RBFEx
ISSN Online: 2675-1372

Revista Brasileira de Fisiologia do Exercício

Systematic review

Impact of Pilates on the quality of life of patients with chronic kidney disease: a systematic review

Impacto do Pilates na qualidade de vida de pacientes com doença renal crônica: uma revisão sistemática

Lucas Oliveira Soares[1,2], Wasly Santana Silva[3], Beatriz Rodrigues Mortari[2], Adriana Malavasi Falleiros[2], André Luis Lisboa Cordeiro[4]

1. Centro Universitário Nobre – Feira de Santana (BA), Brazil
2. Hospital das Clínicas da Faculdade de Medicina da Universidade de São Paulo (HCFMUSP) São Paulo (SP), Brazil
3. Hospital Universitário da Universidade Federal de Sergipe (HUUFS) – Empresa Brasileira de Serviços Hospitalares (EBSERH), Aracaju (SE), Brasil
4. Centro Universitário Nobre – Feira de Santana (BA), Brazil

ABSTRACT

Introduction: The evolution of Chronic Kidney Disease (CKD) is silent and asymptomatic, which makes diagnosis and treatment difficult in the initial phase. Patients with CKD present loss of muscle mass, decreased functional capacity, and quality of life (QoL). **Objective:** To review the effects of the Pilates Method on the QoL of patients with CKD. **Methods:** This is a systematic review carried out according to PRISMA. The search was carried out in December 2022 in the following databases: Google Scholar, Scielo, Lilacs, CINAHL, Pubmed, PEDro, Web of Science, and the Cochrane Central Register of Systematic Review. To carry out the literary search, the PICOT strategy was used, and the studied population was patients with CKD, the intervention was training with the Pilates method, compared with patients who did not undergo training or any other intervention, the evaluated outcome was QoL and we included only randomized controlled clinical trials. **Results:** 3,287 articles were found, of which 3 were considered eligible for our systematic review. Due to methodological heterogeneity, it was not possible to perform a meta-analysis. All studies included showed significant benefits of Pilates practice in the QoL of patients with CKD. **Conclusion:** Our results indicate that the practice of physical exercise with the Pilates method can favor the improvement of QoL in individuals with CKD.

Keywords: renal insufficiency, chronic; Pilates; quality of life.

RESUMO

Introdução: A evolução da Doença Renal Crônica (DRC) é silenciosa e assintomática, o que dificulta o diagnóstico e tratamento na fase inicial. Pacientes com DRC apresentam perda de massa muscular, diminuição da capacidade funcional e qualidade de vida (QV). **Objetivo:** Revisar os efeitos do Método Pilates na QV de pacientes com DRC. **Métodos:** Trata-se de uma revisão sistemática realizada de acordo com o PRISMA. A busca foi realizada em dezembro de 2022 nas seguintes bases de dados Google Acadêmico, Scielo, Lilacs, CINAHL, Pubmed, PEDro, Web of science e o Cochrane Central Register of Systematic Review. Para execução da busca literária foi utilizada a estratégia PICOT, e a população estudada foi paciente com DRC, a intervenção foi o treinamento com o método Pilates, comparado com pacientes que não realizaram o treinamento ou qualquer outra intervenção, o desfecho avaliado foi QV e incluímos apenas ensaios clínicos controlados e randomizados. **Resultados:** Foram encontrados 3.287 artigos, dos quais 3 foram considerados elegíveis para a nossa revisão sistemática. Devido a heterogeneidade metodológica, não foi possível realizar meta-análise. Todos os trabalhos incluídos mostraram benefícios significativos da prática do Pilates na QV de pacientes com DRC. **Conclusão:** Nossos resultados apontam que a prática de exercício físico com o método Pilates pode favorecer a melhora da QV em indivíduos com DRC.

Palavras-chave: doença renal crônica; Pilates; qualidade de vida.

Received: August 19, 2023; Accepted: September 19, 2023

Correspondence: Lucas Oliveira Soares, lucassoaresft@gmail.com

Introduction

The evolution of Chronic Kidney Disease (CKD) is silent and asymptomatic, which makes the diagnosis difficult in the initial phase, or even late when the disease is already advanced, making it an important public health problem [1]. Patients with CKD have significant physical inactivity [2,3], loss of muscle mass [4], and decreased functional capacity [5], these systemic changes intrinsic to CKD cause deleterious effects, significantly affecting quality of life (QoL).

