Authors:

Rafael Lomas-Vega, PhD
María Victoria Garrido-Jaut, PT
Alma Rus, PhD
Rafael del-Pino-Casado, PhD

Affiliations:

From the Department of Health Science, University of Jaén, Jaén (RL-V); Center "El Carmen" of PRODE (Asociación para la promoción de las Personas con Discapacidad en Córdoba), Córdoba (MVG-J); Department of Cellular Biology, University of Granada, Granada (AR); and Department of Nursing, University of Jaén, Jaén (RP-C), Spain.

Correspondence:

All correspondence and requests for reprints should be addressed to: Rafael Lomas-Vega, PhD, Department of Health Science, University of Jaén, Paraje Las Lagunillas s/n, 23071, Jaén, Spain.

Disclosures:

Financial disclosure statements have been obtained, and no conflicts of interest have been reported by the authors or by any individuals in control of the content of this article.

Editor's Note:

Supplemental digital content is available for this article. Direct URL citations appear in the printed text and are provided in the HTML and PDF versions of this article on the journal's Web site (www.ajpmr.com).

0894-9115/16/0000-0000
American Journal of Physical Medicine & Rehabilitation

DOI: 10.1097/PHM.0000000000000575

LITERATURE REVIEW

Effectiveness of Global Postural Re-education for Treatment of Spinal Disorders

A Meta-analysis

ABSTRACT

Lomas-Vega R, Garrido-Jaut MV, Rus A, del-Pino-Casado R: Effectiveness of global postural re-education for treatment of spinal disorders: a meta-analysis. Am J Phys Med Rehabil 2016;00:00–00.

Objective: The aim of this study was to investigate the effects of global postural re-education (GPR) on the treatment of spinal disorders by performing a systematic review and a meta-analysis.

Design: MEDLINE, Scopus, and PEDro databases were searched without language or publication date restrictions. Data on pain and function were used to evaluate the effectiveness of GPR. Randomized controlled trials and controlled clinical trials analyzing the effectiveness of GPR on spinal disorders were selected. The standardized mean difference (SMD) and the corresponding 95% confidence interval (95% CI) were calculated. The meta-analysis was performed using the Comprehensive Meta-analysis 3.3 software.

Results: Seven randomized controlled trials and 4 controlled clinical trials were included in the meta-analysis. The results showed a medium improvement on pain (SMD = −0.63; 95% CI, −0.43 to −0.83) and function (SMD = −0.48; 95% CI, −0.25 to −0.72) after GPR treatment. The positive effect, which was greater in patients with ankylosing spondylitis followed by low back pain and neck pain, was more significant during the intermediate follow-up than immediately after treatment.

Conclusions: This meta-analysis provides reliable evidence that GPR may be an effective method for treating spinal disorders by decreasing pain and improving function.

Key Words: Low Back Pain, Physical Therapy Techniques, Rehabilitation, Spinal Disorders

Spinal disorders encompass a broad spectrum of pathologic findings such as congenital, developmental, degenerative, traumatic, infectious, inflammatory, and neoplastic disorders[1] and can include pain syndromes, disk degeneration, spondylosis, radiculopathy, stenosis, spondylolisthesis, fractures, tumors, and

osteoporosis.[2] Musculoskeletal diseases, including arthritis and back pain, are the second greatest cause of disability and represent the fourth greatest impact on overall health in the world population, even if high heterogeneity exists in rankings of leading causes of disease burden among regions.[3] The direct and indirect costs of treating spinal disorders are estimated at more than $100 billion per year.[4]

Spinal disorders can be treated by active (exercise, education, prevention, and multimodal therapies) or passive therapies (physical modalities, manual therapies, reflex therapies, assistive devices, and drugs).[5] The global postural re-education (GPR) method has been widely used in clinical practice in many countries and has been reported to treat several conditions such as temporomandibular disorders, urinary incontinence, musculoskeletal diseases, and, above all, spinal disorders.[6–12] The GPR is a method that mainly involves global stretching, breath control, and manual control by the therapist in order to provide proprioceptive information to the patient. Therefore, it is halfway between active techniques such as stretching and passive techniques such as manual therapy. Breath control plays an important role during the exercises and may be proposed as one of the beneficial mechanisms of action. A previous study found an increase in maximal respiratory pressures, thoracic expansion, and abdominal mobility[13] after application of GPR.

