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Review

Efficacy and safety of proprioceptive neuromuscular facilitation for chronic low back pain: A meta-analysis of randomized controlled trials

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ABSTRACT

Objectives: This study aimed to evaluate the effectiveness and safety of proprioceptive neuromuscular facilitation for chronic low back pain.

Materials and methods: Eleven databases were searched from their inception through January 2021. The primary outcomes were pain intensity, individual activities, quality of life, and adverse events.

Results: Four randomized controlled trials (RCTs) with 184 patients (mean age: 37.8±3.1 years; range, 35 to 50 years) met the inclusion criteria. The pooled effect size showed proprioceptive neuromuscular facilitation, relieved pain (standard means difference [SMD]: -0.835, 95% CI: -1.139 to -0.531, p<0.001, n=4), and improved individual activity (Roland Morris Disability Questionnaire, SMD: -1.765, 95% CI: -2.642 to -0.888, p<0.001, n=2; Oswestry Disability Index, SMD: -0.893, 95% CI: -1.434 to -0.352, p=0.001, n=1) for chronic low back pain (CLBP).

Conclusion: This study verified that proprioceptive neuromuscular facilitation could relieve pain and improve individual activities without serious adverse events in patients with CLBP; however, it should be cautiously recommended due to the small number of included RCTs.

Keywords: Chronic low back pain, meta-analysis, proprioceptive neuromuscular facilitation, systematic review.

Chronic low back pain (CLBP) is defined as local pain from 12 ribs to the subgluteal fold for more than three months, commonly with no specific pathology.[1] The prevalence of CLBP is about 23% worldwide[2] and even double that in Japan.[3] Chronic low back pain develops usually based on the recurred acute low back pain (about 25 to 50% per year).[4] It is one of the most common skeletal muscle problems, which mainly limits the range of waist motion, decreases strength, endurance, and flexibility of the trunk muscles,[5] results in depression, anxiety, and disability,[6-8] and in turn, it has placed a heavy burden on patients, communities, and the global economy.[9-11] The common conservative managements of CLBP include modalities with heat, ultrasound, electrical stimulation, and physical therapies, such as traction, joint mobilization, manipulation, massage, and exercise.[12] Interestingly, proprioceptive neuromuscular facilitation (PNF) therapy has been applied for CLBP in recent years.[13-16] Proprioceptive neuromuscular facilitation was primarily developed by Dr. Herman Kabat and his collaborators in 1940s[17] and

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is used for numerous neurologic and musculoskeletal diseases.[18] It was reported that PNF could promote neuromuscular responses through stimulating proprioceptors,[19,20] improve muscular strength,[21,22] joint stability, mobility,[23-27] neuromuscular control, and coordination, consequently improving the overall functional ability of patients with CLBP.[28-30] However, the evidence on PNF for the management of CLBP is not sufficient.[20] Thus, the present study was conducted to assess the effectiveness and safety of the PNF for CLBP.

MATERIALS AND METHODS

Search strategy

Eleven databases were electronically searched (PubMed, Science Direct, Wiley Online Library, EBSCO, Web of Science, Ovid, Cochrane Library, and Embase; CNKI, VIP, WanFang) from their inception through January 24, 2021. The search on PubMed used the following index formula: ("pnf" OR "proprioceptive neuromuscular facilitation") AND "back pain" OR "protrusion of intervertebral disc" OR "lumbar muscle degeneration" OR "CLBP" OR "lumbar spine" OR "low back pain") AND ("randomized controlled trial" OR "RCT" OR "controlled"). Other studies were collected through manual searches of reference lists in relevant literature reviews. The search strategy was designed by two authors and performed independently; if discrepancies were to occur, a consensus was reached through discussion. If multiple studies conducted by the same researchers were retrieved, the papers that had detailed data were included. The published languages were limited to English and Chinese.

Inclusion and exclusion criteria

All retrieved articles were evaluated independently by two reviewers (LXL and KYH) according to the following criteria: *(i)* patients: all of the participants had been clinically diagnosed as CLBP; *(ii)* interventions: PNF; *(iii)* comparison: PNF *vs.* routine medical care, conventional rehabilitation, sham PNF, or blank control; *(iv)* outcomes: the primary outcomes included pain intensity, individual activities, health-related quality of life (HRQOL), and safety assessments; *(v)* study design: randomized controlled trials (not including quasi-randomized controlled trials). Exclusion criteria were as follows: *(i)* nonoriginal research articles (e.g., letters, conference abstracts, comments, case reports, reviews); *(ii)* full text or data unavailable; *(iii)* published in a language other than English or Chinese.

