Pilates method and pain in pregnancy: a systematic review and metanalysis

Método Pilates e a dor na gestação: revisão sistemática e meta-análise

Huliana Mendo[1], Matheus Santos Gomes Jorge[1]

DOI 10.5935/2595-0118.20210049

ABSTRACT

BACKGROUND AND OBJECTIVES: The bodily changes resulting from pregnancy can culminate in adverse outcomes to maternal health, including pain, which may be related to postural changes, functional disabilities and impaired quality of life of pregnant women. Due to its effects, the Pilates Method can contribute to alleviate these problems, although its benefits are not a consensus in the literature. In this sense, the objective of this study was to systematically review in the literature the implications of the Pilates Method on pain in pregnant women.
CONTENTS: Systematic review and metanalysis of randomized clinical trials conducted in the databases Embase, Scopus, Cochrane Library, Medline, Web of Science, PEDro, LILACS and SciELO, where the descriptors "Pregnancy" and "Pilates Method" were used. Of the 105 articles found, five met the selection criteria for this study and two were included in the meta-analysis for the outcome pain. The Pilates Method group showed superiority for pain relief compared to the control group ($CI_{95\%}$: -2.24 – -1.13; I^2: 12%). Additionally, the Pilates Method produced less progression of abdominal diastasis, decreased fatigue, maintained anthropometric and hemodynamic parameters, increased abdominal and pelvic floor strength, improved hamstring muscle flexibility, lumbar-pelvic stabilization, posture, functional capacity and quality of life of pregnant women.
CONCLUSION: The Pilates method was superior to the minimum intervention for pain relief in pregnant women, in addition to improving physical conditions.

Keywords: Exercise movement techniques, Pain, Pregnant women, Physical therapy specialty, Quality of life.

RESUMO

JUSTIFICATIVA E OBJETIVOS: As mudanças corporais oriundas da gestação podem culminar em desfechos adversos à saúde materna, incluindo a dor, que pode estar relacionada às alterações posturais, incapacidades funcionais e comprometimento da qualidade de vida das gestantes. Em virtude dos seus efeitos, o Método Pilates pode contribuir para amenizar estes problemas, embora seus benefícios não sejam um consenso na literatura. Neste sentido, o objetivo deste estudo foi revisar sistematicamente na literatura as implicações do método Pilates na gestação.
CONTEÚDO: Revisão sistemática e meta-análise de ensaios clínicos randomizados realizada nas bases de dados Embase, Scopus, *Cochrane Library*, Medline, *Web of Science*, PEDro, LILACS e SciELO, em que se utilizou os descritores "Pregnancy" e "Pilates Method". Dos 105 artigos encontrados, cinco preencheram os critérios de seleção deste estudo e dois foram incluídos na meta-análise para o desfecho dor. O grupo Método Pilates apresentou superioridade para alívio da dor em comparação ao grupo controle ($IC_{95\%}$: -2,24 – -1,13; I^2: 12%). Adicionalmente, o método Pilates produziu menor progressão da diástase abdominal, diminuição da fadiga, manutenção dos parâmetros antropométricos e hemodinâmicos, aumento da força abdominal e do assoalho pélvico, melhora da flexibilidade dos músculos isquiotibiais, da estabilização lombo-pélvica, da postura, da capacidade funcional e da qualidade de vida das gestantes.
CONCLUSÃO: O método Pilates foi superior à intervenção mínima para alívio da dor em gestantes, além de produzir melhora das condições físicas.

Descritores: Dor, Fisioterapia, Gestantes, Qualidade de vida, Técnicas de exercício e de movimento.

INTRODUCTION

During pregnancy, hormonal and physiological changes occur, culminating in musculoskeletal complications[1], which can cause great emotional impact, especially in primiparous women[2]. Among these complications, musculoskeletal pain stands out as one of the main ones[3,4], especially affecting the lumbar, pelvic or pubic regions[5].
Approximately 30% of pregnant women have severe pain symptoms that may interfere in their functional capacity and quality of life (QoL)[4], and several factors, such as postural changes, lumbar hyperlordosis and pelvic ligament loosening may cause pain during pregnancy[3], as well as persist even after this period[6]. Contributing to the advancement of the gestational period is the weakness of the stabilizing muscles of the abdominal region and

Huliana Mendo – https://orcid.org/0000-0003-3708-2639;
Matheus Santos Gomes Jorge – https://orcid.org/0000-0002-4989-0572.

1. University of Passo Fundo, Faculty of Physical Education and Physical Therapy, Passo Fundo, RS, Brazil.

Submitted on December 2, 2020.
Accepted for publication on July 16, 2021.
Conflict of interests: none – Sponsoring sources: none.

Correspondence to:
Matheus Santos Gomes Jorge
Rua Rio de Janeiro, nº 797 – Ipiranga
99300-000 Soledade, RS, Brasil.
E-mail: matheusjorge@upf.br

© Sociedade Brasileira para o Estudo da Dor

pelvic floor[7]. Although evident in most pregnant women, these health problems are little investigated in populations of middle and low income[8].