The GPR method is based on the global stretching of antigravitational muscles and the stretching of muscles that are organized on muscle kinetic chains for approximately 15 to 20 minutes.[6] Treatment postures of GPR especially affect the balance of 2 major chains, usually called anterior chain and posterior chain. The analysis of flexibility of both determines the chain that should be specially treated. The possible mechanism of action of GPR may be the re-equilibrating effect of the different treatment postures on areas of motor cortex that control muscles belonging to the posterior or anterior chains. Global postural re-education maneuver applied in standing subjects increases inhibition in cortical areas controlling flexor muscles, while increasing the excitation of cortical areas controlling extensor muscles. However, when GPR maneuver is applied in subjects in supine position, increased inhibition in cortical areas controlling flexor muscles is not paralleled by excitation of extensor ones.[14]

The literature provides conflicting results regarding the effectiveness of GPR, including studies that showed favorable results and others that did not show significant effects. In addition, there are no meta-analyses available focused on spinal disorders. Therefore, this study aimed to perform a systematic review and a meta-analysis on the effects of GPR on the treatment of spinal disorders, as well as to measure the eventual heterogeneity of results across individual studies and its causes.

METHODS

This systematic review and meta-analysis has been performed according to the guidelines of the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-analysis) statement.[15]

Eligibility Criteria

The following criteria were used for the eligibility of the included studies: (1) the studies involved patients with spinal disorders; (2) the main intervention should be the GPR method; (3) compared with sham treatment, no treatment, usual care, or other therapies; (4) studies with outcome measurements including relief of spinal pain or function, which provided sufficient information about results; and (5) whose methodology was randomized controlled trial (RCT) or controlled clinical trial (CCT).

Systematic Literature Search

Two authors independently searched in MEDLINE, Scopus, and PEDro databases. No language or publication date restrictions were set. The last search was run on November 26, 2015. A sensitive search strategy was used with the following free search terms: (*global posture reeducation* or *global postural re-education* or *GPR* or *RPG* or *postural r*e-education or *posture re-education*) AND (*low back pain* or *back pain* or *neck pain* or *ankylosing spondylitis* or *spondyloarthritis* or *spinal disorders*). The references of retrieved full-text articles and other reviews were searched to identify additional references of interest.

Data Extraction

Data were extracted independently by 2 authors. The information extracted from the selected studies included sample size, patient demographic characteristics, disease diagnosis, treatment approaches in control group, design of study, duration and frequency of exercise sessions, overall duration of treatment, outcome measures, and others. Discussion and consensus were used to resolve discrepancies between authors.

Risk of Bias in Individual Studies

The Cochrane Collaboration Tool[16] was used to assess the risk of bias in individual studies.

Summary of Results

The combined effect was determined by the Hedges' g adjusted by the inverse of the variance using a fixed-effects model. Following the recommendations of Borenstein et al.,[17] a fixed-effect model was used for the meta-analysis because a common underlying effect was assumed, given that only studies on spinal disorders were included. The selected studies used different scales to measure function; therefore, the standardized mean difference (SMD) was used as the measure of the effect. According to Cohen,[18] values for effect size of 0.2 to 0.3, 0.5, and 0.8 correspond to the 3 bands of interpretation of the effect size as small, medium, and large, respectively. The Q test was used for the analysis of heterogeneity, together with the degree of inconsistency (I^2) of Higgins et al.[19] The Egger test[20] was used to determine the funnel plot asymmetry, according to which the publication bias is probable if $P < 0.10$. The estimate of the combined effect considering the possible publication bias was conducted by the trim-and-fill method.[21] Metaregression was used to analyze the moderator variables that explained the heterogeneity of results across the individual studies. Analyses were performed using the Comprehensive Meta-analysis 3.3 software (Biostat; Englewood, NJ).

Sensitivity Analysis

Sensitivity analyses (subgroups) were performed to check differences between results at the different methodological quality levels of the studies.

RESULTS

The initial search identified 87 articles in the databases used. After removing duplicates, 12 articles[22–33] were selected from 61 according to the eligibility criteria. Of these, 2 were eliminated because 1 article[30] was the French translation of the article of Lawand et al.,[31] and another[29] analyzed the same sample as that of Fernandez de las Peñas et al.[28] In the latter case, the same sample, the same intervention, and the same results were published immediately after treatment[29] and after a year's follow-up.[28] After reviewing references of the full-text articles and other relevant reviews, an additional study[34] was included. The number of excluded studies for each inclusion criterion is shown in the flowchart (Fig. 1).