Data extraction

Following the inclusion and exclusion criteria, the eligible studies were elaborately evaluated, and the data were extracted independently by two authors. Data related to the following information was collected: author, year, sample size, age, sex, duration, PNF protocols, and outcomes related to pain intensity, individual activities, HRQOL, and safety assessments. If detailed information on the extracted data was necessary, the authors of the included studies were contacted. Differences and contradictions were resolved by discussion between the two authors.

Quality assessment

Two reviewers evaluated independently the quality of the methodology with the Physiotherapy Evidence Database (PEDro) scale (https://www.pedro.org.au/).[31] The PEDro scale consists of 11 items with the scores (from 0 to 10). Ten items involve methodological quality related to statistical report (i.e., random assignment, covert assignment, baseline comparability, blind subjects, blind therapist, blinded evaluator, adequate follow-up and treatment intention analysis, comparison between groups and point estimates, and variability) and one item (qualification criteria) related to external validity, which is not included in the total scores. The PEDro scores of ≥7 were considered to be high quality, scores of 5 and 6 to be fair, and scores of ≤4 to be low. Any discrepancies in the quality assessment were settled via negotiation.

Statistical analysis

Statistical analyses were conducted using Stata/SE (Statistics Data Analysis Special Edition) version 12.0 software (StataCorp LP, College Station, TX, USA). For dichotomous data, the relative risk and 95% confidence interval (CI) were used to represent the effect sizes, while the standard means difference (SMD) with 95% CI was used for continuous data. The I^2 test was used to assess statistical heterogeneity in the included studies, and I^2 >50% and $p<0.10$ represented substantial heterogeneity.[32] In case of any heterogeneity, the sensitivity analysis, subgroup analysis, meta-regression, or the random-effects model were applied for clarification.[33] The publication bias was evaluated with the following methods: the funnel plots, the Begg's or Egger's test,[34] the trim-and-fill analysis, and the fail-safe number.[35]