Pregnant women benefit from physical therapy when it comes to treating pain, facilitating labor and improving QoL[9]. Among the physiotherapeutic interventions for this public, the Pilates Method (PM) is an alternative for pain relief and improvement of the lumbopelvic region, functional capacity and QoL[10], among other benefits. Nevertheless, the literature points out that the heterogeneity about the practice of PM among pregnant women, as well as the low adherence to the clinical practice guidelines, are factors that drive the need for more grounded research on the subject, especially in cases that present health problems during pregnancy[11].

Therefore, the objective of the present study was to systematically review the literature on the effects of PM during pregnancy.

METHODS

A systematic review and meta-analysis of randomized clinical trials (RCT) following the recommendations proposed by the PRISMA checklist (Preferred Reporting Items for Systematic Reviews and Meta-Analyses), which is specific for reviewing RCT[12].

The present review included RCT, studies whose intervention included PM, and studies whose samples were composed exclusively of pregnant women. The following were excluded: review studies, guidelines, observational studies, qualitative studies, case studies, editorials, expert opinions or studies of any other nature, studies that investigated the effects of other physical therapy approaches, such as Kegel exercises, kinesiotherapy, hydrotherapy, electrothermophototherapy, etc. (associated or not with PM) and studies that included other types of approaches such as nutritional, pharmacological or surgical intervention.

The search strategy was done in pairs in September 2020 using English terms that were in accordance with the Medical Subject Headings (MeSH). The descriptors ''Pregnancy" and "Pilates Method" were used. The search didn't restrict the studies by language, period of publication or type of access (free or restrict). The searched databases were Embase, Scopus, Cochrane Library, Medline, Web of Science, Physiotherapy Evidence Database (PEDro), LILACS and Scielo.

The search conducted on Medline (via PubMed) used database-specific filters to make the search more sensitive, crossing terms contained in "#1" and "#2" (Table 1).

Table 1. Filters for search strategy

#1	"Pregnancy"[Mesh] OR "Pregnancies" OR "Gestation"
#2	"Pilates Method "[Mesh] OR "Method Pilates " OR "Pilates-Based Exercises" OR "Exercises, Pilates-Based" OR "Pilates Based Exercises" OR "Pilates Training" OR "Training, Pilates"

Initially, studies were identified in the databases and duplicate studies were excluded (Identification Phase). The titles, abstracts, and descriptors/keywords of all articles identified by the search strategy were evaluated by two reviewers. In case of disagreement, a third reviewer was requested in order to reach a consensus and for tie-breaking (Screening Phase). Then, all pre-selected studies were evaluated in their entirety, using the same tie-breaking strategy as in the previous phase (Eligibility Phase). Finally, information was extracted regarding the characteristics of the selected studies regarding: identification, samples, methodological procedures, and outcomes. Of the five included articles, two composed the meta-analysis (Inclusion Phase) (Figure 1).

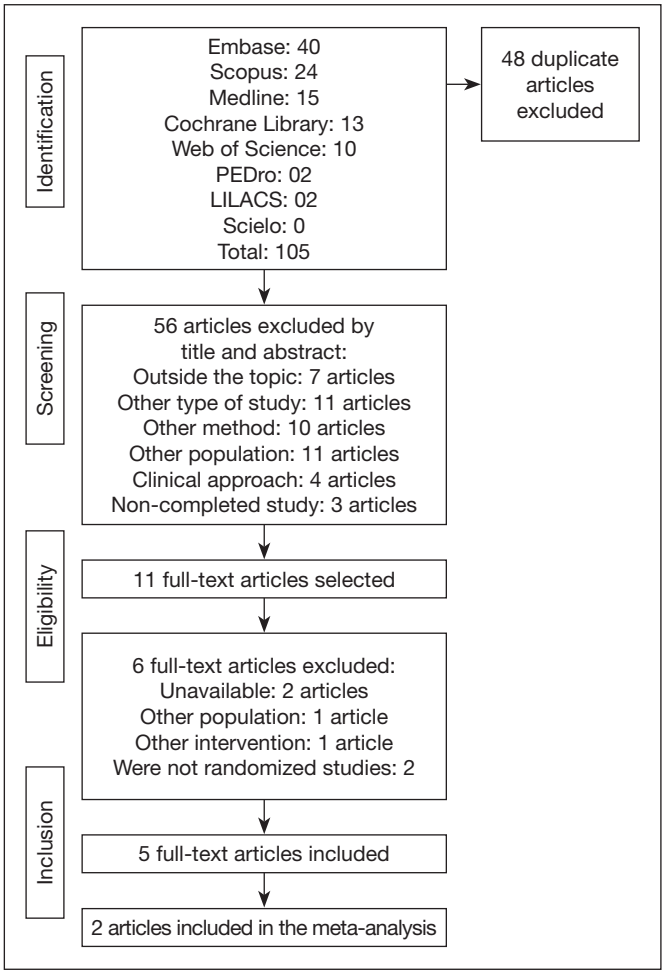


Figure 1. Articles search and selection strategy flowchart

The methodological quality of the included articles was evaluated using the PEDro scale, with scores from zero to 10, in which the following criteria are evaluated: 1. Eligibility criteria; 2. Random allocation; 3. Concealed allocation; 4. Baseline comparability; 5. Blinded subjects; 6. Blinded therapists; 7. Blinded evaluators; 8. Adequate follow-up; 9. Intention-to-treat analysis; 10. Between-group comparisons; 11. Point estimates and variability. The first criterion is not counted in the total score[13].