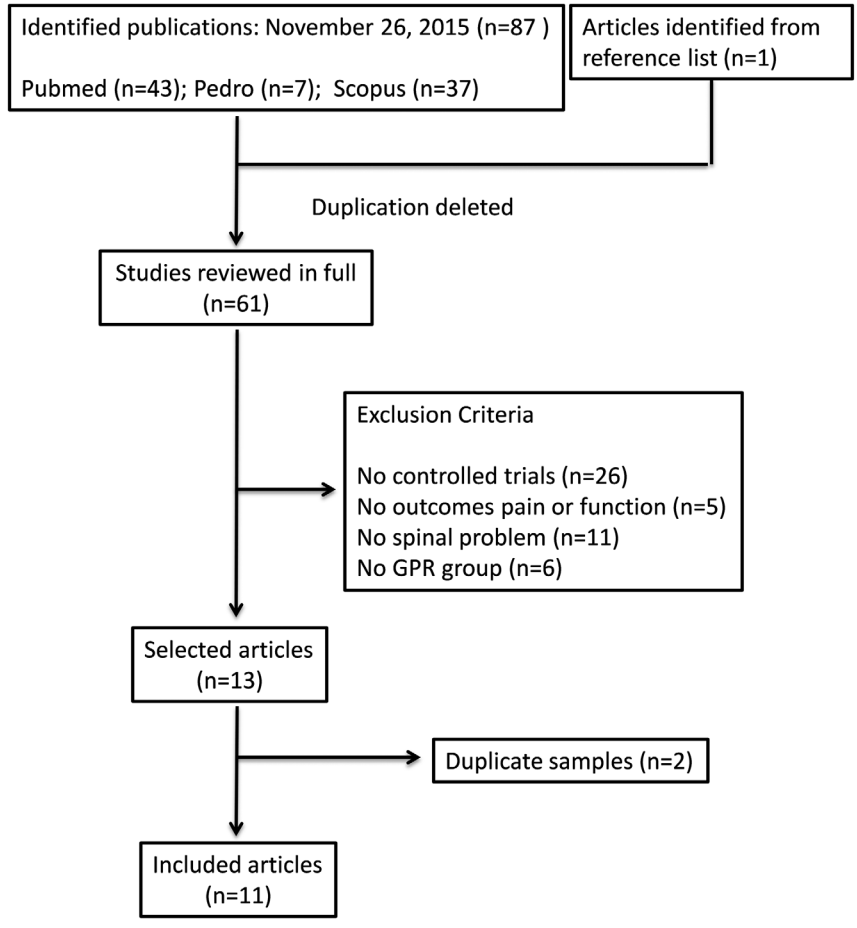

FIGURE 1 *Flowchart of the selection of the studies included in the review.*

TABLE 1 Characteristics of the studies included in the review

Reference	N	Design	Participants: Age (Range and/or Mean), y	Participants: Pathology	Outcome Variable	Comparison	Follow-up, mo
Adorno and Brasil-Neto,[22] 2013	20	RCT	19–60	CNLBP	Pain	Stretching	0
	20						3
Amorim et al,[23] 2014	30	RCT	18–65 (38)	SDANP	Function	Exercises	0
	30				Pain		0
Bonetti et al,[24] 2010	78	CCT	47	PLBP	Function	Stabilization	6
	87						3
	78				Pain		6
	87						3
Castagnoli et al,[25] 2015	50	CCT	60	CLBP	Function	Exercises	0
	20						12
	37				Pain		0
	16						12
Cunha et al,[26] 2008	31	RCT	35–60	CNP	Pain	Stretching	0
	31						1,5
Durmus et al,[27] 2009	32	CCT	38.6	AE	Function	Control	0
	38					Exercises	0
	32				Pain	Control	0
	38					Exercises	0
Fernández de las Peñas et al,[28] 2006	40	RCT	45–46	AE	Function	Physical therapy	0
	40						12
Lawand et al,[30] 2015	60	RCT	48.5	CLBP	Function	Control	6
	60						3
	60				Pain		6
	60						3
Maluf et al,[32] 2010	24	RCT	19–40	TMDs (NP)	Pain	Exercises	0
	24						2
Radhakrishnan et al,[34] 2015	60	RCT	35–45	CNP	Pain	Exercises	0
Silva et al,[33] 2012	35	CCT	18–65 (39)	AE	Pain	Exercises	0

CNLBP indicates chronic nonspecific LBP; SDANP, scapular dyskinesis associated with NP; PLBP, persistent LBP; CLBP, chronic LBP; CNP, chronic NP; TMDs (NP), NP associated with temporomandibular disorders.

At the end of the process, 11 studies were included. The main characteristics of these studies are presented in Table 1. Seven studies were RCTs, and 4 were CCTs. Four studies included patients with low back pain (LBP), 4 works analyzed patients with neck pain (NP), and 3 studies included patients with ankylosing spondylitis (AS). Pain was evaluated in 10 studies and function in 6 studies. The age range of subjects of the selected studies was between 18 and 65 years. Follow-up ranged from no follow-up to 12 months' follow-up.

Table 2 shows the evaluation of quality of the studies. Results revealed that the most important threat to quality was related to the blinded outcome measurement. In one of the selected studies,[26] data collection was performed by a member of the research team without specifying whether the researcher was blinded to the origin of each participant. Similarly, it was not informed who performed data collection in 4 of the selected studies.[22,23,27,34] There was risk of bias in only 2 studies.[25,27] Only one of the RCTs[29] included in this study did not report whether the researchers responsible for the assignment to the experimental groups were blinded to the randomization sequence.