Several factors such as myalgia, fatigue, sleep disorders, and sexual dysfunction contribute significantly to the decrease in QoL [6]. In Brazil, Jesus *et al.* [7] demonstrated that patients with CKD have a significant impairment of QoL, especially those on dialysis because they are dependent on daily or intermittent hemodialysis (HD). In Iran, Ghiasi *et al.* [8] performed a systematic review with meta-analysis to summarize the effects of CKD on QoL. The authors evaluated data from more than 17,000 patients and found that scores on the Short Form 36 (SF-36), Health-related Quality of Life (HRQOL), and Kidney Disease Quality of Life-Short Form (KDQOL-SF) questionnaires were lower on different dimensions compared to other populations [8].

Physical exercise is suggested as the main strategy to increase muscle strength, preventing or delaying functional decline and QoL, a result already demonstrated by the study by Cheema [9]. In this scenario, Pilates appears, as an exercise modality whose principles are breathing control, precision in execution, flexibility, activation of trunk stabilizing muscles, and main focus on the central muscles, diaphragm, and pelvic floor [10,11]. Pilates has already shown that it can be effective in improving the QoL of other populations [12,13], in addition, it possibly has better adherence compared to other exercise programs [14]. Therefore, our work aims to review the effects of the Pilates Method on the QoL of patients with CKD.

Methods

Protocol and registration

This systematic review was completed following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [15]. It is registered in the International Prospective Register of Systematics (PROSPERO) with the number CRD42022369587.

Eligibility criteria

To carry out the literary search, the PICOT strategy [16] was used, the population studied was patients with CKD, the intervention was training with the Pilates method, compared with patients who did not undergo training or any other intervention, the evaluated outcome was QoL and we only included controlled and randomized clinical trials.

Articles with patients aged 18 years or older with dialytic and non-dialytic CKD who performed physical exercise with the Pilates method and specified which movements were performed were included. As exclusion criteria, we defined that studies that combined Pilates with another exercise (aerobic, neuromuscular, inspiratory muscle training, bodybuilding, or hydrogymnastics) and those in which patients had pathophysiological conditions that reduce performance during exercise (neuromuscular diseases, amputations, dementia).

The complete strategy is shown in Chart 1. Randomized and controlled clinical trials were used, without language and year restriction. The descriptors used were based on DecS/Mesh: Renal Insufficiency, Chronic, Pilates, and Quality of Life and their synonyms.

Chart 1 - PICOT strategy[16]

Population	Patient with chronic kidney disease
Intervention	Pilates
Control	Patients who did not undergo Pilates training
Outcome	Quality of life
Study	Controlled and randomized clinical trials

Database

We conducted a survey based on the following databases: Google Scholar, Scielo, Lilacs, Accumulated Index of Literature for Nurses and Other Health Professionals (CINAHL), Pubmed, PEDro (Physiotherapy Evidence Database), Web of Science, and the Cochrane Central Register of Systematic Review. The survey was carried out between December 5 and January 4, 2023.

Below we demonstrate the search strategy of the main platforms we used to carry out the Pubmed and Central review (Chart 2). The research was based on the PICO strategy [16] previously described and Boolean operators AND and OR.

Data items

The following data were extracted from the included studies: (1) aspects of the study population, such as number of patients, diagnosis; (2) aspects of the intervention performed (sample size, type of Pilates movements, intensity, frequency, duration of training and duration of each session); (3) follow-up; (4) outcome measures; and (5) presented results.

Chart 2 - Search strategy in the main databases

PubMed
((Renal Insufficiency, Chronic OR Chronic Kidney Disease OR Chronic Kidney Diseases OR Chronic Kidney Insufficiencies OR Chronic Kidney Insufficienc OR Chronic Renal Disease OR Chronic Renal Diseases OR Chronic Renal Insufficiency OR Chronic Renal Insufficiency OR Disease, Chronic Kidney OR Disease, Chronic Renal OR Diseases, Chronic Kidney OR Diseases, Chronic Renal OR Kidney Disease, Chronic OR Kidney Diseases, Chronic OR Kidney Insufficiencies, Chronic OR Kidney Insufficiency, Chronic OR Renal Disease, Chronic OR Renal Diseases, Chronic OR Renal Insufficiencies, Chronic) AND (Pilates OR Pilates Method OR Exercise Movement Techniques OR Pilates exercise) AND (Quality of Life OR Health Related Quality Of Life OR Health-Related Quality Of Life OR HRQOL OR Life Quality))
Central - Cochrane Central Register of Systematic Review
*Renal Insufficiency, Chronic OR Chronic Kidney Disease OR Chronic Kidney Diseases OR Chronic Kidney Insufficiencies OR Chronic Kidney Insufficiency OR Chronic Renal Disease OR Chronic Renal Diseases OR Chronic Renal Insufficiency OR Chronic Renal Insufficiency OR Disease, Chronic Kidney OR Disease, Chronic Renal OR Diseases, Chronic Kidney OR Diseases, Chronic Renal OR Kidney Disease, Chronic OR Kidney Diseases, Chronic OR Kidney Insufficiencies, Chronic OR Kidney Insufficiency, Chronic OR Renal Disease, Chronic OR Renal Diseases, Chronic OR Renal Insufficiencies, Chronic in in All Text AND Pilates OR Pilates Method OR Exercise Movement Techniques in All Text AND Quality of Life OR Health Related Quality Of Life OR Health-Related Quality Of Life OR HRQOL OR Life Quality in All Text - (Word variations have been searched)

