB (mean difference = 6.31, p < .05) and the ABC (mean difference = 10.57, p= .008) respectively. There were no significant between group differences on any of the selected tests.
Author, Year (Country) PEDro Scale	Sex, N, Age	Study Design (use of control group)	Objective	Intervention	Variables / tests	Results
Kaesler et al. 2007 (Australia) 1/11	F/M, 8, 66-71	Quasi-experimental (N)	To examine the effectiveness of a novel Pilates- inspired exercise program specifically designed to improve balance in an upright position, referred to as postural stability, in older adults.	PG: Pilates equipments (Reformer, Chair, Caddillac, Thera band and Fit ball), 8 weeks, 2 sessions/week, 60 min. All exercises were modified and/or progressed through changing the size and shape of the base of support (e.g. lying to sitting to standing) and increasing the resistance of the equipment. All exercises were repeated twice for 90 s where subjects aimed to complete 15 repetitions each time. An active rest of 30s between stations allowed for equipment change.	Balance-Test Timed Up and Go and four stage balance test. Muscle strength- sit to stand.	There was a significant improvement (P<0.05) in some components of static and dynamic postural sway (8-27%) as well as the TUGUT (7%) following training.
Markovic et al., 2015 (Croatia) 6/11	F, 34, 66-79	Quasi-Experimental (N)	To compare the effects of feedback-based balance and core resistance training utilizing a special computer-controlled device (Huber) with the conventional Pilates training on balance ability, neuromuscular function and body composition of healthy older women.	HG and PG: 8 weeks, 3 sessions/ week. PG: Mat Pilates + thera band, 60 min. Each exercise was performed for 2-4 sets with 15-20s contraction time (isometric exercise) or 15-20 repetitions (dynamic exercise). The difficulty of these exercises was gradually increased at the earliest opportunity. HG- Each training session started with a warm-up phase that included 3-min mobility/calisthenics exercises. This warm-up phase was followed by combined core and balance exercises on the computer-controlled Huber device lasting 25-30min. The force level ranged from 50% of maximum voluntary contraction during the first 2 weeks, over 65% MVC during the next 3 weeks, to 75% of MVC during the last 3 weeks. During the first 2 training weeks, no balance or core perturbations were used. During the first 2 training weeks, no balance or core perturbations were used. During the 3rd week, core perturbations were introduced by raising and lowering the movable column during isometric exercises. During the 4th training week, we introduced balance perturbations via low-velocity rotation of the movable platform. From the 5th week till the end of the exercise program, both core and balance perturbations were included during each exercise.	Muscle strength- Maximal strength of trunk extensors, flexors and lateral flexors was measured under static conditions using a dynamometer with an embedded force sensor. Upper-body strength (one repetition maximum load; 1RM) was measured using a pneumatic bilateral chest press system. Balance- Protocol created by Guiraud et al., 2015 on the force platform. Body composition- bio impedance	Post hoc analysis found that both groups significantly improved upper limb strength (p <0.05; Cohen d = 0.25-0.36). The other variables analyzed improved significantly only for HG.
Mesquita et al., 2015 (Brazil) 4/11	F, 63, 60-80	Randomized controlled trial (Y)	To compare and examine the effects of two exercise protocols on the balance of elderly women.	PG and PNFG- 4 weeks, 3 sessions/ week, 50 min. PG: Mat Pilates + swiss ball, magic circle and theraband. The number of repetitions and level resistance were increased throughout the study using a Swiss ball, thera band, and magic circle. PNFG: The movements were selected considering all the basic facilitation procedures. The resistance was gradually increased throughout the range of motion. During the first week, 1 set of 10 repetitions for each diagonal was performed; in the second week, 2 sets of 10 repetitions were performed; and in the third and fourth weeks, 3 sets of 10 repetitions were performed. CG: did not receive treatment.	Balance-Force platform, TUG test, Functional Reach test, Berg Balance Scale	The GP women presented better performance in the functional reach test and in the TUG than the CG women (p <0.05). However no significant difference was observed between GP and GFNP.

Author, Year (Country) PEDro Scale	Sex, N, Age	Study design (use of control group)	Objective	Intervention	Variables / tests	Results
Mokhtari et. al., 2012 (Iran) 2/11	F, 30, 62-80	Quasi-experimental (Y)	To investigate the efficiency of 12-week Pilates exercises on depression and balance associated with falling in the elderly.	PG: Mat Pilates + theraband, 12 weeks, 3 sessions/week, 60 min. The exercises were divided into 2 parts. The first part of training was performed on the mats (6 weeks) and the second part of exercises was performed using bands (the second 6 weeks).CG: did not receive treatment and were instructed to maintain their current activities.	Balance- functional reach and time up and go	PG: experienced a decrease in time for functional reach test (16.7%) p=0.037, and timed-up-and-go tests (7.2%) p=0.001.