Meta-analysis was performed using Review Manager software version 5.4 (Cochrane Collaboration), using the random effects model. Effect measures were obtained by post-intervention values. The studies were analyzed separately according to the pain variable, measured by the Visual Analog Scale (VAS). A value of $p \leq 0.05$ and 95% confidence interval (CI) were considered statistically significant. Statistical heterogeneity of treatment effects between studies was assessed by Cochrane's Q test and

Table 2. Characterization of the studies' referential data

Authors	Place of origin	Language	PEDro Scale
Canarslan and Akbayrak[14]	Turkey	Turkish	5 / 10
Dias et al.[15]	Brazil	English	5 / 10
Oktaviani[16]	Indonesia	English	3 / 10
Rodríguez-Díaz et al.[17]	Spain	English	5 / 10
Sonmezer, Özköslü and Yosmaoğl[10]	Turkey	English	8 / 10

Table 3. Characterization of studies' samples

Authors	Sample size and age	Information regarding gestation
Canarslan and Akbayrak[14]	Total: 40. Included: 40. PG: 20 (28.7 ± 4.4 years). CG: 20 (24.9 ± 4.6 years).	Gestational time: unspecified. Number of pregnancies: primiparous (75% of PG; 70% of CG).
Dias et al.[15]	Total: 80. Included: 36. PG: 24 (29.00 ± 3.96 years). CG: 12 (29.83 ± 3.09 years).	Gestational time: 14th--16th to 32nd-36th weeks. Number of pregnancies: all primiparous.
Oktaviani[16]	Total: 40. Included: 40. PG: 20 (28.70 ± 6.46 years). CG: 20 (26.95 ± 4.94 years).	Gestational time: 3rd trimester (≥ 28 weeks). Number of pregnancies: parity ≤ 3.
Rodríguez-Díaz et al.[17]	Total: 105. Included: 105. PG: 50 (32.87 ± 4.46 years). CG: 55 (31.52 ± 4.95 years).	Gestational time: 26th--28th to 34th-36th weeks. Number of pregnancies: 78.2% were primiparous.
Sonmezer, Özköslü and Yosmaoğl[10]	Total: 58. Included: 40. PG: 20 (29.00 ± 2.75 years). CG: 20 (28.00 ± 2.10 years).	Gestational time: 22nd to 24th week. Number of pregnancies: parity ≤ 3.

Values expressed as mean ± standard deviation.
PG = Pilates Group; CG = Comparison/Control Group.

inconsistency by the I^2 test, where values above 25, 50, and 75% were considered to indicate moderate, substantial, and considerable heterogeneity, respectively.

RESULTS

The studies place of origin varied, with two coming from Turkey[10,14], one from Brazil[15], one from Indonesia[16], and one from Spain[17]. Four studies were written in English[10,15-17] and one in Turkish[14]. According to the evaluation of the methodological quality of the studies by the PEDro scale, the scores of the articles ranged from three to eight points (Table 2).

The total analyzed data was of 261 pregnant women, whose mean age was 23.06 ± 3.23 years. The data on pregnancy-related information is heterogeneous, with the gestational time ranging from the 14th to 36th week of gestation and most of the samples being primiparous (Table 3).

Several instruments were used for the assessment, among which were: VAS[10,14,16], muscle strength test (abdominal muscles)[14], palpation (abdominal diastasis)[14], SF-36 Questionnaire (quality of life)[14], Beck Depression Inventory (psychological state)[14], Fatigue Severity Scale (fatigue)[14], manometer (pelvic floor muscle strength)[15], Oxford Scale (pelvic floor muscle strength, endurance, and repeatability)[15], anthropometry (height, weight, and body mass index)[17], blood pressure[17], hand dynamometry (hand grip strength)[17], goniometry (hamstring muscle flexibility)[17] and inclinometer (spinal curvatures)[17], Oswestry Questionnaire (functional capacity)[10], Nottingham Health Profile Questionnaire (quality of life)[10] and biofeedback in the lumbopelvic muscles (lumbopelvic stabilization)[10] (Table 4).