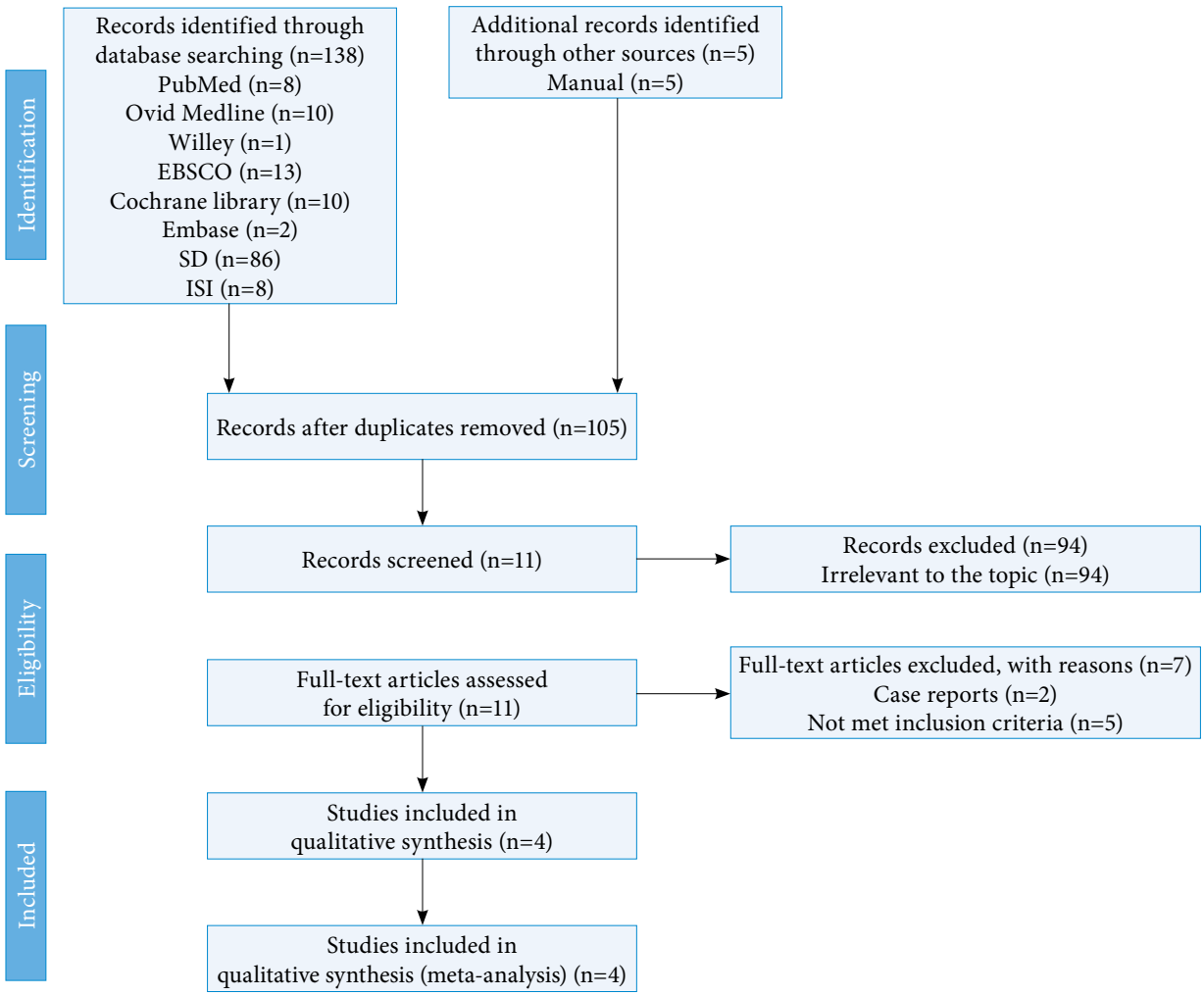

Figure 1. Search flowchart of the meta-analysis.

TABLE 1
The methodological quality of the included studies

ID	Year	First author	1	2	3	4	5	6	7	8	9	10	Score	Eligibility criteria
1	2017	Areeudomwong et al.[1]	Y	Y	Y	N	N	Y	N	N	Y	Y	6	Y
13	2018	Areeudomwong et al.[1]	Y	Y	Y	N	N	Y	Y	N	Y	Y	7	Y
20	2006	Kofotolis et al.[20]	Y	N	Y	N	N	N	N	N	Y	Y	4	N
36	2014	Lee et al.[35]	Y	N	Y	N	N	N	Y	N	Y	Y	5	Y

1: Random allocation; 2: Concealed allocation; 3: Baseline similarity; 4: Blinding of subjects; 5: Blinding of therapists; 6: Blinding of assessors; 7: Measures of key outcomes from more than 85% of subjects; 8: Intention to treat analysis; 9: Between-group statistical comparisons; 10: Point measures and measures of variability.

RESULTS

Study selection

Comprehensive research recorded 143 references through electronic and manual searches. After excluding duplicates, screening titles and abstracts, and assessing the full text in accordance with the study selection criteria, four studies[1,13,20,36] reported between July 7, 2006, and October 9, 2018, were finally included in this study. The research flowchart is displayed in Figure 1 and detailed as supplementary information (SI) in Table 1.

TABLE 2
Heterogeneity tests, met-analyses and sensitivity analyses

Outcomes	No. of study	Eligible patients	Heterogeneity test	SMD	95% CI	*p*
PI all included	4	184	p=0.237 (I^2=29.1%)	-0.835	-1.139, -0.531	<0.001
RMDQ all included	2	86	p=0.085 (I^2=66.4%)	-1.765	-2.264, -0.888	<0.001
ODI all included	1	58	-	-0.893	-1.434, -0.352	0.001
HRQOL-P all included	1	42	-	1.817	1.092, 2.541	<0.001
HRQOL-M all included	1	42	-	-0.006	-0.611, 0.599	0.985

SMD: Standard means difference; CI: Confidence interval; PI: Pain intensity; RMDQ: Roland-Morris Disability Questionnaire; ODI: Oswestry Disability Index; HRQOL-P: Health-related quality of life-physical; HRQOL-M: Health-related quality of life-mental.

Quality assessment

The methodological quality of the included studies were assessed using the PEDro scale (https://www.pedro.org.au/). The quality scores of two studies could be extracted from the PEDro database, while the other two were assessed by the authors based on the PEDro criteria. The mean quality score was 5.5±2.2 (range, 4 to 7). The quality evaluations were summarized in Table 1.