Risk of bias in individual studies

Methodological quality was assessed according to the criteria of the PEDro scale [17], which scores 11 items, namely: 1- Eligibility criteria, 2 - Random allocation, 3 - Blind allocation, 4 - Baseline comparison, 5 - Blind individuals, 6 - Therapists blinded, 7 - Raters blinded, 8 - Appropriate follow-up, 9 - Intent-to-treat analysis, 10 - Between-group comparisons, 11 - Point estimates and variability. Items are scored as present (1) or absent (0), generating a maximum sum of 10 points, the first item being disregarded.

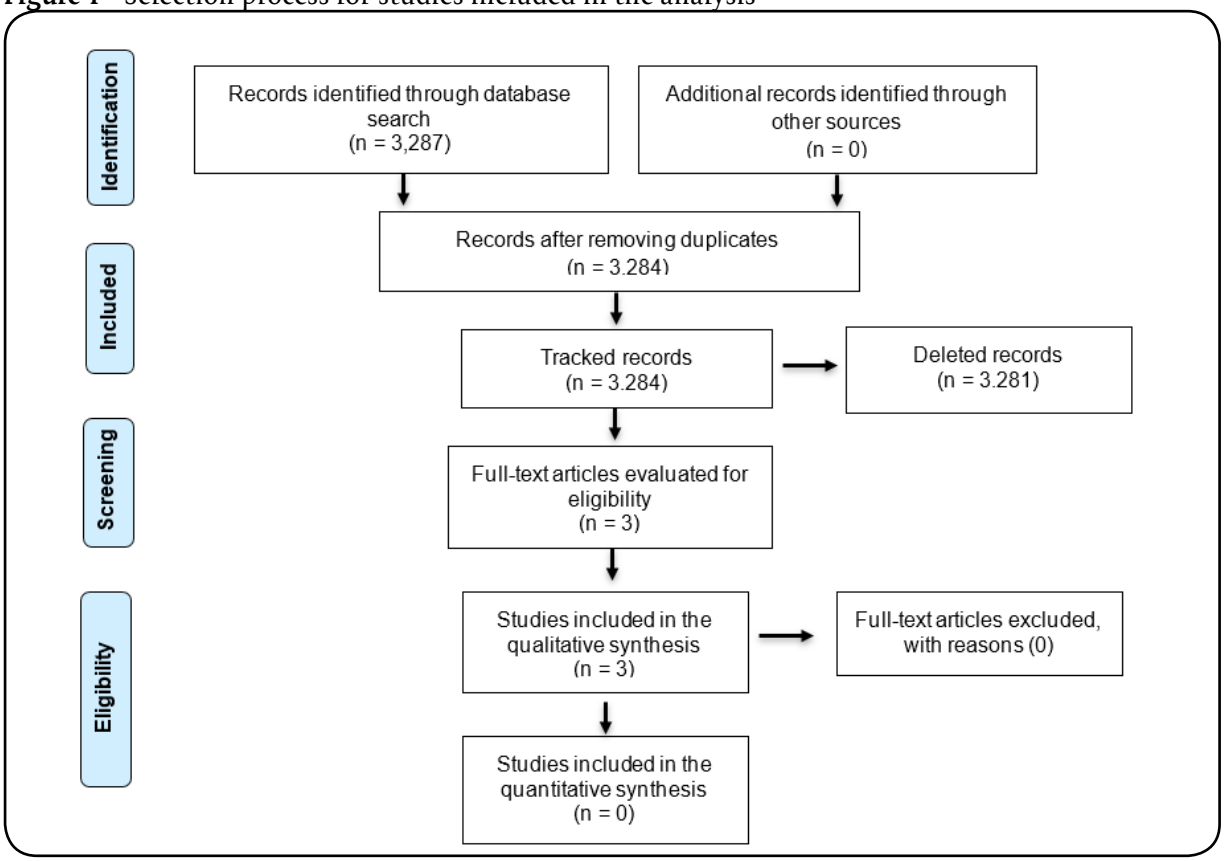
Wherever possible, PEDro scores were drawn from the PEDro database itself. When articles were not found in this database, two independent and trained reviewers evaluated the article with the PEDro scale. Studies were considered high quality if they scored 6 or more. Studies with scores lower than 6 were considered low quality.