Navega et al., 2016 (Brazil) 3/11	F, 31, 60-75	Randomized controlled trial (Y)	To evaluate the influence of the Mat Pilates method on thoracic hyperkyphosis and postural balance among elderly women.	PG: 8 weeks, 2 sessions/week, 60 min. Each exercise was undertaken progressively, evolving from beginner exercises through to advanced level exercises. In order to advance a level of difficulty, each volunteer had to conduct the exercises according to all of the principles set forth in the Mat Pilates method, which were taught at the beginning of the training period. GC: Attended four lectures about aging and health.	Balance- unipodal test	PG: maintained balance levels (p>0.05). CG: There was no significant difference (p>0.005) in any of the variables.
Newell et al., 2012 (United Kingdom) 2/11	F/M, 9, 60-79	Quasi-Experimental (N)	To investigate gait parameters including inter-stride variability and postural sway in a group of elderly subjects attending a weekly Pilates class over eight weeks.	Mat Pilates + swiss ball, thera band and wobble board. 8 weeks, 1 session/ week, 60 min	Static balance: Biodex Balance System	Both anterior to posterior sway and the fall risk index decreased pre - to post - intervention with the fall risk index falling by over 2 points. However, neither parameter reached statistical change (p>0.05).
Oliveira et al., 2016 a (Brazil) 7/11	F, 32, > 60	Quasi-Experimental (N)	To compare the effects of static stretching and Pilates on the flexibility of healthy older women.	PG: and SG: 12 weeks, 2 sessions/week, 60 min. PG: The equipment used for the exercises was: Chair, Cadillac Trapeze, Reformer and Ladder Barrel. Twenty strengthening and stretching exercises were selected for the main body segments. All exercises were performed in a set of ten repetitions. The intensity of the springs was changed according to the evolution of the strength of the volunteer, maintaining the number of repetitions and sets. SG: The exercises were performed actively, with three sets, held for 30 s each, with a 1 min rest interval between sets, prioritizing the major muscles groups.	Flexibility- flexometer	The static stretching exercises improved the trunk flexion and hip flexion movements (p < 0.05), while the Pilates improved all evaluated movements (p < 0.05) with Cohen's indicating a large effect for all variables, except the plantar flexion movement of the ankle which presented a medium effect (d= 0.71). However, over time, the groups presented differences only for the trunk extension movement with a large effect size (p < 0.001, d= 1.17)
Author, Year (Country) PEDro Scale	Sex, N, Age	Study design (use of control group)	Objective	Intervention	Variables / tests	Results
Oliveira et al., 2017 (Brazil) 7/11	F, 32, 64.2 ± 0.8 years	Randomized controlled trial (Y)	Investigate the effects of Pilates on the isokinetic muscular strength of the knee extensors and flexors at 60/s, in elderly women.	PG: and CG: 12 weeks, 2 sessions/week, 60 min. PG: The equipment used for the exercises was: Chair, Cadillac Trapeze, Reformer and Ladder Barrel. . All exercises were performed in a set of ten repetitions. The intensity of the springs was changed according to the evolution of the strength of the volunteer, maintaining the number of repetitions and sets. A moderate level of effort was maintained during sessions (between Borg 3 and 4). GC: The exercises were performed actively, with three sets, held for 30 s each, with a 1 min rest interval between sets, prioritizing the major muscles groups.	Muscle strength- Isokinetic dynamometer	PG: presented a significant improvement (p < 0.01) in all tests performed, when comparing the pre - and post -intervention (intragroup), with an effect size (Cohen's d) reaching 2.03 and 1.33 for the knee flexor and extensor muscles respectively. CG: There were no significant alterations (p > 0.05) in any of the analyzed variables. The PG presented significant improvements when compared to the CG in all tests performed.
Oliveira et al., 2016b (Brazil) 8/11	F, 30, 60-70	Randomized controlled trial (Y)	Verify the influence of Pilates on the isokinetic muscular strength of the elbow flexors and extensors, and on the functionality of the upper limbs, of older women.	PG: The equipment used for the exercises was: Chair, Cadillac Trapeze, Reformer and Ladder Barrel. All exercises were performed in a set of ten repetitions. The intensity of the springs was changed according to the evolution of the strength of the volunteer, maintaining the number of repetitions and sets. A moderate level of effort was maintained during sessions (between Borg 3 and 4). GC: was instructed to maintain their usual activities.	Muscle strength- Isokinetic dynamometer	In the intra-group comparison, the PG improved strength of the elbow extensors and the functionality of the upper limbs (p < 0.05). When comparing the post-intervention moment, the PG was superior to the CG in all variables (p < 0.05), with a large effect size (d > 0.80).