Study characteristics

Four studies with 184 patients (mean age: 37.8±3.1 years; range, 35 to 50 years), 91 patients in the experimental group and 93 in the control group, were involved in this review. Three were conducted in Asia (two in Thailand and one in Korea), and one did not mention the study setting. The intervention used in the experimental group was PNF, and the control group interventions included sham PNF, routine

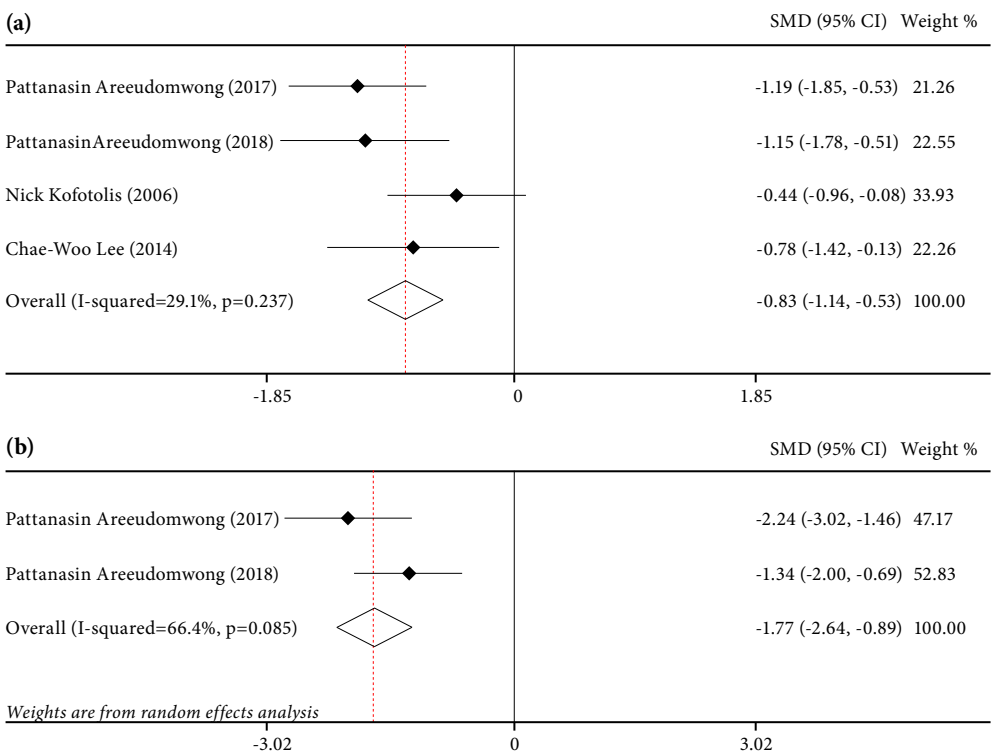

Figure 2. Forest plots of pain intensity and RMDQ.
RMDQ: Roland-Morris Disability Questionnaire.