Results

Selection and characteristics of the studies

After analyzing the articles found in the search strategy, we realized that some databases delivered generic results, thus increasing the number of articles that were excluded for not addressing the topic. At the end of the careful analysis, we included 3 studies (Figure 1), totaling a sample of 170 individuals.

Figure 1 - Selection process for studies included in the analysis



Methodological quality

To assess the methodological quality, the PEDro scale [17] was used. Scores from two articles were already available in the PEDro database, except for Kheirkhah [24] which was evaluated by 2 independent researchers (LO and WS). The scores ranged from 4 to 6 points on a scale of 1 to 10 points (Chart 3). All studies lost points on items related to patient and therapist blinding.

Chart 3 - Methodological quality of eligible studies (n = 3), PEDro scale

Study	1*	2	3	4	5	6	7	8	9	10	11	Total
Kheirkhah *et al.* [18] 2016	S	S	N	S	N	N	N	S	S	S	S	6/10
Rahimimoghadam *et al.* [19] 2017	S	S	N	S	N	N	N	N	N	S	S	4/10
Rahimimoghadam *et al.* [20] 2019	S	S	N	S	N	N	N	S	S	S	S	6/10
Total	3	3	0	3	0	0	0	2	2	3	3	

*Does not contribute to the total score; 1: eligibility criteria; 2: random allocation; 3: concealed allocation; 4: baseline comparability; 5: blind subjects; 6: blind therapists; 7: blind assessors; 8: adequate follow-up; 9: intention-to-treat analysis; 10: between-group comparisons; 11: point estimates and variability; Y: yes; N: No

Characterization and results of the studies

Chart 4 presents the sociodemographic characteristics, and sample distribution in the control group and intervention group.

Chart 4 - General characteristics of each study, objective, population, intervention and control group

Variables	Kheirkha *et al.* [18] 2016	Rahimimoghadam *et al.* [19] 2016	Rahimimoghadam *et al.* [20] 2018
Hospital	Sahahid Beheshti and Akhavan Hospitals, Kashan, Iran.	Akhavan Hospital, Kashan, Iran.	Akhavan Hospital, Kashan, Iran
Population	Adults aged 18 to 70 years, on hemodialysis treatment two to three times a week for at least six months.	Adults aged 18 to 65 years, history of hemodialysis treatment 2 and 3 times a week for at least 6 months.	Adults aged between 18 and 65 years, with chronic kidney disease in stage II (GFR: 60 – 89 mL/min/1.73 m^2) or III (GFR: 30 –59 mL/min/1.73 m^2).
Sample	60	50	50
Kind of study	Controlled and randomized clinical trial.	Controlled and randomized clinical trial.	Controlled and randomized clinical trial.
Objective	To verify the effect of Pilates exercise on the quality of life of hemodialysis patients referred to selected hospitals in Kashan.	To evaluate the effects of Pilates exercise on the general health status of hemodialysis patients.	To evaluate the effects of Pilates exercises on the quality of life of patients with chronic kidney disease.
IG	Pilates	Pilates	Pilates
CG	Educational session on hemodialysis care.	Routine care for hemodialysis patients.	Standard care.

IG = intervention group; CG = group control; GFR = glomerular filtration rate

Chart 5 shows the evaluation and intervention protocols of each study followed by the pre- and post-intervention evaluation.

Chart 5 - Prescrição e protocolos dos estudos: prescrição e movimentos realizados

Variables	Kheirkha *et al.* [18] 2016	Rahimimoghadam *et al.* [19] 2016	Rahimimoghadam *et al.* [20] 2018
Assessment instrument	Short form Kidney Disease Quality of Life (KDQOL-SF).	General Health-28 (GHQ-28).	Short form Kidney Disease Quality of Life (KDQOL-SF).
Movements performed	Bridging, hundred, roll up, one leg circle (both ways), rocker with close legs, single straight leg stretch, double leg stretch, spine stretch forward, single leg kick, side kick up and down, side kick circles, rest position (stretch and relaxation), and curling.	Bridge, Hundred, Roll Up, One Leg Circle (both ways), Close Leg Rocker, Single Straight Leg Stretch, Double Leg Stretch, Spine Stretch Forward, Single Leg Kick, Side Kick Up and Down.	Bridging, Hundred, Roll Up, One Leg Circle (both ways), Rocker with closed legs, Single Straight Leg Stretch, Double Leg Stretch, Spine Stretch Forward, Single Leg Kick, Side Kick up and down, Side Kick circles, Rest position (stretch and relaxation), and Curling. Furthermore, warming up and cooling down movements were completed before and after the exercise