Three studies[10,15,17] applied the MatPilates modality with the help of accessories and two studies[14,16] applied MatPilates exclusively. The frequency varied between one[16] and two[10,14,15,17] times weekly, in a period between eight[10,15-17] and twenty[14] weeks,

Table 4. Characterization of the evaluation tools, intervention protocols and studies outcomes

Authors	Evaluation tools	Pilates Group	Comparison/Control Group	Outcomes
Canarslan and Akbayrak[14]	VAS (low back pain and fatigue intensity); Muscle strength test (abdominal muscle strength); Palpation (abdominal diastasis); SF-36 questionnaire (QoL); BDI (psychological state); FSS (fatigue severity)	Management: MatPilates. Exercises: cleopatra, saw, toy soldier, mermaid, chest stretch, swinging, crock screw, mini squat, one leg stretch, double leg stretch, shoulder bridge, clam, hip twist, side kick, basic push up, salute, rowing, hug a tree, hip twist, side kick, point & flex, arm openings, little abdominal curls, little peace of heaven, leg circles and proprioceptive neuromuscular facilitation exercises. Intensity: 1st protocol (first half of second trimester); 2nd protocol (second half of second trimester); 3rd protocol (first four weeks of third trimester); 4th protocol (last two weeks of third trimester). Sessions: 40 sessions (60 min each). Frequency: 2x/week. Weeks: 20 weeks.	Conduct: irregular voluntary walks. Exercises: unspecified. Intensity: unspecified. Sessions: unspecified. Frequency: unspecified. Weeks: 20 weeks.	After intervention: PG: ↑abdominal muscle strength, ↑abdominal diastasis. CG: ↑pain, ↓abdominal muscle strength, ↑abdominal diastasis. Comparison between groups: Superiority of PG over CG: pain (2nd and 3rd trimester), abdominal muscle strength (2nd and 3rd trimester), abdominal diastasis (2nd and 3rd trimester), quality of life (2nd and 3rd trimester), psychological state (3rd trimester), and fatigue intensity (1st, 2nd, and 3rd trimester).

Continue...

Table 4. Characterization of the evaluation tools, intervention protocols and studies outcomes – continuation

Authors	Evaluation tools	Pilates Group	Comparison/Control Group	Outcomes
Dias et al.[15]	Manometer (PFM strength); Oxford scale (PFM strength, PFM resistance and PFM repeatability).	Conduct: MatPilates + accessories, such as exercise mats, swiss balls and elastic bands. Exercises: unspecified. Intensity: light (4 weeks) → moderate (4 weeks); 8 repetitions; Borg Scale 13-14. Sessions: 16 sessions (60 min each). Frequency: 2x/week. Weeks: 08 weeks.	Conduct: kinesiotherapy. Exercises: walking (10 min); strengthening of lower and upper limbs and trunk (with elastic band and body weight resistance); stretching and relaxation. Intensity: light (4 weeks) → moderate (4 weeks); 8 repetitions; Borg Scale 13-14. Sessions: 16 sessions (60 min each). Frequency: 2x/week. Weeks: 08 weeks.	After intervention: PG: ↑HS strength (Oxford Scale): ↑HS resistance, ↑HS repeatability. CG: no difference. Comparison between groups: Superiority of PG over CG: HS strength (Oxford Scale), HS resistance, and HS repeatability.
Oktaviani[16]	VAS (pain intensity)	Management: MatPilates. Exercises: gentle breathing and stretching (10 min), 70-80 unspecified Pilates exercises (50-60 min), relaxation (10 min). Intensity: unspecified. Sessions: 08 sessions (60 min each). Frequency: 1x/week. Weeks: 08 weeks.	Conduct: kinesiotherapy. Exercises: unspecified. Intensity: unspecified. Sessions: 08 sessions (60 min each). Frequency: 1x/week. Weeks: 08 weeks.	After intervention: PG: ↓pain. CG: ↓pain. Comparison between groups: Superiority of PG over CG: pain.
Rodríguez-Díaz et al.[17]	Anthropometry (height, weight, and BMI); Blood pressure; Manual dynamometry (manual strength); Goniometry (ischial flexibility); Inclinometer (spine curvatures).	Conduct: MatPilates + accessories (balls, elastic bands and Magic Circle). Exercises: posture and warm-up (5-8 min), aerobic and toning phase (25-30 min); flexibility phase (5-10 min); relaxation (5-10 min), unspecified. Intensity: unspecified. Sessions: 16 sessions (40-45 min each). Frequency: 2x/week. Weeks: 08 weeks.	Conduct: monitored general guidance. Exercises: unspecified. Intensity: unspecified. Sessions: unspecified. Frequency: unspecified. Weeks: 08 weeks.	After intervention: PG: ↑weight, ↑BMI, ↓SBP, ↓SBP, ↑HS, ↑flexibility of the hamstring muscles, ↓thoracic kyphosis, ↓lumbar lordosis, CG: ↑weight, ↑BMI, ↑SBP, ↑SBP, ↓HS, ↓flexibility of the hamstring muscles, ↑thoracic kyphosis, ↑lumbar lordosis. Comparison between groups: Superiority of PG over CG: all variables.
Sonmezer, Özköslü and Yosmaoğl[10]	VAS (pain intensity); Oswestry questionnaire (impact on functional capacity); NHP Questionnaire (QoL); Biofeedback in lumbopelvic muscles (lumbar stabilization)	Conduct: MatPilates + accessories (balls, elastic bands and Magic Circle). Exercises: *chest stretch, swinging, one arm circle, double arm circle, cat, dog, toy soldier, side rotation, push up, roll down, roll up, shoulder bridge, one leg stretch, scissors, side kick, spine stretch, spine twist, double arm stretch, leg pull prone (plank).* Intensity: 2-3 sets, 3-12 repetitions. Progression every two weeks. Sessions: 16 sessions. Frequency: 2x/week. Weeks: 08 weeks.	Conduct: prenatal and monitored general guidance. Exercises: not prescribed. Intensity: does not apply. Sessions: does not apply. Frequency: does not apply. Weeks: 08 weeks.	After intervention: PG: ↓pain, ↓disability, ↑QoL (sleep and physical mobility parameters), ↑lumbar-pelvic stabilization. CG: no alterations. Comparison between groups: Superiority of PG over CG: all variables.

