Original Article

Pain neuroscience education and pilates for elderly with chronic low back pain: randomized controlled clinical trial

Educação em neurociência da dor e Pilates para idosos com dor lombar crônica: ensaio clínico controlado randomizado

Educación en neurociencia del dolor y pilates para personas mayores con dolor lumbar crónico: ensayo clínico controlado aleatorizado

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Abstract

Objective: Verify the effect of Pain Neuroscience Education combined with Pilates on catastrophizing in older people with chronic non-specific low back pain.

Methods: A randomized controlled clinical trial with 80 participants divided into two groups: Pilates combined with Pain Neuroscience Education Group – PEG, and Pilates Group – PG. The measurements were taken at baseline, post-intervention, and after 6 months (follow-up). The protocol included three individual 30-min PNE sessions (only for PEG) and, after that, 8 weeks of Pilates (twice a week, 50 min/session, for both groups).

Results: Comparisons of pre-post and follow-up differences in catastrophizing, kinesiophobia, disability, and pain intensity showed no evidence that PNE had any additional effects when compared with exercises alone. One likely advantage of the present PNE protocol was that the dropout rates for the PEG group were lower than for the PG group, showing that PNE has increased exercise adherence.

Conclusion: The clinical relevance of the study is that Pilates is a safe intervention for older people with non-specific chronic low back pain, and that PNE can increase adherence to exercise for this population.

Resumo

Objetivo: Avaliar o efeito da Educação em Neurociência da Dor aliada ao Pilates na catastrofização da dor em idosos com lombalgia crônica inespecífica.

Métodos: Ensaio clínico controlado randomizado com 80 participantes divididos em dois grupos: Grupo Pilates combinado com Educação em Neurociência da Dor – GPE, e Grupo Pilates– GP. As medidas foram feitas no início, pós-intervenção e após seis meses (seguimento). O protocolo incluiu três sessões individuais de Educação em Neurociência da Dor (END) de 30 min (somente para o GPE) e, posteriormente, oito semanas de Pilates (duas vezes por semana, 50 min/sessão, para ambos os grupos).

Resultados: Comparações das diferenças pré-pós e de seguimento em catastrofização, cinesiofobia, incapacidade e intensidade da dor não mostraram evidências de que a END teve efeitos adicionais em comparação com os exercícios isoladamente. Uma vantagem provável do presente protocolo de END foi que as taxas de abandono para o GPE foram menores do que para o GP, mostrando que a END aumentou a adesão ao exercício.

Conclusão: A relevância clínica do estudo é que o Pilates é uma intervenção segura para idosos com dor lombar crônica inespecífica e a END pode aumentar a adesão ao exercício nessa população.

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Conflicts to interest: A part of this manuscript has been presented at the 17th World Congress on Pain, held September 12-16th, 2018, Boston, USA, with the title "Pain Neuroscience Education Associated with Pilates Method in Older Adults with Chronic Low Back Pain: Preliminary Study". Effects of Pain Neuroscience Education Combined with Pilates on Catastrophizing for Older People with Non-Specific Chronic Low Back Pain: Randomized Controlled Clinical Trial – 2020 Federal University of São Carlos.

Resumen

Objetivo: Evaluar el efecto de la educación en neurociencia del dolor como aliada a la práctica de pilates en la catastrofización del dolor en personas mayores con lumbalgia crónica inespecífica.

Métodos: Ensayo clínico controlado aleatorizado con 80 participantes divididos en dos grupos: Grupo pilates combinado con educación en neurociencia del dolor (GPE) y Grupo pilates (GP). Las medidas se realizaron antes y después de la intervención y después de seis meses (seguimiento). El protocolo incluía tres sesiones individuales de educación en neurociencia del dolor (END) de 30 minutos (solo para el GPE) y, posteriormente, ocho semanas de pilates (dos veces por semana, 50 min/sesión, para ambos grupos).