Pain

Ten studies (6 RCTs and 4 CCTs), with 11 independent comparisons, presented data for pain. The pain scales used were the visual analog scale and the numeric rating scale. The results of individual studies are shown in Figure 2. Of the 11 valid comparisons, 6 showed statistically significant differences (negative direction), and 5 did not reveal significant differences (3 with negative direction and 2 with positive direction). The combined effect of all the studies yielded a value of SMD = −0.63 (95% confidence interval [CI], −0.43 to −0.83), which means a medium effect on pain, measured in standard scores, favorable to the GPR group. Individual results showed a moderate degree of heterogeneity (P for the Q test = 0.024; I^2 = 51.4%). The analysis of the funnel plot (Fig. 3) and the results of the Egger test (P = 0.80) suggested the

TABLE 2 Analysis of the methodological quality of the studies included in the review

Reference	Generation of Randomization Sequence	Concealment of Randomization Sequence	Blinded Outcome Measurement	Losses	Publication of All the Results Expected	Others
Adorno and Brasil-Neto,[22] 2013	−	−	?	−	−	
Amorim et al,[23] 2014	−	−	?	−	−	
Bonetti et al,[24] 2010	NA	NA	−	−	−	
Castagnoli et al,[25] 2015	NA	NA	−	+	−	
Cunha et al,[26] 2008	−	−	?	−	−	
Durmuş et al,[27] 2009	NA	NA	?	+	−	
Fernández de las Peñas et al,[28] 2006	−	−	−	−	−	
Lawand et al,[30] 2015	−	−	−	−	−	
Maluf et al,[32] 2010	−	−	−	−	−	
Radhakrishnan et al,[34] 2015	−	?	?	−	−	
Silva et al,[33] 2012	NA	NA	−	−	−	

+ Indicates high risk of bias; −, low risk of bias; ?, no information available; NA, not applicable.

absence of publication bias. The estimate of the combined effect considering the possible publication bias by the trim-and-fill[21] method matched the combined effect previously calculated (SMD, −0.63; 95% CI, −0.43 to −0.83).

The main problem of quality of the individual studies included in this section was the lack of information about the blinded outcome measurement. Therefore, a sensitivity analysis (subgroups) was performed (see forest plot in http://links.lww.com/PHM/A302), and results showed that the combined effect for the subgroup of studies conducted with blinded outcome measurement was SMD = −0.67 (95% CI, −0.39 to −0.95), and that for the subgroup of studies without information about such a criterion of quality was SMD = −0.59 (95% CI, −0.31 to −0.87). An analysis of subgroups according to the type of design (RCT or CCT) was also performed (see forest plot in http://links.lww.com/PHM/A302), and results showed values of SMD = −0.55 (95% CI, −0.28 to −0.82) for the RCT subgroup and −0.72 (95% CI, −0.43 to −1.02) for the CCT subgroup. All these results show a medium improvement in pain favorable to the GPR group.

Metaregression was performed to identify variables that may explain the heterogeneity found in the results derived from the individual studies. This analysis revealed that the duration of the follow-up and the type of pathology accounted for 56% of heterogeneity (I^2 = 31.7%, P = 0.19) (see scatterplots in http://links.lww.com/PHM/A302). The type of design (RCT or CCT), the type of comparison (control or other intervention), and the number of hours of treatment did not contribute to the regression model.

Table 3 shows the values of the combined effect for pain, stratified by follow-up and pathology. The combined effect values were slightly higher in the different follow-up times in comparison to the immediate posttest, although these differences were not statistically significant. Patients with AS showed the highest effect of GPR treatment, followed by patients with LBP, and finally NP patients, although these differences were not statistically significant.

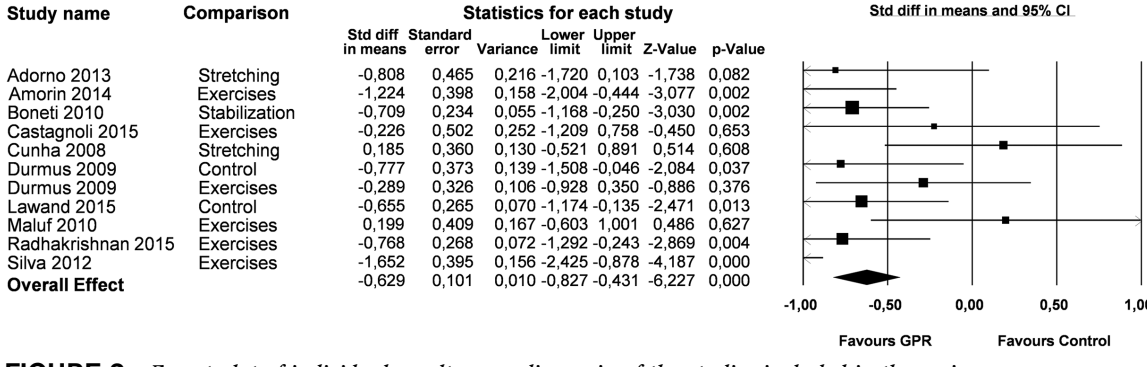

FIGURE 2 *Forest plot of individual results regarding pain of the studies included in the review.*

