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ACTIVATION OF LUMBAR SPINE STABILIZER MUSCLES IN PEOPLE WITH CHRONIC LOW BACK PAIN: A SYSTEMATIC REVIEW

ATIVAÇÃO DOS MÚSCULOS ESTABILIZADORES DA COLUNA LOMBAR EM PESSOAS COM DOR LOMBAR CRÔNICA: UMA REVISÃO SISTEMÁTICA

ACTIVACIÓN DE LOS MÚSCULOS ESTABILIZADORES DE LA COLUMNA LUMBAR EN PERSONAS CON LUMBALGIA CRÓNICA: UNA REVISIÓN SISTEMÁTICA

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ABSTRACT

Objective: To compare the level of activation of the lumbar spine stabilizing muscles between people with chronic low back pain and healthy people. Methods: A systematic search was performed on May 10, 2021, of the following databases: PubMed, Physiotherapy Evidence Database and Cochrane Library. Inclusion and exclusion criteria were based on the PICO format. Two authors independently examined all articles that were selected for full reading. Disagreements were resolved through a discussion between the authors. Results: The bibliographical search identified 525 records, 165 of which were duplicates. After screening the titles, abstracts and the full text of the remaining 360 studies, 352 articles were excluded, and 8 articles were included in this review. The eight studies assessed the level of muscle activation in patients with chronic low back pain. In six studies patients with chronic low back pain had a higher activation level, in one study there was no statistically significant difference between groups,and in one study the activation level was lower in the chronic low back pain group. Discussion: This review was the first to review electromyography studies of the lumbar spine stabilizer muscles, covering all types of exposure procedures for evaluation. We believe that the recommendation of healthcare professionals for these patients to contract the stabilizer muscles are totally unnecessary. Conclusion: Patients with low back pain have a higher level of lumbar spine stabilizer muscle activation than healthy people. ***Level of evidence IIA; Systematic review of cohort studies.***

Keywords: Low Back Pain; Electromyography; Spine.

RESUMO

Objetivo: Comparar o nível de ativação dos músculos estabilizadores da coluna lombar entre pessoas com dor lombar crônica e pessoas saudáveis. Métodos: Uma busca sistemática foi realizada no dia 10 de maio de 2021nos seguintes bancos de dados: PubMed, Physiotherapy Evidence Database e Cochrane Library. Os critérios de inclusão e exclusão foram baseados no formato PICO. Dois autores examinaram todos os artigos que foram selecionados para a leitura completa de forma independente.As discordâncias foram resolvidas por meio de uma discussão entre os autores. Resultados: A pesquisa bibliográfica identificou 525 registros, dos quais 165 eram duplicatas. Depois da triagem dos títulos, resumos e texto completo dos 360 estudos restantes, 352 artigos foram excluídos e oito artigos foram incluídos nesta revisão. Os oito estudos avaliaram o nível da ativação muscular em pacientes com dor lombar crônica;em seis estudos pacientes com dor lombar crônica tiveram maior nível de ativação, em um estudo não houve diferença estatisticamente significante entre os grupos e em um estudo, o nível de ativação foi menor no grupo de dor lombar crônica. Discussão: Esta revisão foi a primeira a analisar estudos de eletromiografia dos músculos estabilizadores da coluna lombar, abrangendo todos os tipos de procedimentos de exposição para a avaliação. Podemos acreditar que as recomendações dos profissionais de saúde para que esses pacientes contraiam os músculos estabilizadores são totalmente desnecessárias. Conclusões: Os pacientes com lombalgia têm nível de ativação dos músculos estabilizadores da coluna lombar maior em comparação compessoas saudáveis. ***Nível de evidência IIA; Revisão sistemática de estudos de coorte.***

Descritores: *Dor Lombar; Eletromiografia; Coluna Vertebral.*

RESUMEN

Objetivo: Comparar el nivel de activación de los músculos estabilizadores de la columna lumbar entre personas con lumbalgia crónica y personas sanas. Métodos: Se realizó una búsqueda sistemática el 10 de mayo de 2021 en las siguientes bases de datos: PubMed, Physiotherapy Evidence Database y Cochrane Library. Los criterios de inclusión y exclusión se basaron en el formato PICO. Dos autores examinaron de forma independiente todos los artículos que se seleccionaron para su lectura completa. Los desacuerdos se resolvieron mediante una discusión entre los autores. Resultados: La búsqueda bibliográfica identificó 525 registros, de los cuales 165 eran duplicados. Tras seleccionar los títulos, los resúmenes y el texto completo de los 360 estudios restantes, se excluyeron 352 artículos y se incluyeron 8 artículos en esta revisión. Los ocho estudios evaluaron el nivel de activación muscular