Oliveira et. al. 2015 (Brazil) 4/11	M/F, 32, 63.62 ± 1 y	Randomized controlled trial (Y)	To determine the effects of Pilates on lower leg strength, postural balance and the health-related quality of life of older adults.	PG: Pilates equipments, 12 weeks, 2 sessions/week, 60 min. Sequence of 20 stretching and strengthening exercises, 1 series of 10 repetitions, moderate intensity (between 3-4 Borg Scale), as the participants evolved the load of the springs was increased. GC: 20 static stretching exercises, 3 sets of 30s each, prioritizing large muscle groups.	Muscle strength- Isokinetic dynamometer. Balance - Berg Balance Scale. Functional mobility- The Timed Up and Go	In the intragroup analysis, PG showed a significant improvement in all variables. In the intergroup analysis, PG showed significant improvement in most variables, except for the Berg Balance Scale (p = 0.0509).

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Pata et al., 2013 (United States) 4/11	F/M, 35, 61-87	Quasi-Experimental (N)	To determine if a Pilates- based program is effective in improving dynamic balance, mobility, and postural stability in order to decrease the number of falls in older adults.	Mat Pilates with accessories, 8 weeks, 2 sessions/week, 60min.	Balance and fall risk- Forward reach test. Functional mobility- TUG. Postural stability and fall risk- Turn 180 test.	Significant improvements were seen in the TUG test 1, 39s (p <0.001), Turn 180 Test (p= 0.002) and 1.13 inches in the Forward Reach Test (p < 0.049) .
Pérez et al., 2014 (Brazil) 2/11	F, 22, 65-74	Quasi-Experimental (N)	To analyze the Pilates Method to assess whether it can help to improve the performance of activities that older adults under- take in their daily lives.	Mat Pilates, 12 weeks, 2 sessions/week, 50min. The exercise protocol was amended by adding new intermediate-level exercises.	Functional autonomy- Battery Test of Daily Life Activities for Physically Independent Elderly	The results were statistically significant in most of the tests (error of significance p < 0.05), only one (climb steps) did not present a statistically significant difference.
Author, Year (Country) PEDro Scale	Sex, N, Age	Study design (use of control group)	Objective	Intervention	Variables / tests	Results
Pinheiro et al., 2014 (Brazil) 1/11	F, 13, 60-80	Quasi-Experimental (N)	To analyze the effects of Pilates on the strength and conductivity of the electrical stimulation of the lumbar paraspinal muscles as well as muscle contraction transversus abdominis in older women before and after performing Pilates exercises on the ground.	Mat Pilates + swiss ball, magic ring and thera band, 4 weeks, 3 sessions/week, 50 min. Stretching and exercises were performed for the Upper Limbs, trunk and Lower Limbs, with repetitions and strength increasing along the exercise weeks.	Muscle strength- surface electromyography and Stabilizer Pressure Biofeedback unit.	There was an increase in paravertebral muscle strength (from 18.20± 4.67 to 27.18 ± 8.37 p=0,001), improvements in the electrical activation of paravertebral muscles from both the left (before: 35.06 ±20.22; after: 49.18±23.86 p=0,003) and right (before: 32.55±15.10; after: 45.92 ±19.37 p=0,001) sides and improvement of the transverse abdominal muscle activation (from - 1.66 ± 1.72 to -7.92 ± 5.78 p< 0.003).
Plachy et al., 2012 (Hungary) 3/11	F, 42, 67.1 ± 4.5	Randomized controlled trial (Y)	To assess whether two slightly different half-year-long regular training programmes had a positive effect on flexibility, range of motion and endurance in a sample population of elderly persons.	PG: Pilates 24 weeks, 3 sessions/ week, 60 min. WAPG- 2 sessions/ week of water aerobic + 1 session/ week of pilates. CG: not reported.	Flexibility: five types of active joint ROM measurements. Aerobic endurance: 6-minute walk test. Endurance and lower body strength: Sit-to-stand test for 30 seconds	No difference was found in the CG and for PG and WAPG significant differences were found in all variables (p <0.05).