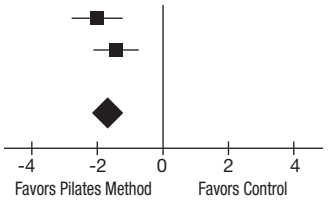
↓ = decrease; ↑ = increase; → = intensity progression; < = less than; PG = Pilates group; CG = comparison/control group; VAS = Visual Analog Scale; QoL = quality of life; BDI = Beck Depression Inventory; FSS = Fatigue Severity Scale; PFM = pelvic floor muscles; NHP = Nottingham Health Profile. SBP = systolic blood pressure; DBP = Diastolic blood pressure; HS = handgrip strength.

totaling eight[16], 16[10,15,17] and 40[14] sessions. The comparison groups presented varied modalities, such as irregular voluntary walking[14], kinesiotherapy[15,16] and general guidance[10,17]. In all studies, PM showed superiority over control interventions in all analyzed outcomes (Table 4).

According to the meta-analysis, the PM group was superior to the CG in improving pain as measured by VAS in postpartum women ($CI_{95\%}$: -2.24 – -1.13; I^2: 12%). The level of heterogeneous inconsistency of the statistical analysis was 12%, indicating low inconsistency on results (Table 5).

Table 5. Comparison between the Pilates Method versus Control regarding pain measured by the Visual Analog Scale

Study or subgroup	Pilates Method			Control				Mean difference IV, Random, CI 95%	Mean difference IV, Random, CI 95%
	Mean	SD	Total	Mean	SD	Total	Weight		
Canarslan and Akbayrak[14]	2.23	1.9	20	6	1.8	20	45.8%	-2.00 [-2.77. -1.22]	
Sonmezer, Özköslü and Yosmaoğl[10]	1.72	1.08	20	3.84	1.75	20	54.2%	-1.43 [-2.13. -0.73]	
			40			40	100.0%	-1.69 [-2.24. -1.13]	
Heterogeneity: Tau²=0,02; Chi²=1,14, df= 1 (p = 0,29); I²= 12%									
General effect test: Z= 5,97 (p < 0.00001)									



Mean = mean of the groups; SD = standard deviaton; Weight = statistical relevance of the study; IV = inverse variance; CI = confidence interval; Fixed = fixed effect; Random = random effect; I2 = heterogeneity index; Z = global effect test; Chi2 = Chi-square test; Tau2 = Kendall's Tau test; df = degree of freedom; p-value.

DISCUSSION

The main finding of this study was the superiority of the PM group over the control or minimal intervention group for pain relief in pregnant women. In addition, PM produced less progression of abdominal diastasis, decreased fatigue, maintenance of anthropometric and hemodynamic parameters, increased abdominal and pelvic floor strength, improved flexibility of the hamstring muscles, lumbopelvic stabilization, posture, functional capacity, and QoL in pregnant women.

PM is a beneficial strategy for the overall health of women and can improve pain, lower limb strength, QoL[18], among other physical and psychological aspects, especially in the improvement of the pelvic floor and social well-being. However, there is little information and recommendations about the safe and appropriate instructions of this method for pregnant women, besides divergences regarding its safety in special situations, frequency and dosage[11], which is why the present work investigated this physiotherapeutic intervention in this specific population. The present study observed that PM produced benefits for the health of pregnant women, including the aspect of pain[10,14,16]. Moreover, there was evidence that most studies point to these benefits when the technique is applied at least twice a week, over a period of eight weeks, totaling 16 sessions. The main symptoms that pregnant women face are musculoskeletal pain, which may affect the lumbar and pelvic regions, the back, hips, and even wrists[1]. Moreover, about 30% of pregnant women have severe symptoms that usually compromise their daily activities and QoL, requiring rest and time off work[4]. Thus, PM was presented as a strategy for pain relief[10,14,16], improved functional capacity[10] and QoL[10] in pregnant women.

An experimental study with 10 women with primary dysmenorrhea who underwent 10 PM sessions showed that after the intervention there was a decrease in pain during menstrual periods in these patients[19]. This corroborates the present review, where three studies[10,14,16] showed a decrease in pain after PM.