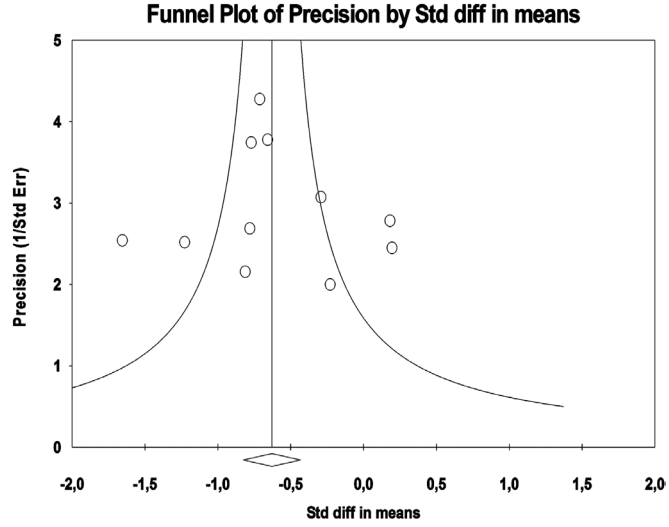

FIGURE 3 *Funnel plot of individual results regarding pain of the studies included in the review.*

Function

Six studies (3 RCTs and 3 CCTs), with 7 independent comparisons, presented data for function. Several scales were used to measure function, including the Roland-Morris Questionnaire and the Oswestry Disability Index for LBP, the Neck Disability Index for NP, and the Bath Ankylosing Spondylitis Functional Index for AS. Results of the individual studies are shown in Figure 4. Of the 7 valid comparisons (all with negative direction), only 4 showed statistically significant differences.

The combined effect of all the studies yielded a value of SMD = −0.48 (95% CI, −0.25 to −0.72), which means a medium effect on function, measured in standard scores, favorable to the GPR group. The results of the individual studies did not show heterogeneity (P for the Q test = 0.772; I^2 = 0.0%). The Egger test results (P = 0.66) suggested the absence of publication bias, whereas the funnel plot analysis (Fig. 3) revealed some degree of asymmetry. Therefore, the combined effect was also calculated using the trim-and-fill[21] method, and the same value as that obtained previously (SMD, −0.48; 95% CI, −0.25 to −0.72) was found.

The results of the sensitivity analysis (subgroups) (see forest plot in http://links.lww.com/PHM/A302) showed that the combined effect for the subgroup of studies conducted with blinded outcome measurement was SMD = −0.44 (95% CI, −0.15 to −0.72), and that for the subgroup of studies without information about such a criterion of quality was SMD = −0.58 (95% CI, −0.18 to −0.98). An analysis of subgroups according to the type of design (RCT or CCT) was also performed (see forest plot in http://links.lww.com/PHM/A302), and results showed values of SMD = −0.41 (95% CI, −0.06 to −0.76) for the RCT subgroup and −0.54 (95% CI, −0.23 to −0.85) for the CCT subgroup. All these results show a medium improvement in function favorable to the GPR group.

DISCUSSION

This study is the first meta-analysis that investigates the effects of GPR on the treatment of

TABLE 3 Combined effect on pain stratified by follow-up or pathology

	k	Point Estimate	Lower Limit	Upper Limit	Heterogeneity (I^2)	Publication Bias (P for Egger Test)
Stratification by follow-up						
Posttest	9	−0.54	−0.78	−0.31	65.3	0.64
<6 mo	5	−0.79	−1.07	−0.51	79.3	0.21
≥6 mo	3	−0.64	−0.96	−0.31	0.0	0.003
Stratification by pathology						
LBP	4	−0.65	−0.96	−0.35	0.0	0.5
NP	4	−0.47	−0.80	−0.13	72.2	0.65
AS	3	−0.82	−1.23	−0.41	71.8	0.22

k Indicates number of studies.

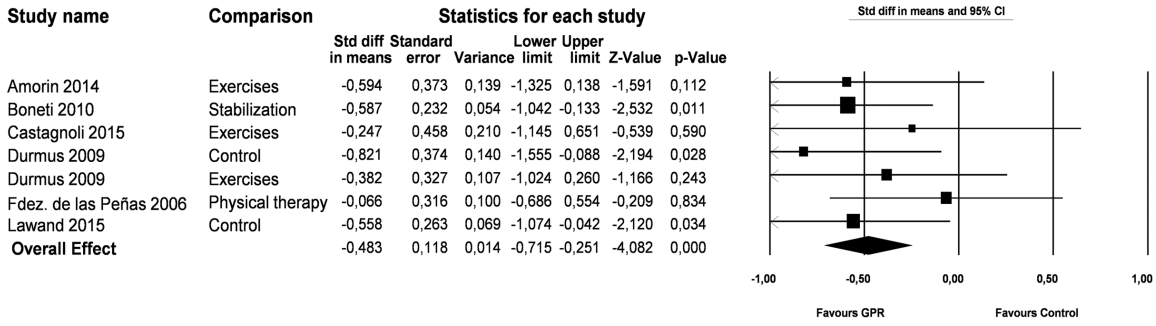

FIGURE 4 *Forest plot of individual results regarding function of the studies included in the review.*