Rodrigues et al., 2010a (Brazil) 5/11	F, 52, 66 ± 4	Randomized controlled trial (Y)	To evaluate the effects of the Pilates method on the personal autonomy, static balance and quality of life in healthy elderly females.	PG: Pilates apparatus (Cadillac, Reformer, Combo Chair and Wall Unit) + bobath ball, 8 weeks, 2 sessions/week ,60min. The springs used were the same for all the volunteers, however, to work on individual needs, adjustments were made to the angle in which they were inserted in the apparatus. Each exercise was performed for a maximum of ten repetitions. CG: not reported.	Functional autonomy:GDLAM Balance: Tinetti Protocol.	There were significant post-test differences in the PG in the following areas balance (Δ%= 4.35%, p= 0.0001) and General Index of GDLAM (Δ% = 13.35%, p = 0.0001).
Rodrigues et al., 2010b (Brazil) 3/11	F, 52, 66±4	Randomized controlled trial (Y)	To assess the effect of the Pilates method on elderly women's functional autonomy.	PG: Pilates apparatus (Cadillac, Reformer, Combo Chair and Wall Unit) +bobath ball, 8 weeks, 2 sessions/week, 60min. Each exercise was performed for a maximum of ten repetitions and the intensity was regulated through the springs. CG: did not receive treatment.	Functional autonomy: GDLAM.	The PG obtained significantly better results in all the tests and in the general GDLAM index (p = 0.035).
Roller et al., 2017 (United States) 6/11	F/M, 55, 65-95	Randomized controlled trial (Y)	To investigate the effects of Pilates exercises using a Reformer on measures of fall risk, balance and mobility, self-efficacy, and active range of motion in adults age 65 and over at risk for falls compared to a control group.	PG: Pilates apparatus (Reformer) 10 weeks, 1 session/week, 45 min. 10 exercises with 10 repetitions, the load ranged from 2 to 4 springs depending on the participant's ability.CG: did not receive treatment.	Balance- TUG, ABC scale, SOT, ADT,BBS and 10 MWT Flexibility- goniometer	There was a significant interaction between group and time on the TUG, BBS, 10MWT, and SLR, hip extension, and ankle dorsiflexion AROM measurements. Over time, subjects in the Pilates intervention group improved their scores significantly on all mentioned measures, whereas subjects in the control group did not (P< 0.05).
Author, Year (Country) PEDro Scale	Sex, N, Age	Study design (use of control group)	Objective	Intervention	Variables / tests	Results
Ruiz-Montero et al., 2014 (Spain) 2/11	F, 303, 60-70	Quasi-Experimental (N)	To examine the differences in anthropometric measurements using an aerobic and Pilates exercise program which lasted 24 weeks.	24 weeks, 2 sessions/week, 55-60 min. The training program consisted of music-based aerobics and Pilates, basic to intermediate level. The program comprised Pilates exercises for upper- and lower-body strength, agility, and aerobic capacity. During the first session of the intervention process, participants were asked their perceived level of exertion on a scale of 0–10 (Borg scale) to establish the initial level and then gradually increase exercise intensity.	Bodyweight- electronic scale. Skinfold thickness-caliper with a precision of 0.2 mm. The equation used to determine FM was: corporal density of Durnin–Womersley. Girths-flexible metallic tape measure with a precision of 0.1 mm.	The percentage of fat mass decreased significantly (pre-test, 32.89%, 8.65, post-test, 28.25%, 6.58, P = 0.01). The percentage of lean mass remained unchanged (P <0.05).

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Siqueira et al., 2009 (Brazil) 3/11	F, 52, 62-70	Randomized controlled trial (Y)	To evaluate the effects of Pilates method in static balance of healthy elderly females.	PG: Pilates apparatus (Cadillac, Reformer, Combo Chair and Wall Unit) + bobath ball, 8 weeks, 2 sessions/week, 60min. Each exercise was performed for a maximum of ten repetitions and the intensity was regulated through the springs. CG: did not receive treatment.	Static balance: Tinetti Protocol.	GP presented an evolution of 1.03 in the Tinetti protocol total score ( $p > 0.001$ ).