As the gestational period proceeds, there is a decrease in the electromyographic activity and in the strength of the PFM and abdominal muscles attributed to the increase in the overload that this musculature undergoes during pregnancy[7]. The principles of PM include the strengthening of the pelvic floor and the prevention and/or treatment of dysfunctions of this region caused by pregnancy[20]. Such benefits were observed in two included studies[14,15] in which this intervention was beneficial for increasing muscle strength and resistance in this region. In addition, it's noteworthy that during static contraction pain decreases muscle activity[21], resulting in compensation by other muscles to perform the desired movements and, consequently, in increase of pain[22], resulting in a vicious cycle.

There is a decline in handgrip strength as the gestational period advances[23], requiring attention to this aspect in these individuals. One of the listed studies[17] verified that PM was beneficial to the handgrip strength of pregnant women when compared to the usual conducts, corroborating a research that showed that PM twice a week, during 12 weeks, produced better effects for the increase of handgrip strength and abdominal resistance in pregnant women when compared to usual physical activities[24].

Gestational static and dynamic musculoskeletal alterations, such as decreased trunk mobility and altered movements, increased mass, and body dimensions[25] can lead to pain and discomfort, causing limitations in daily life and professional activities[26]. Therefore, PM can be an alternative for these problems, because it involves a synchronous work between body and mind[27], providing direct and indirect effects on several aspects, from the prevention of health-related problems to physiological changes[28], as is the case during the gestational period. In that sense, one of the studies[10] showed that PM was beneficial to improve the functional capacity of pregnant women.

Obesity can affect up to 60% of pregnant women with a history of overweight, which can lead to adverse health outcomes, such as diabetes mellitus, cardiovascular diseases, endocrine changes, among other comorbidities[29]. Such complications are not restricted to the mother, and may be extended to newborns, predisposing them to the risk of being born with a higher percentage of body fat and obesity in childhood[30]. Therefore, PM can have effects on the mother's body composition aiming to minimize these possible future adverse outcomes. Although some studies[17] observed that PM was not able to prevent the increase in body weight and BMI of pregnant women, it proved to be superior to the usual conducts because the individuals in the conventional treatment showed a significantly higher increase in these variables when compared to the individuals in the PG.

One of the main disorders that occur during pregnancy is hypertension, which can affect up to 10% of cases, being clo-

sely related to adverse health outcomes such as pre-eclampsia, premature placental abruption, premature delivery, fetal growth restriction, stillbirths, the development of cardiometabolic diseases, and secondary maternal death. Thus, it's necessary that blood pressure control is rigidly performed during this period[31,32], and one of the strategies is physical exercise.

Systemic arterial hypertension is the main chronic disease most prevalent in the general population, and its management involves, besides lifestyle changes, the performance of aerobic and resistance exercises. Thus, PM uses exercises similar to conventional treatment and has the potential to reduce blood pressure in individuals with hypertension[33], including during pregnancy, as observed in one of the included studies[17].

Low back pain is one of the conditions with the highest impact all over the world, and the greatest restriction occurs in lateral trunk flexion, as well as in the range of motion of the hamstring muscles[34]. Thus, a study conducted with 47 healthy college women showed that PM was effective in improving the hamstring muscles flexibility, abdominal muscle endurance, and abdominal and lumbar muscle activity[35], which is in agreement with the findings of the present review, since the studies included pointed to the improvement of the hamstring muscles flexibility[17] and increased abdominal muscle strength[14].

The adequate alignment is a prerequisite for efficiently performing a movement, especially the pelvic alignment, which has great influence and can impair the performance of some movements when altered. Thus, PM performed during 14 weeks with two weekly sessions becomes an effective strategy to improve body biomechanics[36], as observed in one of the selected studies[17].

During pregnancy, body modifications, such as the anteriorized gravity center, the increase in lumbar curvature, and the installation of a compensatory mechanism, most of the time produce musculoskeletal pain, especially in the spine, negatively impacting the pregnant woman's QoL. In this sense, PM can benefit these patients, mainly by alleviating low back pain, improving physical performance and biomechanical alignment, as well as health, general psychic and social well-being , and preparation for childbirth[37]. This was pointed out in the present review, which observed that PM was able to reduce pain[10,14,16] (even more than the minimal intervention[10,14]), promoting the improvement of posture and pelvic alignment[10,17], functional capacity[10] and QoL[10,14] of pregnant women.

Reinforcing previous considerations, the literature shows that PM can be capable of promoting, besides pain relief, improvement in flexibility and muscle strength, functional capacity[38] and spinal alignment, effects that can be maintained in the long term[39]. Thus, PM is an approach that, producing benefits on the pain of pregnant women, consequently improves other physical parameters.

A limitation of this study was the fact that sensitivity or meta-regression analysis was not performed, even when inconsistency in the outcome of the statistical analysis was observed. Nevertheless, this does not prevent the generation and dissemination of the present findings on the effects of PM in pregnant women.