Chart 5 - Continuation

Variables	Kheirkha et al. [18] 2016	Rahimimoghadam et al. [19] 2016	Rahimimoghadam et al. [20] 2018
Prescription	The 13 movements were repeated for 4 sets from the first week. Before starting the exercises, warm-up was performed and at the end, relaxing exercises were performed.	In the first week, all 13 movements were repeated 4 times per session. Then, in each week, two more repetitions of all movements were added. Before starting the exercises, warm-up was performed and at the end, relaxing exercises were performed.	In the first two weeks, all 13 were repeated 10 times. In the following weeks to the last (3-12) the number of repetitions reached 70-80 times.
Results	In the IG, there was a significant difference in the satisfaction score pre 48.5 ± 13.7 vs post 60.5 ± 12.8 (P-value 0.003) and importance pre 50.5 ± 14.1 vs post 64.3 ± 13.6 (P-value 0.001. There was also a difference in the mean differences of the dimensions of satisfaction and importance comparing the two groups at the beginning and end of the study respectively: IG 12 ± 1.1 vs CG 2.9 ± 0.5 (P-value 0.0001) and GI 13.8 ± 1.5 vs CG 2.8 ± 0.7 (P-value 0.0001).	In the intervention group, there was a significant difference in the final general health score. Before intervention 45.24±9.9 vs 31.2±6.9 after intervention (P-value 0.002) and in comparison, with CG 44.4(7.37) vs IG 31.2(6.9). There was also a difference in the mean differences of the general health dimensions comparing the two groups at baseline and at the end of the study: IG 14(0.87) vs CG 1.6(1.3) (P-value 0.001).	There were significant increases in QoL dimension scores in the experimental group after the intervention. Before intervention 21.9 ± 12.4 vs 52 ± 13.07 (P-value 0.001) and compared to CG 20.9 ± 11.8 vs IG 52 ± 13.07. There was also a difference in the mean differences of the dimensions of quality of life KDQoL-SF36 (Total QoL) comparing the two groups at baseline and at the end of the study: GI 30.1 ± 0.67 vs GC 0.3 ± 7.4 (P-value 0.001).

IG = intervention group; CG = group control; GFR = glomerular filtration rate; QoL = quality of life; U = Mann-Whitney test

Exercise protocols and progression

In the protocol by Kheirhah *et al.* [18] all 13 movements were repeated four times per session and continued until the end of the program without changing the number of repetitions and training duration. Rahimimoghadam *et al.* [19], describe very well how the progression of the exercises was performed. In the first week, all 13 movements were repeated 4 times per session, and each week, two more repetitions were added to all movements, so in the 4th week, all movements were performed 10 times, continuing until the end of the program.

Corroborating with the previously mentioned studies, Rahimimoghadam *et al.* [20] describe that the progression of the exercises was based on the increase of the repetitions and the duration of the training time. The time progressed according to the sessions, the first two sessions lasted 45 minutes, and from the third session, it was increased until it reached 70 minutes. In the first and second sessions, the number of exercises started with 10 repetitions and 45 minutes duration. In subsequent sessions, stretching exercises of about 5 minutes were added, Pilates exercises of 50 minutes and relaxation movements, of about 5 minutes. In these sessions (sessions 3-12), the number of exercises reached 70 to 80 repetitions with 70 minutes duration.

Pilates and quality of life

Of the articles included in this systematic review [18-20], all showed a significant increase in QoL in patients with CKD submitted to exercise using the Pilates method compared to the control group. The amount of movements performed was similar between the studies, all performed warm-up exercises prior to the start of training and relaxation exercises at the end [18-20].

Discussion

This systematic review of the literature identified, in all analyzed studies, an increase in QoL related to the practice of Pilates in individuals with CKD. The results were obtained through questionnaires that assessed QoL through the dimensions of physical health, mental health, and CKD components. None of the studies analyzed direct variables, such as functional capacity or metabolic response in functional tests. The quality analysis of the papers showed moderate to low methodological quality, which implies a reduction in their inference power.

The Pilates method has diversified over time, with the extension of its use in different contexts and, currently, in different clinical conditions. Improvements in functionality and QoL in individuals undergoing Pilates have been described, from elderly people with chronic musculoskeletal disorders [21] to women with breast cancer [22]. In individuals with CKD, as far as we know, this was the first systematic review of the literature to assess its effects on QoL. We identified that the practice of Pilates improved self-reported functionality in terms of physical, instrumental activities of daily living, and mental, possibly acting in an inverse way to the pathophysiology of CKD.