Sofianidis et al., 2016 (Greece) 4/11	F/M, 36	Randomized controlled trial (Y)	To compare the effects of two different exercise programs, Pilates exercise and Latin dance, on factors related to static and dynamic balance control of healthy older adults.	12 weeks, 2 sessions/week, 60 min. PG: Mat Pilates with power balls, ribbons-tires and weights. Each session included exercises adapted to the age and the purpose of the intervention GD: each session included learning of Latin dances appropriate for their age such as Tango, Rumba, Bachatta and basic steps of Social-American System with and without a partner.	Static balance: tandem stance and one leg stance. Dynamic balance: periodic sway with and without metronome guidance.	Analysis revealed a significant reduction of the trunk sway amplitude during the tandem stance with eyes closed, reduction in the center of pressure displacement during one-leg stance, increase in the amplitude of trunk oscillation during the sway task for both interventions groups.
Taskiran et al., 2014 (Turkey) 5/11	F/M, 58, 78±6.8	Randomized controlled trial (Y)	To Investigate whether Pilates and yoga affect quality of life and physical performance of elderly living in a nursing home.	PG e YG: 8 weeks, 3 sessions/week, 50 min. PG: Mat Pilates + weights+ elastic bands. The degree of difficulty and level of the exercises were modified according to the performance of the subjects. YG: The degree of difficulty and duration of the asanas was increased gently according to the capacity of the subjects. Each week, an average of 7 poses was taught. Each pose was maintained for 4 seconds at the beginning of the training program and then increased to 12 seconds at the end. CG: did not receive treatment and were instructed to maintain their current activities.	Functional autonomy-SFT; Muscle strength-dynamometer; Balance-BBS; body composition-bioimpedance	Measurements of strength and flexibility tests increased only in YG ( $p = 0.017$ ) and ( $p = 0.019$ ) respectively, but did not persist after 6 months. No changes in body composition and balance were observed for any of the groups ( $p < 0.05$ ).
Author, Year (Country) PEDro Scale	Sex, N, Age	Study design (use of control group)	Objective	Intervention	Variables / tests	Results
Vasconcelos et al., 2016 (Brazil) 4/11	F, 148, ≥60	Quasi-experimental (N)	To assess the effect of different modalities of physical exercises on functional capacity and anthropometric measurements of 148 older women.	STG, FG, GHP-16 weeks, 2 sessions/week, 60min. Moderate to vigorous intensity on the Borg scale (12 to 15 points). STG- the training was prescribed in a circuit format, entailing three circuits with thirty-second intervals between exercises, repetition range of between eight to ten and initial load corresponding to 70% of the 10-RM test on the exercises assessed. FG: physical resistance and strength exercises for lower and upper limbs which consisted of exercises using free weights. The training was organized in a circuit format with rest periods, in two sets of ten repetitions with moderate load and passive rest of 1 min between sets. ; WAPG -The Hydrogymnastics session included aerobic exercises with focusing on the main muscle groups with 1 min per exercise and 30-second active intervals + Mat Pilates, with volume of 10 repetitions for exercise.	Functional autonomy-SFT e anthropometric measurements / Body composition- balance, stadiometer and meter	GHP: significant differences on all functional tests and anthropometric measurements. The GHP had greater weight loss compared to the GF ( $p = 0.04$ ) and GTF ( $p=0.004$ ), reduction in BMI compared to the GF ( $p=0.029$ ) and GTF ( $p=0.003$ ). There were not differences between groups in functional test performance.
Vieira et al., 2017 (Brazil) 5/11	F, 40,60-80	Randomized controlled trial (Y)	To investigate the effects of a 12-week Pilates-inspired exercise program on the functional performance of community-dwelling older women.	PG: Mat Pilates with accessories, 12 weeks, 2 sessions/ week, 60 min. CG: did not receive treatment and were instructed to maintain their current activities.	Postural balance- One leg stance test. Functional mobility- TUG. Strength and Dynamic balance- Five-times sit-to-stand test. Aerobic capacity- Six-minute walk test.	PG: time effects were observed for five-times sit-to-stand ( $p=0.03$ ) and 6 minute-walk tests ( $p < 0.01$ ). Only among PG subjects did the time spent to rise from a chair and return to a seated position decrease significantly (2.0 s faster, $p = 0.02$ ) and the distance walked in 6 min increase (30 m, $p < 0.01$ ). One-leg stance test and TUG performance remained unaltered in both groups.

F: female; M: male; PG: Pilates group; CG: control group; BG: balance group; STG: strength training group; WAG: water aerobics group; GG: gym group; USSG: unstable support surface group; WG- walking group; HG: Huber group; PNFG: proprioceptive neuromuscular facilitation group ; SG: stretching group; WAPG: water aerobic + pilates group; YG: yoga group; TUG- time up and go; BBS: Berg Balance Scale; SFT: Senior Fitness Test. ABC: Activities-Specific Balance Confidence; TEG: traditional exercise group; FG: functional group