spinal disorders by improving pain and function. Of the 11 studies included, 10 studies evaluated the effect of GPR on pain and 6 studies on function. Four studies focused on LBP, 4 on NP, and 3 studies on AS. A moderate heterogeneity was found in the analysis of pain, whereas null heterogeneity was revealed for function. An analysis of meta-regression was performed to determine the factors that explained the heterogeneity, and results showed that much of the heterogeneity was explained by both the type of pathology and the duration of the follow-up. The type of design, the type of comparison (control or other intervention), and the duration of the treatment did not influence the effect found.

In this study, GPR showed an average effect on pain improvement of SMD = −0.63 (95% CI, −0.43 to −0.83) and a slightly lower effect on function (SMD, −0.48; 95% CI, −0.25 to −0.72) in different pathologic findings. The sensitivity analysis reported both that the effect on pain may be greater during the follow-up versus the immediate posttest and that the pathology most benefited by GPR may be AS, followed by LBP and NP, although differences were not statistically significant. No evidence of publication bias was found, concluding that results may be consistent.

Global postural re-education is a method of postural treatment; thus, the evaluation of postural disorder in patients is key for the implementation and dosage of this technique. A previous study[35] examined reliability of the muscular chain evaluation and found that reliability was moderate to substantial for 12 of 23 evaluated posture indices (PIs) for physical therapists and perfect for 19 of 23 evaluated PIs in the case of experts on GPR. Reliability on posture evaluation was moderate to substantial for 12 PIs for physical therapists and moderate to perfect for 18 PIs for the experts. The agreement between physical therapists and experts was good for most muscular chain evaluations and PI. Therefore, these results suggest that the evaluation of both chains restriction and postural disorder with the GPR method is reliable if performed by therapists with a certain level of expertise.

The results of this study showed that the benefit of GPR for the treatment of NP is significant, but lower than that for other pathologic findings. A recent review has suggested that breathing exercises, general fitness training, stretching alone, and feedback exercises combined with pattern synchronization may not change pain or function from the immediate posttest to the short-term follow-up.[36] The results of the present work are consistent with these findings, because in this study the short-term effect of GPR was lower than during the long-term follow-up. Global postural re-education may also be used in combination with other therapeutic techniques, as it has been found that the addition of stretching and aerobic exercise may improve the effectiveness of other physical interventions to treat NP.[37]

Results in LBP patients showed a medium effect of GPR on pain and function that was more significant over the middle term. Other methods, such as Pilates, may be more effective on pain and functionality over the short term than a minimal intervention, usual care, or other exercises. However, Pilates may be similar or less effective than other therapies or exercises over the middle term.[38,39] A recent meta-analysis has found a beneficial but small effect (SMD, −0.32; 95% CI, −0.44 to −0.19) for strength/resistance and coordination/stabilization exercise programs in comparison with other interventions in the treatment of chronic LBP.[40] However, function was not analyzed in this study. The effect of GPR may be similar to that of aerobic exercise, which showed a small to medium effect on pain and function for chronic LBP.[41]

Several reviews in AS patients have reported beneficial effects of exercise by improving functionality

and quality of life.[42–44] In this study, GPR showed significant improvements in both pain and function compared with control groups and with other physical treatments. However, the number of studies examined has been scarce, which suggests to be cautious when drawing conclusions.

Global postural re-education may be a safe method of treatment. Some of the most demanding exercises used in GPR (sedestation) may increase cardiovascular demand. However, this response may decrease to baseline values within 5 minutes after completing the exercises.[45] In addition, the studies included in this review reported no adverse effects of GPR.

This review has several limitations. First, despite the sensitive strategy used for searching studies, few works were found that evaluated the effect of GPR on pain and function. Second, both CCTs and RCTs were included in this review, and the sensitivity analysis performed showed a slight overestimation of the effect due to the CCTs, both for pain and function. However, the findings found in this study are consistent, because no heterogeneity was found in the analysis of the effect on function, and the main sources of heterogeneity found in the analysis of the effect on pain were analyzed. Moreover, no publication bias was found. No high risk of bias was found in the selected studies regarding losses, incomplete publication of the expected results, or randomization sequence in the case of RCTs. When the risk of bias was found (blinded outcome measurement), the sensitivity analysis revealed that the combined effect scarcely varied when excluding such studies.

On the other hand, it may be necessary to increase the number and quality of the studies that investigate the effects of GPR on different health conditions related to the spine (e.g., RCTs with high methodological quality and large sample size). No controlled trials were found focused on other pathologic findings related to the spine, such as disk herniation or spondylolisthesis. It may be advisable therefore to test the effect of GPR on these other conditions in which nonexperimental studies may show promising findings. The studies should also include other relevant outcome variables such as health status, quality of life, effect on drugs in take, use of surgery, or effect on work activity, among others.