Resultados: La comparación de las diferencias antes-después y de seguimiento en catastrofización, kinesiofobia, incapacidad e intensidad del dolor no mostró evidencias de que la END tenga efectos adicionales en comparación con los ejercicios de forma aislada. Una ventaja probable del presente protocolo de END fue que los índices de abandono del GPE fueron menores que en el GP, lo que demuestra que la END aumentó la adherencia al ejercicio.

Conclusión: La relevancia clínica del estudio es que pilates es una intervención segura para personas mayores con dolor lumbar crónico inespecífico y la END puede aumentar la adherencia al ejercicio en esta población.

Brazilian Clinical Trials Registry: U1111-1190-673

Introduction

Low back pain is the chronic pain that affects older people and, as a consequence, can cause negative physical, mental, and social impacts.[1,2] However, despite efforts in using both pharmacological and nonpharmacological interventions,[3] the management of chronic pain in older people is not effective.[4]

Exercise, defined as "planned, structured, and repetitive bodily movements that are performed to improve or maintain one or more components of physical fitness",[5] is the most recommended intervention to treat chronic low back pain.[6]

Among several types of exercises, there is the Pilates Method, which claims to improve muscle strength and mobility and hence decrease pain intensity and functional disability.[7]

Pain Neuroscience Education (PNE) is considered an innovative strategy that proposes to educate patients to reconceptualise pain through the understanding of the neurophysiological, neurobiological, sociological, and physical components that may be involved in their individual pain experience.[8] Pain Neuroscience Education is considered a low-cost intervention that has several benefits for people with chronic pain. A number of studies,[9,10] including systematic reviews,[11,12] suggest that PNE is effective in reducing pain levels, disability, catastrophization, and kinesiophobia in adults. A recent systematic review has suggested that, when combined, exercises and pain education have better results for pain and disability reduction than any of the two interventions alone.[13]

Nonetheless, the literature is still limited regarding studies that have assessed the effectiveness of PNE along with other intervention for older people with chronic low back pain. Hence, the present study aimed to verify the effect of PNE combined with Pilates on catastrophizing, kinesiophobia, pain, and disability in older people with chronic low back pain. The hypothesis was that the association of PNE and Pilates would have better and more lasting outcomes than Pilates alone for this population.

Methods

This is a randomized controlled clinical trial, developed in São Carlos-Brazil. The population studied was composed of elderly with chronic low back pain. This study included participants with non-specific low back pain (pain between the lower rib margins and the buttock creases);[2] both genders, aged ≥60 years old; scores greater than the cutoff score according to education in the Mini Mental State Examination[14,15],scores ≤5 in the 15-item Geriatric Depression Scale;[16] and pain lasting at least 6 months. Exclusion Criteria were physical therapy treatment for pain management 6 months prior to their participation; surgery for pain management; medical diagnosis of fibromyalgia, neoplasms, radiculopathies, and active inflammatory diseases; and previous spine or lower limbs fractures.

The sample size calculation was performed using the SAS System for Windows (Statistical Analysis System) statistical program, version 9.2. (SAS Institute Inc, 2002-2008, Cary, NC, USA); the calculations were based on a pilot study conducted with 20 individuals analyzing the outcome variable, catastrophization, with a standard deviation of 9.29 and a mean of 15.85. A significance level of 95% was used, and margins of error of 1.80 and 2.05 (nominal error on the variable scale) were used for catastrophizing; thus, the estimated sample was 80 volunteers. Based on these criteria, 40 participants per group were included.

The primary outcome was pain catastrophizing and it was assessed with the Pain Catastrophizing Scale (PCS). The PCS is a self-administered questionnaire that consists of 13 items describing thoughts and feelings that individuals may experience when they are in pain, and consists of elements of rumination (8–11), magnification (6, 7, and 13), and helplessness (1–5 and 12). The items are rated on a 5-point Likert-type scale: (0) not at all, (1) to a slight degree, (2) to a moderate degree, (3) to a great degree, and (4) all the time. The total scores for the PCS range from 0 to 52; higher scores indicate greater frequency of catastrophic thoughts, and the total value was used to compare pre- and post-intervention results. The scale is validated for Brazil and has good parameters of reliability and psychometric property, a Cronbach's alpha value of 0.91 for the total PCS, and of 0.93 (helplessness), 0.88 (magnification), and 0.86 (rumination) for the respective subdomains.[17,18]