Among patients with CKD, the literature has already well described a high prevalence of frailty and morbidity, causing functional dependence or disability [23]. The main consequence of this is the decrease in QoL, which is directly proportional to the increase in age and the reduction in GFR, with an even more important drop in those undergoing HD29. A cohort [24] of 5,888 people from the community assessed functional disability among its participants. The presence of limitation in ADLs was almost twice as high in participants with CKD. In another study, Odden *et al.* [25], a cohort of 1,024 participants with a mean age of 65 years, with stable coronary disease, found that the chances of low functional capacity were six times greater for participants with GFR less than 60 ml/min/1.73m^2. Other consequences include a decrease in flexibility, strength, and muscle tropism, with an impact on low capacity in instrumental activities of daily living [23].

Continuing with the previous thought, we suggest that the main physical benefits arising from the practice of Pilates in CKD are related to increased muscle strength and flexibility, as reported in other studies [26,27], however, the evidence is conflicting to argue improvement of cardiovascular conditioning and functional capacity [28]. Some observational studies point to this improvement after 6 to 8 weeks

of training, but this evidence cannot impute causality, mainly because they associated the Pilates program with aerobic activities [29,30]. In contrast, Sarmento *et al.* [31] verified in a study with patients hospitalized with CKD, a greater advantage of Pilates concerning a conventional physiotherapy protocol in the outcomes of functionality and functional capacity measured by an incremental step test, in an intragroup analysis. However, when an extra group analysis was performed, there was no significant difference between Pilates and conventional physical therapy. It is important to highlight that, in the study by Sarmento, due to its nosocomial nature, the interventions lasted 10 consecutive days or less, invariably insufficient time to evaluate the main muscular and systemic adaptations to training with physical exercise.

Another important point to highlight is the mental and cognitive impacts caused by CKD. Studies demonstrate a dependent and independent association between cognitive dysfunction and CKD severity, as measured by GFR. Seliger [32] *et al.* demonstrated that the prevalence of dementia in these individuals was 37%, in a 6-year follow-up. In addition, in another study [33] it was observed that elderly people with GFR lower than 60 ml/min/1.73m^2 presented a faster decline in cognition, especially in memory domains. Our findings lead to the understanding that the benefits of Pilates permeate physical function, also collaborating to improve mental and cognitive aspects in CKD. Similar results were found in an extensive review of reviews with a sample of 128,119 individuals [34]. In this study, the practice of physical activity, in different modalities, was able to reduce mild to moderate symptoms of depression, anxiety and psychological distress compared to usual care in all populations and specifically in greater magnitude in those with CKD and other chronic diseases [34].

In this systematic review of the literature, we identified that the practice of Pilates can act directly on the physical dysfunctions of CKD, thus contributing to the improvement of QoL. However, it is important to take into account the specificity of the results presented here to define the need to associate Pilates with other interventions, according to the individuality of the patient.

Limitations

The small number of works and the heterogeneity in the QoL assessment methods are the main limitations of this systematic review. These factors made it impossible to carry out the meta-analysis, which does not allow us to establish a causal reaction in our work. Moreover, the methodological quality of the analyzed works also limits our power of inferences. The increment of objective evaluation such as functional tests, and the type and location of vascular access for hemodialysis in future studies are necessary to establish the association between QoL and functional capacity and safety in performing Pilates.

Conclusion

Our results point out that the practice of physical exercise with the Pilates method can favor the improvement of the quality of life in individuals with chronic kidney disease. More studies, with standardization of quality of life assessment and association with functional and clinical parameters, are needed to better elucidate these findings in the future.

Potential conflict of interest
No conflicts of interest potentially relevant to this article were reported.

Financing source
There were no external funding sources for this study.

Authors' contributions
Research conception and design: Soares LO; **Obtaining data:** Soares LO, Silva WS, Mortari BR; **Data analysis and interpretation:** Soares LO, Silva WS, Mortari BR; **Statistical analysis:** Soares LO, Silva WS; **Writing of the manuscript:** Soares LO, Silva WS, Mortari BR, Cordeiro ALL; **Critical review of the manuscript for important intellectual content:** Soares LO, Silva WS, Mortari BR, Falleiros AM, Cordeiro ALL.