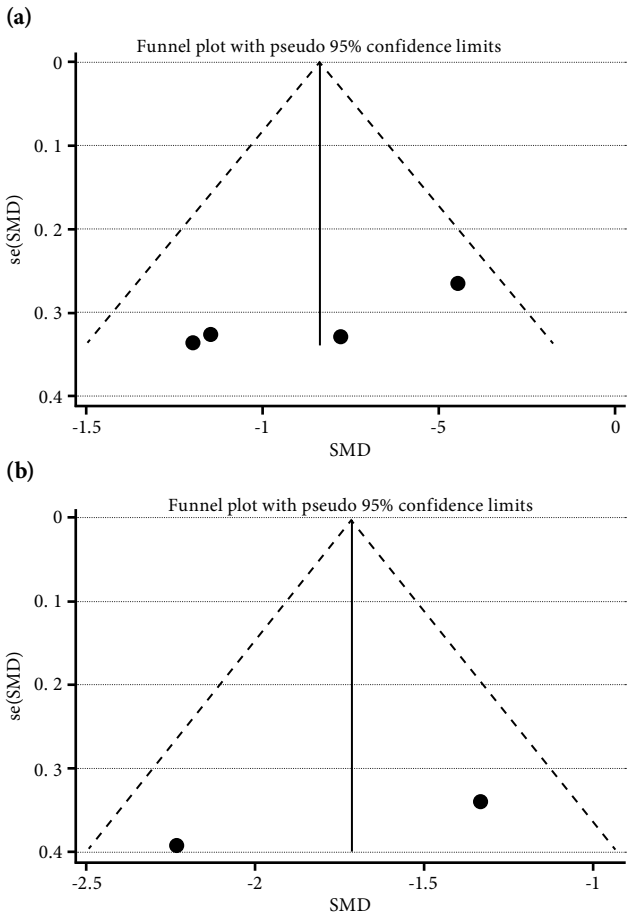

Figure 3. Funnel plots of pain intensity and RMDQ.

SMD: Standard means difference; RMDQ: Roland-Morris Disability Questionnaire.

rehabilitation training, blank control, or education for patients with CLBP. The pain intensity data included Visual Analog Scale (VAS; two studies),[37] numeric pain rating scale (NPRS; one study),[38] and Borg back pain intensity scale (BBPS; one study).[39] The IA data included the Roland Morris Disability Questionnaire (RMDQ)[40] and the Oswestry Disability Index (ODI).[41] The HRQOL data consisted of physical (HRQOL-P) and mental (HRQOL-M) functions of quality of life.[42,43] Table 2 demonstrates the detailed characteristics of the included studies.

Results synthesis

Effect size of pain intensity

The pain intensity data (four studies, 184 patients)[1,13,20,36] were analyzed with a fixed-effects model and showed no significant heterogeneity (I^2=29.1%, p=0.237). The pooled SMD and 95% CI: (-0.835 and (-1.139, -0.531), p<0.001) revealed that PNF relieved the pain in patients with CLBP compared to the control group, which was confirmed in the forest plots (Figure 2a). More information about meta-analysis was detailed as SI in Table 2. The sensitivity, subgroups, and meta-regression analyses could not be conducted due to the small number of included studies. For publication bias analysis,[44] the funnel plots were visually symmetrical (Figure 3a), which indicated no obvious publication bias. The Begg's and Egger's tests also confirmed this (p=0.308; p=0.105; respectively). All details related to publication bias analysis were shown as SI in Table 3.

Effect size of RMDQ

The pooled RMDQ data (two studies, 154 patients)[1,13] showed positive but heterogeneous results with a random model (I^2=66.4%, p=0.085). The results showed that PNF improved individual activities in patients with CLBP (SMD: -1.765, 95% CI: -2.642 to -0.888, p<0.001, Figure 2b, SI Table 2). The visually symmetrical funnel plot (Figure 3b) and the Begg's test (p=1.000, SI Table 3) suggested that no publication bias was observed.

Effect size of ODI

Oswestry Disability Index data (one study, 58 patients)[20] was not pooled with the meta-analysis, and the positive SMD and 95% CI: (-0.893, -1.434 to -0.352,

TABLE 3
Publication bias analyses

Outcomes	No. of study	Patients	Begg's test	Egger's test
PI	4	184	P = 0.308	P = 0.105
RMDQ	2	86	P = 1.000	-
ODI	1	58	-	-
HRQOL(P)	1	42	-	-
HRQOL(M)	1	42	-	

PI: Pain intensity; RMDQ: Roland-Morris Disability Questionnaire; ODI: Oswestry Disability Index; HRQOL-P: Health-related quality of life-physical; HRQOL-M: Health-related quality of life-mental.

p=0.001) should be interpreted prudently in clinical settings (SI Table 2).

Effect size of HRQOL-P and HRQOL-M

The HRQOL data (one study, 42 patients)[1] conveyed discrepant results. The HRQOL-P data yielded positive results (SMD: 1.817, 95% CI: 1.092 to 2.541, p<0.001), while the HRQOL-M data showed that PNF did not improve the psychological state in patients with CLBP (SMD: -0.006, 95% CI: -0.611 to 0.599, p=0.985, SI Table 2).

Safety assessments

No serious adverse events were reported in all four studies included.