The secondary outcomes were disability, pain intensity and kinesiophobia. Disability was measured with the Roland Morris Disability Questionnaire (RMDQ), which consists of 24 items related to daily life activities. The score is calculated by the sum of the questions marked by the participant, and ranges from zero, meaning no disability, to 24, meaning the worst disability .[19,20] The minimal difference in RMDQ is five points. The Brazilian version for low back pain also has adequate validity and reliability, a Cronbach's alpha value of 0.90, Pearson correlation coefficient between two halves (0.82).[21]

Pain intensity was evaluated with the Visual Analogue Scale (VAS), a 100-mm line (0 mm = no pain; 100 mm = the worst pain ever felt) over which the participants were asked to mark the point they believe better describes their pain. A change of 15-20% is considered clinically relevant.[22]

Kinesiophobia was measured with the Tampa Scale for Kinesiophobia (TSK). The TSK is a questionnaire with 17 questions related to somatic sensations and activity avoidance and each item is scored from 1 ("strongly disagree) to 4 ("strongly agree"). Four of the items are reversely scored, with scores ranging from 17 to 68, a higher score indicating greater fear of (re)injury. The Brazilian version for kinesiophobia also has adequate validity and reliability, applied to subjects with non-specific chronic lumbar pain. The Rasch analysis revealed a reliability coefficient of 0.95 for the items.[23,24]

The reliability of the results from each instruments applied in this study was evaluated using Cronbach's alpha of each instrument. The Tampa Scale for Kinesiophobia (TSK) had a Cronbach's alpha of 0.60, the Pain Catastrophizing scale of 0.89 and the RMDQ of 0.88.

The recruitment was between July 2018 and August 2018 was disclosed in social media, advertisements via local news outlets, university community newsletters, banners or leaflets posted at strategic locations in the city, radio and television, targeting older people from different social and educational levels. All the older individuals who were interested in taking part in the study contacted the researchers, who kept names for a database. After that, a single evaluator familiarized with the process made telephone contact to confirm the inclusion and non-inclusion criteria. All the older individuals who fit the inclusion criteria were invited to take part in the study and then took part in one face-to-face assessment session to confirm eligibility and to apply both the Mini Mental State Examination and the 15-item Geriatric Depression Scale.

Once included, the participants were randomly assigned to either the Pilates Group (PG) or to the Pilates and PNE Group (PEG) using simple randomization, conducted by an investigator who was

not involved with the recruitment and treatment of the participants. The researcher generated one allocation random sequence in Excel for Windows. Allocations were concealed using sealed, opaque, and sequentially numbered envelopes, and the participant was allocated to the group according to the envelope chosen.

The researcher responsible for the assessment sessions (before treatment, after treatment, and at the 6-month follow-up) was blinded to participants' allocation, and the participants were blinded to the study hypothesis. Both researchers responsible for the interventions of PNE and Pilates were blinded to the results of the evaluations and did not communicate during the development of the study. The physical therapist that conducted the Pilates sessions was also blinded to the participants' allocation, in order to avoid detection bias.

The participants received PNE sessions given by a gerontologist with a 2-year experience; a gerontologist is a bachelor in gerontology. The Pilates sessions were conducted by a physical therapist with a 6-year experience on the method. The PG received 16 1h-Pilates sessions, twice a week, during 8 weeks, held in small groups (of 5 participants maximum), the interventions were held in the physiotherapy clinic of the university. The PEG received three individual PNE sessions, each one lasting 30 minutes, on three different days, with a 2-day interval between sessions. After completing the PNE sessions, the PEG participants received the same Pilates protocol described for the PG. The PNE sessions content and the Pilates protocol are described in the Supplemental Digital Content.