CONCLUSION

The PM, when applied in a frequency of two weekly sessions over a period of eight weeks, is superior to the minimal intervention for pain relief in pregnant women. Furthermore, this approach produces improvement in the physical conditions of this population, such as less progression of abdominal diastasis, decreased fatigue, maintenance of anthropometric and hemodynamic parameters, abdominal and pelvic floor strength increase, improvement in hamstring muscles flexibility, of lumbopelvic stabilization, posture, functional capacity, and QoL.

AUTHORS' CONTRIBUTIONS

Huliana Mendo

Data Collection, Conceptualization, Methodology, Writing - Preparation of the original, Writing - Review and Editing

Matheus Santos Gomes Jorge

Statistical analysis, Funding Acquisition, Data Collection, Conceptualization, Resource Management, Project Management, Research, Methodology, Writing - Preparation of the original, Writing - Review and Editing, Software, Supervision, Validation, Visualization

REFERENCES

1. Kesikburun S, Güzelküçük Ü, Fidan U, Demir Y, Ergün A, Tan AK. Musculoskeletal pain and symptoms in pregnancy: a descriptive study. Ther Adv Musculoskelet Dis. 2018;10(12):229-34.
2. Westerneng M, Witteveen AB, Warmelink JC, Spelten E, Honig A, de Cock P. Pregnancy-specific anxiety and its association with background characteristics and health--related behaviors in a low-risk population. Compr Psychiatry. 2017;75(75):6-13.
3. Casagrande D, Gugala Z, Clark SM, Lindsey RW. Low back pain and pelvic girdle pain in pregnancy. J Am Acad Orthop Surg. 2015;23(9):539-49.
4. Liddle SD, Pennick V. Interventions for preventing and treating low-back and pelvic pain during pregnancy. Cochrane Database Syst Rev. 2015;(9):CD001139.
5. Meucci RD, Perceval AH, Lima DR de, Cousin E, Marmitt LP, Pizzato P, et al. Occurrence of combined pain in the lumbar spine, pelvic girdle and pubic symphysis among pregnant women in the extreme south of Brazil. Rev Bras Epidemiol. 2020;23(1):1-12.
6. Colla C, Paiva LL, Thomaz RP. Therapeutic exercise for pregnancy low back and pelvic pain: a systematic review. Fisioter Mov. 2017;30(2):399-411.
7. Moccellin AS, Rett MT, Driusso P. Existe alteração na função dos músculos do assoalho pélvico e abdominais de primigestas no segundo e terceiro trimestre gestacional? Fisioter Pesqui. 2016;23(2):136-41.
8. Duarte VM, Meucci RD, Cesar JA. Dor lombar intensa em gestantes do extremo Sul do Brasil. Cien Saude Colet. 2018;23(8):2487-94.
9. Castro AS, Castro AC, Mendonça AC. Physiotherapeutic approach in the pre-partum: proposed protocol and evaluate pain. Fisioter Pesq. 2012;19(3):210-4.
10. Sonmezer E, Özköslü MA, Yosmaoğlu HB. The effects of clinical pilates exercises on functional disability, pain, quality of life and lumbopelvic stabilization in pregnant women with low back pain: a randomized controlled study. J Back Musculoskelet Rehabil. 2020;1(1):1-8.
11. Mazzarino M, Kerr D, Morris ME. Pilates program design and health benefits for pregnant women: A practitioners' survey. J Bodyw Mov Ther. 2018;22(2):411-7.
12. Galvão TF, Pansani TS, Harrad D. Principais itens para relatar revisões sistemáticas e meta-análises: a recomendação PRISMA. Epidemiol Serv Saúde. 2015;24(2):335-42.
13. PEDro. Escala PEDro [Internet]. PEDro. 2020 [cited 2020 Nov 10]. p. 1. Available from: https://pedro.org.au/portuguese/resources/pedro-scale/
14. Canarslan B, Akbayrak T. Assessing the effects of clinical pilates exercises on the strength of abdominal muscles and diastasis recti abdominis in pregnant women. Fiz Rehabil. 2017;28(2):42-3.
15. Dias NT, Ferreira LR, Fernandes MG, Resende APM, Pereira-Baldon VS. A Pilates exercise program with pelvic floor muscle contraction: Is it effective for pregnant women? A randomized controlled trial. Neurourol Urodyn. 2018;37(1):379-84.
16. Oktaviani I. Pilates workouts can reduce pain in pregnant women. Complement Ther Clin Pract. 2018;31(1):349-51.
17. Rodríguez-Díaz L, Ruiz-Frutos C, Vázquez-Lara JM, Ramírez-Rodrigo J, Villaverde--Gutiérrez C, Torres-Luque G. Effectiveness of a physical activity programme based on the Pilates method in pregnancy and labour. Enferm Clín. 2017;27(5):271-7.