References

1. Romão Junior JE. Chronic kidney disease: definition, epidemiology and classification. Braz J Nephrol. 2004;26(3suppl1):1-3. doi: 10.1111/jch.14186

2. Heiwe S, Dahlgren MA. Living with chronic renal failure: coping with physical activity of daily living. Advances in Physiotherapy. 2004;6:147-57. doi: 10.1080/14038190410019540

3. Johansen KL. Exercise and chronic kidney disease: current recommendations. Sports Med. 2005;35:489-99. doi: 10.2165/00007256-200535060-00003

4. Flisinski M, Brymora A, G Elminowska-Wenda, J Bogucka, K Walasik, A Stefanska, *et al*. Morphometric analysis of muscle fibre types in rat locomotor and postural skeletal muscles in different stages of chronic kidney disease. J Physiol Pharmacol. 2014;65:567-76.

5. Marinho DF, Melo RDC, Sousa KEP, Oliveira FA, Vieira JNS, Antunes CSP *et al*. Functional capacity and quality of life in chronic kidney disease. Rev Pesqui Fisioter. 2020;10(2):212-19. doi: 10.5935/0101-2800.20150008

6. Fletcher BR, Damery S, Aiyegbusi OL, Anderson N, Calvert M, Cockwell P *et al*. Symptom burden and health-related quality of life in chronic kidney disease: A global systematic review and meta-analysis. PLoS Med. 2022;19(4):e1003954. doi: 10.1371/journal.pmed.1003954

7. Jesus NM, de Souza GF, Mendes-Rodrigues C, Almeida Neto OP, Rodrigues DDM, Cunha CM. Quality of life of individuals with chronic kidney disease on dialysis. Braz J Nephrol. 2019;41(3):364-74. doi: 10.1590/2175-8239-JBN-2018-0152

8. Ghiasi B, Sarokhani D, Dehkordi AH, Sayehmiri K, Heidari MH. Quality of Life of patients with chronic kidney disease in Iran: Systematic Review and Meta-analysis. Indian J Palliat Care. 2018;24(1):104-11. doi: 10.4103/IJPC.IJPC_146_17

9. Cheema E, Alhomoud FK, Kinsara ASA, Alsiddik J, Barnawi MH, Al-Muwallad MA, *et al*. The impact of pharmacists-led medicines reconciliation on healthcare outcomes in secondary care: A systematic review and meta-analysis of randomized controlled trials, PLoS One. 2018;13(3)e0193510. doi: 10.1371/journal.pone.0193510

10. Duff WRD, Andrushko JW, Renshaw DW, Chilibeck PD, Farthing JP, Danielson J, *et al*. Impact of Pilates exercise in multiple sclerosis: a randomized controlled trial. Int J MS Care. 2018;20(2):92-100. doi: 10.7224/1537-2073.2017-066

11. Caldwell K, Harrison, M., Adams, M., Triplett, N.T., 2009. Effect of Pilates and taiji quan training on self-efficacy, sleep quality, mood, and physical performance of college students. J Bodyw Mov Ther. 2009;13,155e163. doi: 10.1016/j.jbmt.2007.12.001

12. Natour J, Cazotti Lde A, Ribeiro LH, Baptista AS, Jones A. Pilates improves pain, function and quality of life in patients with chronic low back pain: a randomized controlled trial. Clin Rehabil. 2015;29(1):59-68. doi: 10.1177/0269215514538981

13. Vancini RL, Rayes ABR, Lira CAB, Sarro KJ, Andrade MS. Pilates and aerobic training improve levels of depression, anxiety and quality of life in overweight and obese individuals. Arq Neuropsiquiatr. 2017;75(12):850-57. doi: 10.1590/0004-282X20170149

14. Denham-Jones L, Gaskell L, Spence N, Pigott T. A systematic review of the effectiveness of Pilates on pain, disability, physical function, and quality of life in older adults with chronic musculoskeletal conditions. Musculoskeletal Care. 2022;20(1):10-30. doi: 10.1002/msc.1563

15. Maher D, Liberati A, Tetzlaff J, Altman DG. The PRISMA Group. Preferred Reporting Items for Systematic Reviews and Meta- Analyses: The PRISMA Statement. PLoS Med.2009;6(7):e1000097. doi: 10.1371/journal.pmed.1000097

16. Haynes BR. Formulating research questions. J Clin Epidemiol 2006;59(9):881-6.

17. Maher CG, Sherrington C, Herbert RD, Moseley AM, Elkins M. Reliability of the PEDro scale for rating quality of randomized controlled trials. Phys Ther 2003; 83:713-21.