Pain Neuroscience Education (PNE): The intervention proposed for this study was based on the book Explain Pain[8] and addressed the following topics: 1) Transition from acute to chronic pain; 2) Characteristics of chronic pain and acute pain; 3) How pain becomes chronic (nervous system plasticity, modulation, modification, central sensitization, neuromatrix pain theory); 4) Potential support factors for central sensitization (such as emotions, stress, disease perceptions, pain cognitions, and pain behavior); 5) The role of the brain in pain perception; and 6) Psychosocial factors related to pain, and cognitive and behavioral responses related to pain. The intervention was presented verbally, with illustrations, examples, and metaphors and, during the sessions, the participants were encouraged to pose any questions they had. Appropriate language and rhythm that took into account the participant's level of literacy, intellectual ability, and health knowledge were used, and the content of the previous session was always summarized by the researcher before starting any new content. The participants learned about the principles of the PNE, and were instructed to put it into practice in their daily activities. Thus, in the subsequent sessions, they brought what they put into practice on a daily basis and reviewed everything they learned.

Pilates Intervention: The Pilates sessions lasted 1 hour and were initially composed of 13 basic and intermediate level Pilates exercises, considered enough for the volunteers to learn the principles of the method and to perform the exercises. Each exercise was performed in a series of 10 repetitions and, every 2 weeks, two new intermediate and advanced level exercises were included, totaling 19 exercises of the intermediate and advanced levels in the last two weeks of the protocol. The exercises focused on the stretching of the posterior chain of the lower limbs and trunk, on the mobilization of the lumbar spine, and on the strengthening of the power house. All the exercises had variations to turn them easier or more difficult, hence making the Pilates sessions adaptable to each volunteer. If the volunteer could not perform the exercise at its normal difficulty, an easier variation was offered so that the volunteers would not stop performing the exercise. The difficulty level for each exercise was determined according to individual needs and increased as the participants reduced their postural compensation. The exercises that made up the Pilates protocol were the following: One Leg Circle, One Leg Stretch, The Hundred, Shoulder Bridge, Tree, The Side Kick Kneeling, Criss Cross, Spine Stretch, The Saw, The Leg Pull Front, Cat Stretching, Standing Calf, Hamstring Stretch Variant, Side Board, Oblique Rolling Back, The Jack Knife, Swan Dive, Side to Side, and Bird Dog.[25]

For the analysis, a database was created using the Excel 2010 software and double data entry was performed. After double entry validation, data was exported to the SAS system for Windows software (9.2). For comparisons involving groups and times, the linear regression model with mixed effects (random and fixed effects) was performed. For the comparisons of the variables, the post-test by orthogonal contrasts was used.[26] For comparisons between the groups in relation to deltas (mean differences), covariance analysis (ANCOVA) was performed.[27] All the models were adjusted for schooling level, time of pain, times of week, gender, age, number of medications, and number of diseases (possible confounders). For the volunteers lost throughout the study, an intention-to-treat (ITT) analysis was performed with the repetition of initial assessment data. For all the statistical tests, the significance level of 5% was adopted.

This study was approved by the Human Research Ethics Committee from Federal University of São Carlos (2.322.194/2017) and by the Health Secretary of São Carlos (protocol number 111/2016); the study was conducted according to the Declaration of Helsinki (2013) and Brazilian National Health Council (resolution 466/2012) (*Certificate of Presentation of Ethical Appreciation:* 65687317.2.0000.5504). The development of this study met national and international standards of ethics in research involving human subjects.