18. Mazzarino M, Kerr D, Wajswelner H, Morris ME. Pilates method for women's health: systematic review of randomized controlled trials. Arch Phys Med Rehabil. 2015;96(12):2231-42.
19. Araújo LM, Silva JM, Bastos WT, Ventura PL. Diminuição da dor em mulheres com dismenorreia primária, tratadas pelo método Pilates. Rev Dor. 2012;13(2):119-23.
20. Fernandes KTMS, Santos RN. Os benefícios do Método Pilates no fortalecimento do assoalho pélvico no período gestacional: uma revisão bibliográfica. Rev Cient Escol Estad Saud Publ Cândido Santiago (RESAP). 2016;2(3):152-62.
21. Falla D, Farina D, Dahl MK, Graven-Nielsen T. Muscle pain induces task-dependent changes in cervical agonist/antagonist activity. J Appl Physiol. 2007;102(2):601-9.
22. Ervilha UF, Arendt-Nielsen L, Duarte M, Graven-Nielsen T. Effect of load level and muscle pain intensity on the motor control of elbow-flexion movements. Eur J Appl Physiol. 2004;92(1–2):168-75.
23. Żelaźniewicz A, Pawłowski B. Maternal hand grip strength in pregnancy, newborn sex and birth weight. Early Hum Dev. 2018;119(1):51-5.
24. Santos JCL, Vancini RL, Sarro KJ. Impacto de 12 semanas de prática de Pilates solo na força de preensão manual, resistência abdominal e na flexibilidade avaliada por fotogrametria em mulheres saudáveis. Pensar a Prática. 2017;20(2):1-11.
25. Ostgaard HC, Andersson GB, Schultz AB, Miller JA. Influence of some biomechanical factors on low-back pain in pregnancy. Spine. 1993;18(1):61-5.
26. Mann L, Kleinpaul JF, Teixeira CS, Konopka CK. Dor lombo-pélvica e exercício físico durante a gestação. Fisioter Mov. 2008;21(2):99-105.
27. Rodrigues BG, Cader SA, Oliveira EM, Torres NV, Dantas EHM. Avaliação do equilíbrio estático de idosas pós-treinamento com Método Pilates. Rev Bras Ciência Mov. 2009;4(17):25033.
28. Mello NF, Costa DL, Vasconcellos SV, Lensen CMM, Corazza ST. The effect of the Contemporary Pilates method on physical fitness, cognition and promotion of quality of life among the elderly. Rev Bras Geriatr Gerontol. 2018;21(5):597-603.
29. Moll U, Olsson H, Landin-Olsson M. Impact of pregestational weight and weight gain during pregnancy on long-term risk for diseases. PLoS One. 2017;12(1):e0168543.
30. Catalano PM, Shankar K. Obesity and pregnancy: mechanisms of short term and long term adverse consequences for mother and child. BMJ. 2017;1(1):1-16.
31. American College of Obstetricians and Gynecologists, Task Force on Hypertension in Pregnancy. Hypertension in pregnancy. Report of the American College of Obstetricians and Gynecologists' Task Force on Hypertension in Pregnancy. Obstet Gynecol. 2013;122(5):1122-31.
32. Magee LA, Singer J, von Dadelszen P. CHIPS Study Group. Less-tight versus tight control of hypertension in pregnancy. N Engl J Med. 2015;372(24):2367-8.
33. Gonzáles AI, Nery T, Fragnani SG, Pereira F, Lemos RR, Bezerra PP, et al. Pilates exercise for hypertensive patients: a review of the literature. Altern Ther Heal Med. 2016;5(22):38-43.
34. Sadler SG, Spink MJ, Ho A, De Jonge XJ, Chuter VH. Restriction in lateral bending range of motion, lumbar lordosis, and hamstring flexibility predicts the development of low back pain: a systematic review of prospective cohort studies. BMC Musculoskelet Disord. 2017;18(1):179.
35. Kibar S, Yardimci FÖ, Deniz Evcik SA, Alhan A, Manço M, Ergin ES. Can a pilates exercise program be effective on balance, flexibility and muscle endurance? A randomized controlled trial. J Sports Med Phys Fitness. 2016;56(10):1139-46.
36. Ahearn EL, Greene A, Lasner A. Some Effects of supplemental pilates training on the posture, strength, and flexibility of dancers 17 to 22 years of age. J Danc Med Sci. 2018;22(4):192-202.
37. Silva JKS, Nascimento LGC do, Borges AMA, Dantas SS, Barbosa JGA, Vidal GP. Benefícios do Método Pilates aplicado em gestantes: um foco nas alterações posturais. Temas em Saúde. 2019;19(2):242-58.
38. Miyamoto GC, Franco KFM, van Dongen JM, Franco YRDS, de Oliveira NTB, Amaral DDV, et al. Different doses of Pilates-based exercise therapy for chronic low back pain: a randomised controlled trial with economic evaluation. Br J Sports Med. 2018;52(13):859-68.
39. González-Gálvez N, Vaquero-Cristóbal R, Marcos-Pardo PJ. Effect of Pilates Method on muscular trunk endurance and hamstring extensibility in adolescents during twelve weeks training and detraining. J Bodyw Mov Ther. 2020;24(2):11-7.

This is an open-access article distributed under the terms of the Creative Commons Attribution License.