In conclusion, this meta-analysis provides reliable evidence that GPR may be an effective technique for the treatment of spinal disorders by decreasing pain and improving function. Thus, GPR may be recommended for the treatment of certain spinal disorders, including AS, LBP, and NP.

Supplementary Checklist

PRISMA Checklist: http://links.lww.com/PHM/A301

REFERENCES

1. Waldrop R, Cheng J, Devin C, et al: The burden of spinal disorders in the elderly. *Neurosurgery* 2015; 77(suppl 4):S46–50
2. Alshami AM: Prevalence of spinal disorders and their relationships with age and gender. *Saudi Med J* 2015;36:725–30
3. Murray CJ, Vos T, Lozano R, et al: Disability-adjusted life years (DALYs) for 291 diseases and injuries in 21 regions, 1990–2010: a systematic analysis for the Global Burden of Disease Study 2010. *Lancet* 2012; 380:2197–223
4. Indrakanti SS, Weber MH, Takemoto SK, et al: Value-based care in the management of spinal disorders: a systematic review of cost-utility analysis. *Clin Orthop Relat Res* 2012;470:1106–23
5. Negrini S, Imperio G, Villafañe JH, et al: Systematic reviews of physical and rehabilitation medicine Cochrane contents. Part 1. Disabilities due to spinal disorders and pain syndromes in adults. *Eur J Phys Rehabil Med* 2013;49:597–609
6. Teodori RM, Negri JR, Cruz MC, et al: Global Postural Re-education: a literature review. *Rev Bras Fisioter* 2011;15:185–9
7. Vanti C, Generali A, Ferrari S, et al: General postural rehabilitation in musculoskeletal diseases: scientific evidence and clinical indications [in Italian]. *Reumatismo* 2007;59:192–201
8. Barroqueiro C, Morais NV: The effects of a global postural reeducation program on an adolescent handball player with isthmic spondylolisthesis. *J Bodyw Mov Ther* 2014;18:244–58
9. Di Ciaccio E, Polastri M, Bianchini E, et al: Herniated lumbar disc treated with global postural reeducation. A middle-term evaluation. *Eur Rev Med Pharmacol Sci* 2012;16:1072–7
10. Di Ciaccio E, Polastri M, Gasbarrini A: Cervical disc herniation: is the regression flawed by age? A case report. *Int J Ther Rehabil* 2013;20:612–6
11. Fozzatti MC, Palma P, Herrmann V, et al: Impact of global postural reeducation for treatment of female stress urinary incontinence. *Rev Assoc Med Bras* 2008;54:17–22
12. Monteiro W, Francisco de Oliveira Dantas da Gama T, dos Santos RM, et al: Effectiveness of global postural reeducation in the treatment of temporomandibular disorder: case report. *J Bodyw Mov Ther* 2013; 17:53–8
13. Moreno MA, Catai AM, Teodori RM, et al: Effect of a muscle stretching program using the global postural reeducation method on respiratory muscle strength

and thoracoabdominal mobility of sedentary young males [in Portuguese]. *J Bras Pneumol* 2007;33: 679–86