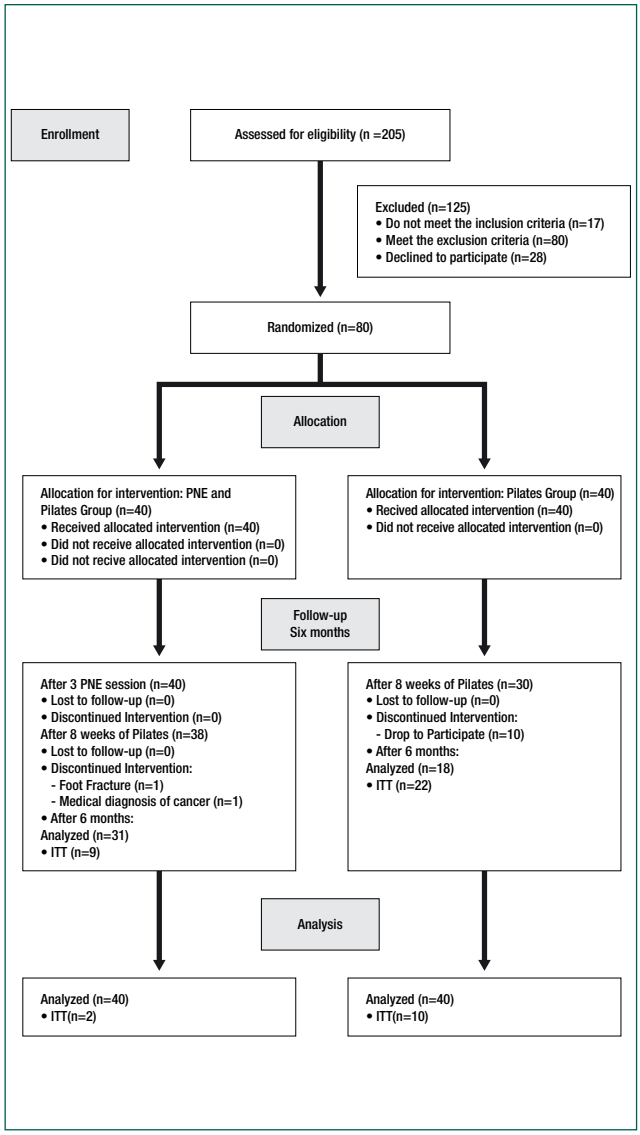

Figure 1. Flowchart of the trial

Results

Figure 1 shows the study flowchart. For the volunteers lost during the study due to dropout, medical diagnosis of cancer or foot fracture, an intention-to-treat (ITT) analysis was performed based on the repetition of the initial assessment data.

Regarding the sociodemographic characteristics of the 80 participants, divided between PEG (n = 40) and PG (n = 40), there are no statistics differences between the groups for the variables considered (sex, age, weight, height, body mass index, education, pain duration). Table 1 presents the mean and standard deviation of the variables in the PG and in the PEG at the different times studied (baseline, post-intervention, and after 6 months - follow up).

In the intragroup analysis, statistical differences were observed in the pre-post, pre-follow-up, and post-follow-up comparisons with improvement of all the studied variables (catastrophizing, kinesiophobia, pain intensity, and disability) in both groups (Table 2).

Table 3 presents the ANCOVA analyses of intergroup comparisons of pre-post differences in catastrophizing, kinesiophobia, disability, and pain intensity instruments. There is no evidence

Table 1. Mean and standard deviation scores for catastrophizing, kinesiophobia, disability and pain intensity variables for the Pilates Group and Pilates and PNE Group at the baseline, post-intervention and 6-month follow-up

Variables	Pilates Group (n=40)			Pilates and PNE Group (n=40)		
	Baseline	Post	Follow-Up	Baseline	Post	Follow-Up
Catastrophizing	10.2(8.2)	7.4(6.2)	2.6(0.9)	11.5(8.5)	9.5(7.1)	4.6(4.1)
Kinesiophobia	36.6(8.4)	32.1(6.6)	28.5(2.7)	36.5(7.0)	34.0(9.1)	30.0(7.2)
Disability	7.5(4.5)	4.2(3.5)	2.3(1.5)	7.8(4.8)	4.5(4.3)	2.7(3.3)
Pain	2.6(2.5)	1.7(1.7)	1.2(1.1)	3.0(2.5)	1.3(1.5)	1.4(1.7)

Table 2. Intragroup comparisons of catastrophizing, kinesiophobia, disability, and pain intensity variables in the PG and PEG at the different times studied (baseline or pre-intervention, post-intervention and 6-month follow up)