DISCUSSION

In the present study, it was confirmed that PNF could relieve the pain intensity and improve individual activities and the physical function of the quality of life without any serious adverse events in middle-aged patients with CLBP by comparison with conventional medical care, rehabilitation, and sham PNF. The efficacy of PNF for CLBP was evaluated with pain intensity, RMDQ, ODI, HRQOL, and safety assessments.[45-47] First, for the relief of pain intensity, the present study showed the positive results for PNF in CLBP without any heterogeneity and publication bias. Second, the results demonstrate that the scores of RMDQ and ODI were both significantly decreased after the PNF treatment, which verified the efficacy of PNF for the alleviation of disability in CLBP patients. Third, the study revealed that PNF improved only the physical function of HRQOL, although this was not meta-analyzed. Finally, the results of this study also suggest that the PNF is relatively safe as no adverse events were reported in any of the included studies. Compared with previous studies, our results are consistent with a recent narrative review,[18] other two meta-analyses[12,48] designed as PNF+Swiss ball versus PNF or PNF + dynamic soft tissue mobilization (DSTM) versus PNF, proving the value of PNF + Swiss ball or PNF+DSTM for patients with CLBP. Based on the present and previous studies, PNF could be recommended as a promising therapeutic modality for CLBP patients.

Proprioceptive neuromuscular facilitation can be applied as an adjunctive therapy with conventional care or as a standalone modality in recent clinical guidelines for low back pain.[49,50] Based on the above results and discussion, it is suggested that the PNF therapy should be referred to patients with CLBP. The frequency, intensity, time, and type of PNF were recommended as follows: *(i)* frequency and intensity, 15 sets/group, 30-60 sec rest/group, 3 groups/time, 3-5 times/week, 4-6 weeks; *(ii)* time: 30-45 min/time; *(iii)* type, the diagonal and spiral direction PNF.

There were some limitations in the present study. First, only four randomized controlled trials were included in the meta-analysis, and the sample size was small (n=184). Second, the efficacy of PNF for CLBP was assessed on short-term data (immediately after intervention) since the data related to the long-term follow-up were not reported in all included studies. Third, the age of the recruited patients ranged from 35 to 50 years; therefore, the effect of PNF on the young or aged patients with CLBP could not be confirmed. Lastly, there is substantial heterogeneity in the treatment duration, frequency, and intensity in the included studies. More rigorously designed and multi-center randomized control trials with a large sample size to evaluate the efficacy of PNF for various populations in CLBP are needed. The standardization of the PNF protocol should be given more attention based on the frequency, intensity, time, and type parameters. In addition, the long-term efficacy and adverse events of PNF for CLBP should be assessed in future RCTs.

In conclusion, this systematic review provided current evidence that PNF could relieve pain and improve individual activities without any serious adverse events in patients with CLBP; however, it should be cautiously recommended due to the small number of included randomized controlled trials.

Data Sharing Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

Author Contributions: Methodology, writing-review & editing, funding acquisition: L.L.X.; Writing-original draft, data curation, analysis: H.K.Y.; Data curation, analysis; Z.R.; Supervision, conceptualization: L.Z.Y.; Analysis, visualization: P.L.H.