14. Oliveri M, Caltagirone C, Loriga R, et al: Fast increase of motor cortical inhibition following postural changes in healthy subjects. *Neurosci Lett* 2012; 530:7–11
15. Liberati A, Altman DG, Tetzlaff J, et al: The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: explanation and elaboration. *J Clin Epidemiol* 2009; 62:e1–34
16. Higgins JP, Altman DG, Gotzsche PC, et al: The Cochrane Collaboration's tool for assessing risk of bias in randomised trials. *BMJ* 2011;343:d5928
17. Borenstein MHL, Higgins JPT, Rothstein HR. *Introduction to Meta-analysis*, Chichester, UK, John Wiley & Sons, Ltd, 2009
18. Cohen J: A power primer. *Psychol Bull* 1992;112: 155–9
19. Higgins J, Thompson S, Deeks J, et al: Statistical heterogeneity in systematic reviews of clinical trials: a critical appraisal of guidelines and practice. *J Health Serv Res Policy* 2002;7:51–61
20. Egger M, Davey Smith G, Schneider M, et al: Bias in meta-analysis detected by a simple, graphical test. *BMJ* 1997;315:629–34
21. Duval S, Tweedie R: Trim and fill: a simple funnel-plot-based method of testing and adjusting for publication bias in meta-analysis. *Biometrics* 2000;56: 455–63
22. Adorno ML, Brasil-Neto JP: Assessment of the quality of life through the SF-36 questionnaire in patients with chronic nonspecific low back pain. *Acta Ortop Bras* 2013;21:202–7
23. Amorim CS, Gracitelli ME, Marques AP, et al: Effectiveness of global postural reeducation compared to segmental exercises on function, pain, and quality of life of patients with scapular dyskinesis associated with neck pain: a preliminary clinical trial. *J Manipulative Physiol The* 2014;37:441–7
24. Bonetti F, Curti S, Mattioli S, et al: Effectiveness of a 'global postural reeducation' program for persistent low back pain: a non-randomized controlled trial. *BMC Musculoskelet Disord* 2010; 11:285
25. Castagnoli C, Cecchi F, del Canto A, et al: Effects in short and long term of global postural reeducation (GPR) on chronic low back pain: a controlled study with one-year follow-up. *Scientific World J* 2015; 2015:271436
26. Cunha AC, Burke TN, França FJ, et al: Effect of global posture reeducation and of static stretching on pain, range of motion, and quality of life in women with chronic neck pain: a randomized clinical trial. *Clinics (Sao Paulo)*. 2008;63:763–70
27. Durmuş D, Alayli G, Uzun O, et al: Effects of two exercise interventions on pulmonary functions in the patients with ankylosing spondylitis. *Joint Bone Spine* 2009;76:150–5
28. Fernandez de las Peñas C, Alonso-Blanco C, Alguacil-Diego IM, et al: One-year follow-up of two exercise interventions for the management of patients with ankylosing spondylitis: a randomized controlled trial. *Am J Phys Med Rehabil* 2006;85:559–67
29. Fernández-de-Las-Peñas C, Alonso-Blanco C, Morales-Cabezas M, et al: Two exercise interventions for the management of patients with ankylosing spondylitis: a randomized controlled trial. *Am J Phys Med Rehabil* 2005;84:407–19
30. Lawand P, Lombardi Junior I, Jones A, et al: Les effets d'un programme d'etirements musculaires selon la méthode de rééducation posturale globale (RPG) sur les patients souffrant de lombalgie chronique: un essai randomisé controlé. *Rev Rhum* 2015; 82:322–6
31. Lawand P, Lombardi Junior I, Jones A, et al: Effect of a muscle stretching program using the global postural reeducation method for patients with chronic low back pain: a randomized controlled trial. *Joint Bone Spine* 2015;82:272–7
32. Maluf SA, Moreno BG, Crivello O, et al: Global postural reeducation and static stretching exercises in the treatment of myogenic temporomandibular disorders: a randomized study. *J Manipulative Physiol Ther* 2010;33:500–7
33. Silva EM, Andrade SC, Vilar MJ: Evaluation of the effects of global postural reeducation in patients with ankylosing spondylitis. *Rheumatol Int* 2012;32: 2155–63
34. Radhakrishnan R, Senthil P, Rathnamala D, et al: Effectiveness of global posture re-education on pain and improving quality of life in women with chronic neck pain. *Int J Phys Educ Sports Health* 2015;1:7–9
35. Fortin C, Feldman DE, Tanaka C, et al: Inter-rater reliability of the evaluation of muscular chains associated with posture alterations in scoliosis. *BMC Musculoskelet Disord* 2012;13:80
36. Gross A, Kay TM, Paquin JP, et al: Exercises for mechanical neck disorders. *Cochrane Database Syst Rev* 2015;1:CD004250
37. O'Riordan C, Clifford A, van de Ven P, et al: Chronic neck pain and exercise interventions: frequency, intensity, time, and type principle. *Arch Phys Med Rehabil* 2014;95:770–83
38. Yamato TP, Maher CG, Saragiotto BT, et al: Pilates for low back pain. *Cochrane Database Syst Rev* 2015; 7:CD010265
39. Wells C, Kolt GS, Marshall P, et al: The effectiveness of Pilates exercise in people with chronic low back pain: a systematic review. *PLoS One* 2014;9:e100402
40. Searle A, Spink M, Ho A, et al: Exercise interventions for the treatment of chronic low back pain: a systematic review and meta-analysis of randomised controlled trials. *Clin Rehabil* 2015;29:1155–67

41. Meng XG, Yue SW: Efficacy of aerobic exercise for treatment of chronic low back pain: a meta-analysis. *Am J Phys Med Rehabil* 2015;94:358–65

42. Liang H, Zhang H, Ji H, et al: Effects of home-based exercise intervention on health-related quality of life for patients with ankylosing spondylitis: a meta-analysis. *Clin Rheumatol* 2015;34:1737–44

43. Martins NA, Furtado GE, Campos MJ, et al: Exercise and ankylosing spondylitis with New York modified criteria: a systematic review of controlled trials with meta-analysis. *Acta Reumatol Port* 2014;39:298–308

44. O'Dwyer T, O'Shea F, Wilson F: Exercise therapy for spondyloarthritis: a systematic review. *Rheumatol Int* 2014;34:887–902

45. Mota YL, Barreto SL, Bin PR, et al: Cardiovascular responses in the seated posture of the global postural re-education (GPR) method. *Rev Bras Fisioter* 2008; 12:161–8