Variables	Pairwise comparison	Estimated Difference (CI)	p- value[a]	Variables	Pairwise comparison	Estimated Difference (CI)	p- value[a]
Catastrophizing	Pre – Post	2.6 (0.2-5.0)	0.032	Catastrophizing	Pre – Post	1.6(-0.5-3.8)	0.144
	Pre - Follow	5.8(2.9-8.7)	<0.001		Pre - Follow	6.8(4.5-9.1)	<0.001
	Post - Follow	3.1(0.3-6.0)	0.029		Post - Follow	5.2(2.9-7.5)	<0.001
Kinesiophobia	Pre – Post	4.23(1.37-7.10)	0.004		Pre – Post	1.37(-1.24-3.99)	0.301
	Pre - Follow	6.47(3.03-9.90)	0.000	Kinesiophobia	Pre - Follow	5.00(2.23-7.76)	0.001
	Post - Follow	2.24(-1.13-5.60)	0.191		Post - Follow	3.62(0.91-6.34)	0.009
Disability	Pre – Post	2.58(1.13-4.02)	<0.001		Pre – Post	2.14(0.83-3.46)	<0.001
	Pré - Follow	3.46(1.73-5.20)	<0.001	Disability	Pre - Follow	4.61(3.21-6.00)	<0.001
	Post - Follow	0.89(-0.81-2.59)	0.302		Post - Follow	2.46(1.09-3.83)	<0.001
Pain	Pre – Post	0.29(-0.64-1.21)	0.540	Pain	Pre – Post	1.00(0.15-1.85)	0.021
	Pre - Follow	0.40(-0.69-1.50)	0.468		Pre - Follow	1.02(0.13-1.91)	0.026
	Post - Follow	0.12(-0.97-1.21)	0.831		Post - Follow	0.02(-0.86-0.90)	0.964

Statistical Test - linear regression model with mixed effects (mixed model); [a] p-value: significance level of 5%, model adjusted for education, time of pain, times of pain in the week, gender, age, number of medications and number of diseases; CI - 95% Confidence Interval; PG - Pilates Group; PEG - Pilates and PNE Group

that the PEG had any greater change in its results when compared to the PG. No association was found between the PEG and PG groups at the pre-post and follow-up moments in any of the variables studied by the ANCOVA covariance analysis (Table 4).

Table 4 presents the analysis of the effect of catastrophization, kinesiophobia, disability, and pain.

Discussion

The results of the present study show that there is no additional benefit of adding a PNE program to Pilates for older people with non-specific chronic low back pain regarding pain catastrophizing, kinesiophobia, pain intensity, and disability. To the best of authors' knowledge, this is the first study that does not support the initial hypothesis.

The PNE protocol used in the present study has some peculiarities: the participants underwent three individual 30-min sessions of PNE, as older people may present greater difficulty in learning

Table 3. Intergroups comparisons of the pre-post differences between the PEG and PG regarding the catastrophizing, kinesiophobia, disability and pain intensity variables

	Pairwise comparison	Estimated Difference (CI)	p- value[a]	Effect size (d de Cohen)[b]
Catastrophizing	Pre (PG/PEG)	-0.55(-3.54-2.43)	0.715	-0.16
	Post (PG/PEG)	-1.57(-4.79-1.65)	0.337	-0.31
	Follow (PG/PEG)	0.45(-3.22-4.12)	0.808	-0.68
Kinesiophobia	Pre (PG/PEG)	0.77(-2.59-4.14)	0.650	0.01
	Post (PG/PEG)	-2.09(-5.74-1.56)	0.259	-0.23
	Follow (PG/PEG)	-0.70(-4.89-3.49)	0.741	-0.28
Disability	Pre (PG/PEG)	-0.04(-1.84-1.76)	0.964	-0.08
	Post (PG/PEG)	-0.47(-2.41-1.47)	0.630	-0.09
	Follow (PG/PEG)	1.10(-1.10-3.30)	0.324	-0.26
Pain	Pre (PG/PEG)	-0.34(-1.27-0.60)	0.478	-0.14
	Post (PG/PEG)	0.38(-0.65-1.41)	0.469	0.23
	Follow (PG/PEG)	0.28(-0.94-1.50)	0.649	-0.16