18. Kheirkhah D, Mirsane A, Ajorpaz NM, Rezaei M. Effects of Pilates exercise on quality of life of patients on hemodialysis. Crit Care Nurs J. 2016;9(3):e6981. doi: 10.1016/j.jbmt.2016.05.012

19. Rahimimoghadam Z, Rahemi Z, Mirbagher Ajorpaz N, Sadat Z. Effects of Pilates exercise on general health of hemodialysis patients. J Bodyw Mov Ther. 2017;21(1):86-92. doi: 10.1016/j.jbmt.2016.05.012

20. Rahimimoghadam Z, Rahemi Z, Sadat Z, Mirbagher Ajorpaz N. Pilates exercises and quality of life of patients with chronic kidney disease. Complement Ther Clin Pract. 2019;34:35-40. doi: 10.1016/j.ctcp.2018.10.017

21. Denham-Jones L, Gaskell L, Spence N, Pigott T. A systematic review of the effectiveness of Pilates on pain, disability, physical function, and quality of life in older adults with chronic musculoskeletal conditions. Musculoskeletal Care. 2022;20(1):10-30. doi: 10.1002/msc.1563

22. Espíndula RC, Nadas GB, Rosa MID, Foster C, Araújo FC, Grande AJ. Pilates for breast cancer: A systematic review and meta-analysis. Rev Assoc Med Bras. 1992;63(11):1006-12. doi: 10.1590/1806-9282.63.11.1006

23. Anand S, Johansen KL, Kurella Tamura M. Aging and chronic kidney disease: the impact on physical function and cognition. J Gerontol A Biol Sci Med Sci. 2014;69(3):315-22. doi: 10.1093/gerona/glt109

24. Shlipak MG, Stehman-Breen C, Fried LF, Song X, Siscovick D, Fried LP, Psaty BM, Newman AB. The presence of frailty in elderly persons with chronic renal insufficiency. Am J Kidney Dis. 2004;43(5):861-7. doi: 10.1053/j.ajkd.2003.12.049

25. Odden MC, Whooley MA, Shlipak MG. Association of chronic kidney disease and anemia with physical capacity: the heart and soul study. J Am Soc Nephrol. 2004;15(11):2908–15. doi: 10.1097/01.ASN.0000143743.78092.E3

26. Guclu-Gunduz A, Citaker S, Irkec C, Nazliel B, Batur-Caglaya HZ. The effects of Pilates on balance, mobility and strength in patients with multiple sclerosis. NeuroRehabilitation. 2014;34(2):337–42. doi: 10.3233/NRE-130957

27. Cruz-Ferreira A, Fernandes J, Laranjo L, Bernardo LM, Silva A. A systematic review of the effects of Pilates method of exercise in healthy people. Arch Phys Med Rehabil. 2011;92(12):2071–81. doi: 10.1016/j.apmr.2011.06.018

28. Oliveira FC, Almeida FA, Gorges B. Effects of Pilates method in elderly people: Systematic review of randomized controlled trials. J Bodyw Mov Ther. 2015;19(3):500-8. doi: 10.1016/j.jbmt.2015.03.003

29. Souza C, Krüger RL, Schmit EFD, Wagner Neto ES, Reischak-Oliveira Á, de Sá CKC, Loss JF. Cardiorespiratory adaptation to Pilates training. Res Q Exerc Sport. 2021;92(3):453-59. doi: 10.1080/02701367.2020.1749222

30. Tinoco-Fernández M, Jiménez-Martín M, Sánchez-Caravaca MA, Fernández-Pérez AM, Ramírez-Rodrigo J, Villaverde-Gutiérrez C. The Pilates method and cardiorespiratory adaptation to training. Res Sports Med. 2016;24(3):281-6.doi: 10.1080/15438627.2016.1202829

31. Sarmento LA, Pinto JS, da Silva AP, Cabral CM, Chiavegato LD. Effect of conventional physi-

cal therapy and Pilates in functionality, respiratory muscle strength and ability to exercise in hospitalized chronic renal patients: a randomized controlled trial. Clin Rehabil. 2017;31(4):508-20. doi: 10.1177/0269215516648752

32. Seliger SL, Siscovick DS, Stehman-Breen CO, *et al*. Moderate renal impairment and risk of dementia among older adults: The Cardiovascular Health Cognition Study. J Am Soc Nephrol. 2004;15(7):1904–11. doi: 10.1097/01.asn.0000131529.60019.fa

33. Buchman AS, Tanne D, Boyle PA, Shah RC, Leurgans SE, Bennett DA. Kidney function is associated with the rate of cognitive decline in the elderly. Neurology. 2009;73(12):920–27. doi: 10.1212/WNL.0b013e3181b72629

34. Singh B, Olds T, Curtis R, Dumuid D, Virgara R, Watson A, *et al*. Effectiveness of physical activity interventions for improving depression, anxiety and distress: an overview of systematic reviews. Br J Sports Med. 2023. doi: 10.1136/bjsports-2022-106195