Conflict of Interest: The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

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REFERENCES

1. Areeudomwong P, Wongrat W, Neammesri N, Thongsakul T. A randomized controlled trial on the long-term effects of proprioceptive neuromuscular facilitation training, on pain-related outcomes and back muscle activity, in patients with chronic low back pain. Musculoskeletal Care 2017;15:218-29.
2. Rubin DI. Epidemiology and risk factors for spine pain. Neurol Clin 2007;25:353-71.
3. Fujii T, Matsudaira K. Prevalence of low back pain and factors associated with chronic disabling back pain in Japan. Eur Spine J 2013;22:432-8.
4. Mendonça L, Monteiro-Soares M, Azevedo LF. Prediction of clinical outcomes in individuals with chronic low back pain: A protocol for a systematic review with meta-analysis. Syst Rev 2018;7:149.
5. Sipko T, Kuczyński M. The effect of chronic pain intensity on the stability limits in patients with low back pain. J Manipulative Physiol Ther 2013;36:612-8.
6. Luz Júnior MAD, Almeida MO, Santos RS, Civile VT, Costa LOP. Effectiveness of kinesio taping in patients with chronic nonspecific low back pain: A systematic review with meta-analysis. Spine (Phila Pa 1976) 2019;44:68-78.
7. Nascimento PR, Costa LO. Low back pain prevalence in Brazil: A systematic review. Cad Saude Publica 2015;31:1141-56.
8. da C Menezes Costa L, Maher CG, Hancock MJ, McAuley JH, Herbert RD, Costa LO. The prognosis of acute and persistent low-back pain: A meta-analysis. CMAJ 2012;184:E613-24.
9. Hoy D, Bain C, Williams G, March L, Brooks P, Blyth F, et al. A systematic review of the global prevalence of low back pain. Arthritis Rheum 2012;64:2028-37.
10. Dagenais S, Caro J, Haldeman S. A systematic review of low back pain cost of illness studies in the United States and internationally. Spine J 2008;8:8-20.
11. Park K, Seo K. The effects on the pain index and lumbar flexibility of obese patients with low back pain after PNF scapular and PNF pelvic patterns. J Phys Ther Sci 2014;26:1571-4.
12. Young KJ, Je CW, Hwa ST. Effect of proprioceptive neuromuscular facilitation integration pattern and swiss ball training on pain and balance in elderly patients with chronic back pain. J Phys Ther Sci 2015;27:3237-40.
13. Areeudomwong P, Buttagat V. Proprioceptive neuromuscular facilitation training improves pain-related and balance outcomes in working-age patients with chronic low back pain: A randomized controlled trial. Braz J Phys Ther 2019;23:428-36.
14. George AJ, Kumar D, Nikhil NP. Effectiveness of trunk proprioceptive neuromuscular facilitation training in mechanical low back pain. International Journal of Current Research 2013;5:1965-8.
15. Aman JE, Elangovan N, Yeh IL, Konczak J. The effectiveness of proprioceptive training for improving motor function: A systematic review. Front Hum Neurosci 2015;8:1075.
16. Kofotolis ND, Vlachopoulos SP, Kellis E. Sequentially allocated clinical trial of rhythmic stabilization exercises and TENS in women with chronic low back pain. Clin Rehabil 2008;22:99-111.
17. Sandel ME. Dr. Herman Kabat: Neuroscience in translation … from bench to bedside. PM R 2013;5:453-61.
18. Smedes F, Heidmann M, Schäfer C, Fischer N, Stępień A. The proprioceptive neuromuscular facilitation-concept; the state of the evidence, a narrative review. Physical Therapy Reviews 2016;21:17-31.
19. Costa LC, Andrade A, Lial L, Moreira R, Lima AC, Magvinier A, et al. Investigation of alpha band of the electroencephalogram before and after a task of proprioceptive neuromuscular facilitation. J Exerc Rehabil 2017;13:418-24.
20. Kofotolis N, Kellis E. Effects of two 4-week proprioceptive neuromuscular facilitation programs on muscle endurance, flexibility, and functional performance in women with chronic low back pain. Phys Ther 2006;86:1001-12.
21. Kofotolis N, Vrabas I, Kalogeropoulou E, Sambanis M, Papadopoulos C, Kalogeropoulos I. Proprioceptive neuromuscular facilitation versus isokinetic training for strength, endurance and jumping performance. Journal of Human Movement Studies 2002;42:155-65.
22. Kofotolis N, Vrabas IS, Vamvakoudis E, Papanikolaou A, Mandroukas K. Proprioceptive neuromuscular facilitation training induced alterations in muscle fibre type and cross sectional area. Br J Sports Med 2005;39:e11.
23. Lustig SA, Ball TE, Looney M. A comparison of two proprioceptive neuromuscular facilitation techniques for improving range of motion and muscular strength. Isokinetics and Exercise Science 1992;2:154-9.
24. Cornelius WL, Hands MR. The effects of a warm-up on acute hip joint flexibility using a modified PNF stretching technique. J Athl Train 1992;27:112-4.
25. Lucas RC, Koslow R. Comparative study of static, dynamic, and proprioceptive neuromuscular facilitation stretching techniques on flexibility. Percept Mot Skills 1984;58:615-8.
26. Osternig LR, Robertson R, Troxel R, Hansen P. Muscle activation during proprioceptive neuromuscular facilitation (PNF) stretching techniques. Am J Phys Med 1987;66:298-307.
27. Osternig LR, Robertson RN, Troxel RK, Hansen P. Differential responses to proprioceptive neuromuscular facilitation (PNF) stretch techniques. Med Sci Sports Exerc 1990;22:106-11.
28. Kim BR, Lee HJ. Effects of proprioceptive neuromuscular facilitation-based abdominal muscle strengthening training on pulmonary function, pain, and functional disability index in chronic low back pain patients. J Exerc Rehabil 2017;13:486-90.
29. Adler SS, Beckers D, Buck M. PNF in practice: an illustrated guide. 4th ed. Berlin: Springer Science & Business Media; 2007.
30. Adler SS, Beckers D, Buck M. PNF in Practice. 4th ed. Berlin: Springer-Medizin; 2014.
31. Deeks JJ, Higgins JPT, Altman DG. Analysing data and undertaking meta-analyses. In: Cochrane handbook for systematic reviews of interventions. London: Cochrane Training; 2008. p. 241-84.
32. DerSimonian R, Laird N. Meta-analysis in clinical trials revisited. Contemp Clin Trials 2015;45:139-45.