Statistical Test - linear regression model with mixed effects (mixed model); [a] p-value - significance level of 5%, model adjusted for education, time of pain, times of pain in the week, gender, age, number of medications and number of diseases; [b] calculated from the sample means and standard deviations; CI - 95%; PG - Pilates Group; PEG - Pilates and PNE Group

Table 4. Analysis of the effect of catastrophization, kinesiophobia, disability and pain

	Pairwise Comparison	Estimated Difference (CI)	p-value[a]
Catastrophizing	PG - PEG	-2.05(-5.39-1.29)	0.226
Kinesiophobia	PG-PEG	-3.33(-7.52-0.87)	0.118
Disability	PG-PEG	-0.78(-2.98-1.41)	0.480
Pain	PG-PEG	0.28(-1.14-1.70)	0.697

Statistical Test - covariance analysis (ANCOVA); [a] p-value - significance level of 5%, model adjusted for education, time of pain, times of pain in the week, gender, age, number of medications and number of diseases; CI - 95%; PG - Pilates Group; PEG - Pilates and PNE Group

and concentration over a long period of time. All the sessions took place before the Pilates intervention began, and the participants in the PEG group were instructed not to comment about the sessions during the exercises, for blinding purposes. This may have prevented them to insert their knowledge into exercising, and thus confusing them. Even though they were instructed to talk to their families on the concepts worked on during the PNE sessions, they did not share that knowledge among individuals perceived as equals (older people with low back pain), which is considered to be a big part of learning, and which may have impacted on their transference of concepts to their daily life activities.

Additionally, other studies do not thoroughly describe the PNE protocol, which does not allow for a comparison between protocols or for a replication of the studies and, as such, hinders the comparison of results. In a study with different types of chronic pain individuals, one group received a booklet of metaphors and stories to reconceptualize pain (PNE) and the other group, a booklet containing advice on how to manage chronic pain for people with pain according to established cognitive-behavioral principles; as a result, the PNE group showed less pain catastrophizing, but no change was observed in the pain and disability variables in both groups.[9]

When combined with aquatic exercises for older people (>50 years old) with low back pain, no differences were found regarding kinesiophobia, but the group that received PNE showed less pain and disability at the 3-month follow-up.[10] A number of reviews[11-29] conducted with patients with chronic low back pain, and pain neuroscience education interventions provide evidence of the efficacy of this on the catastrophizing, kinesiophobia, disability, and pain levels variables. However, the studies included in those reviews differ from the present study concerning methodological design, age of the participants, and time of the proposed intervention.

One likely advantage of the present PNE protocol was that the dropout rates for the PEG group were lower than for the PG group, showing that PNE has increased exercise adherence. Exercise is the most recommended intervention for treating all chronic pain disorders in general[30] and low back pain specifically,[31,32] and PNE may be advantageous for older people by showing them the importance of staying physically active.

The present study has some limitations. First, the participants had low disability and pain levels at baseline, which may have impacted on how much they would improve due to the treatment. Thus, future study protocols should have a inclusion criteria moderate to severe levels of the studies variables. The PNE protocols used in other studies are not well described, and no specific protocol for this population was previously published; as such, the present study brings a new proposal. Future studies should focus on other PNE protocols, for example, with longer PNE sessions, or group sessions, or studies that would assess, for example, the cost-effectiveness of PNE, medication consumption, and other types of exercises. The study results filled an important gap in the scientific literature regarding the use of PNE in elderly people with chronic low back pain. The results and limitations of our clinical trial opened doors for further nursing research with a focus on providing health with more quality and accessibility for the Brazilian population. It should be note that the PNE could be a care practice provided by nurses for patients with chronic pain.

Conclusion

The results of this study indicate that adding PNE to a Pilates intervention did not lead to any additional effect for older people with non-specific chronic low back pain. The clinical relevance of the study is that Pilates is a safe intervention for older people with non-specific chronic low back pain, and that PNE can increase adherence to exercise for this population.

Collaborations

Rossetti ES, Campos MM, Souza EN, Avila MA, Gramani-Say K and Hortense P were involved in the design and interpretation of the analyses, contributed to the writing of the manuscript, and read and approved the final manuscript.

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