33. Egger M, Davey Smith G, Schneider M, Minder C. Bias in meta-analysis detected by a simple, graphical test. BMJ 1997;315:629-34.
34. Mai J Z, Li H, Fang J Q, et al. Estimation of fail-safe number in meta-analysis. J Evid Based Med 2006;6:297-303.
35. Lee CW, Hwangbo K, Lee IS. The effects of combination patterns of proprioceptive neuromuscular facilitation and ball exercise on pain and muscle activity of chronic low back pain patients. J Phys Ther Sci 2014;26:93-6.
36. de Morton NA. The PEDro scale is a valid measure of the methodological quality of clinical trials: A demographic study. Aust J Physiother 2009;55:129-33.
37. Streiner DL, Norman GR, Cairney J. Health measurement scales: a practical guide to their development and use. Oxford: Oxford University Press; 2015.
38. Jensen MP, McFarland CA. Increasing the reliability and validity of pain intensity measurement in chronic pain patients. Pain 1993;55:195-203.
39. Rodriguez CS. Pain measurement in the elderly: A review. Pain Manag Nurs 2001;2:38-46.
40. Jirarattanaphochai K, Jung S, Sumananont C, Saengnipanthkul S. Reliability of the Roland - Morris Disability Questionnaire (Thai version) for the evaluation of low back pain patients. J Med Assoc Thai 2005;88:407-11.
41. Davies CC, Nitz AJ. Psychometric properties of the Roland-Morris Disability Questionnaire compared to the Oswestry Disability Index: A systematic review. Physical Therapy Reviews 2009;14:399-408.
42. 36-Item Short Form Survey from the RAND Medical Outcomes Study. RAND Health. Available at: http://www.rand.org/health/surveys_tools/mos/mos_core_36item.html. [Accessed: November 5, 2014].
43. Hays RD, Morales LS. The RAND-36 measure of health-related quality of life. Ann Med 2001;33:350-7.
44. Lin L, Chu H. Quantifying publication bias in meta-analysis. Biometrics 2018;74:785-94.
45. Rampersaud YR, Bidos A, Fanti C, Perruccio AV. The need for multidimensional stratification of chronic low back pain (LBP). Spine (Phila Pa 1976) 2017;42:E1318-E1325.
46. Cedraschi C, Marty M, Courvoisier DS, Foltz V, Mahieu G, Demoulin C, et al. Core Outcome Measure Index for low back patients: Do we miss anxiety and depression? Eur Spine J 2016;25:265-74.
47. Trampas A, Kitsios A, Sykaras E, Symeonidis S, Lazarou L. Clinical massage and modified Proprioceptive Neuromuscular Facilitation stretching in males with latent myofascial trigger points. Phys Ther Sport 2010;11:91-8.
48. Kotteeswaran K, Snigdha J, Alagesan J. Effect of Proprioceptive Neuromuscular Facilitation stretching and dynamic soft tissue mobilization on hamstring flexibility in subjects with low back ache - single blinded randomised controlled study. International Journal of Pharma and Bio Sciences 2014;5:228-33.
49. NICE guideline. Low back pain and sciatica in over 16s: assessment and management. Available at: http:www.nice.org.uk/guidance/NG59/chapter/Recommendations#non-invasive-treatments-for-low-back-pain-andsciatica [Accessed: Month, Day, 2016].
50. Stochkendahl MJ, Kjaer P, Hartvigsen J, Kongsted A, Aaboe J, Andersen M, et al. National Clinical Guidelines for non-surgical treatment of patients with recent onset low back pain or lumbar radiculopathy. Eur Spine J 2018;27:60-75.