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en pacientes con lumbalgia crónica; en seis estudios los pacientes con lumbalgia crónicapresentaron un nivel de activación más alto, en un estudio no hubo diferencias estadísticamente significativas entre los grupos y en un estudio,el nivel de activación fue más bajo en el grupo con lumbalgia crónica. Discusión: Esta revisión fue la primera en analizar los estudios de electromiografía de los músculos estabilizadores de la columna lumbar, abarcando todo tipo de procedimientos de exposición para evaluación. Podemos creer que las recomendaciones de los profesionales de la salud para que estos pacientes contraigan los músculos estabilizadores son totalmente innecesarias. Conclusiones: Los pacientes con lumbalgia tienen un mayor nivel de activación de los músculos estabilizadores de la columna lumbar en comparación con las personas sanas. ***Nivel de evidencia IIA; Revisión sistemática de estudios de cohortes.***

Descriptores: *Lumbalgia; Electromiografía; Columna Vertebral.*

INTRODUCTION

Low back pain is a tissue and/or neurological injury that affects the lower region of the trunk and may or may not radiate to the lower limbs. We can classify low back pain in several ways, asacute, subacute, or chronic low back pain. Acute low back pain lasts for up to six weeks, with a marked improvement in the mean level of pain and disability in most patients. Subacute low back pain lasts for between six weeks and three months and from this period onwards has only small reductions in mean pain and disability. Chronic low back pain is characterized by a duration of more than three months.[1-3]

According to Kisner and Colby,[4] spinal stability is divided into three subsystems: passive (bones and ligaments), active (muscles), and neural control. These subsystems are interrelated, and the instability of a vertebral segment is a result of a combination of tissue damage, muscle weakness, and inadequate neuromuscular control. The active subsystem plays a very important role in spinal stability. With out the dynamic stabilizing activity of the trunk muscles, the spine would collapse in the upright position.[4]

The muscles characterized as spinal stabilizers are the rectus abdominis (RA), the internal obliques (IO), the external obliques (EO), the transverse abdominis (TrA),the quadratus lumborum (QL), the multifidi (MT), iliopsoas (IP) (iliacus and psoas major), and erector spinae muscles (ES) (iliocostalis, longissimus, and spinalis).[4]

Electromyography (EMG) is used to assess the activation of the stabilizing muscles. Electromyography is a method of recording the electrical activity of a muscle during contraction. The basic result is the temporal pattern of the different synergistic muscles active during the movement being observed. Therefore, through EMG, voluntary muscle activity is determined directly through the muscle action potential detected by electrodes placedon thesurface of the skin over the muscle.[5]

In clinical practice, we observe many professionals giving patients verbal and tactile commands for them to contract the stabilizing muscles to improve the stabilization and motor controlof the lumbar spine and regional segments. However, it is still not known how this muscle activation patternworks in these patients nor do we know whether patients with chronic low back pain activate in the same way or whether there is some change in this pattern as compared to a healthy person. Therefore, the objective of this systematic review is to compare the level of muscle activation of the stabilizer muscles of the lumbar spine between people with chronic low back pain and people without low back pain symptoms.

METHODS

Inclusion and exclusion criteria

Inclusion criteria: (1) biomechanical, observational studies or clinical trials; (2) published before May 2021; (3) using electromyography as abasis for evaluation; (4) with two or more groups, at least one of which is made up of participants with chronic low back pain and another,as the control group, consisting of participants who do not have episodes of low back pain; (5) that include at least one lumbar spine stabilizer muscle in the evaluation;and (6) that compare the level of muscle activation results between the groups.

Exclusion criteria: (1) studies that are not biomechanical, not observational, and not clinical trials; (2) that do not use electromyography as abasis for evaluation; (3) with no control group; (4) with groups with participants with spondylolisthesis, ankylosing spondylitis, spinal osteoarthritis or inflammation, nerve root compression, neuromuscular disease, scoliosis (20º or more), those who had undergone any type of surgical procedure of the spine, who had a malignant tumor, hypertension, was pregnant or breast-feeding; or (5) that did not include at least one lumbar spine stabilizer muscle in the evaluation.

Search strategy

On May10, 2021, a systematic search was conducted of the PubMed, Physiotherapy Evidence Database (PEDro), and the Cochrane Library databases, combining terms for low back pain, electromyography, and spine. The search process performed is summarized in Table 1.

Study selection

One of the authors (WJA), by means of the titles and then the abstracts, selected the studies that compared the muscle activity of the lumbar spinestabilizer muscles in people with low back pain and in asymptomatic people for a full reading of the study text. Results from each database were reviewed and duplicates were removed manually. Two authors (WJ and MSB) examined all the articles selected for a full reading independently. Disagreements were resolved through discussion between the authors. A PRISMA[6] flowchart was created to summarize the article selection process (Figure 1).

Data extraction

One of the authors (WJ) performed the extraction of data from the selected articles.The following information was extracted from each article: 1) participant characteristics: sample size, mean age, sex, and diagnosis; 2) study objective; 3) muscles evaluated; 4) exposure procedures; and 5) results.

This systematic review was not evaluated by the Institutional Review Board.

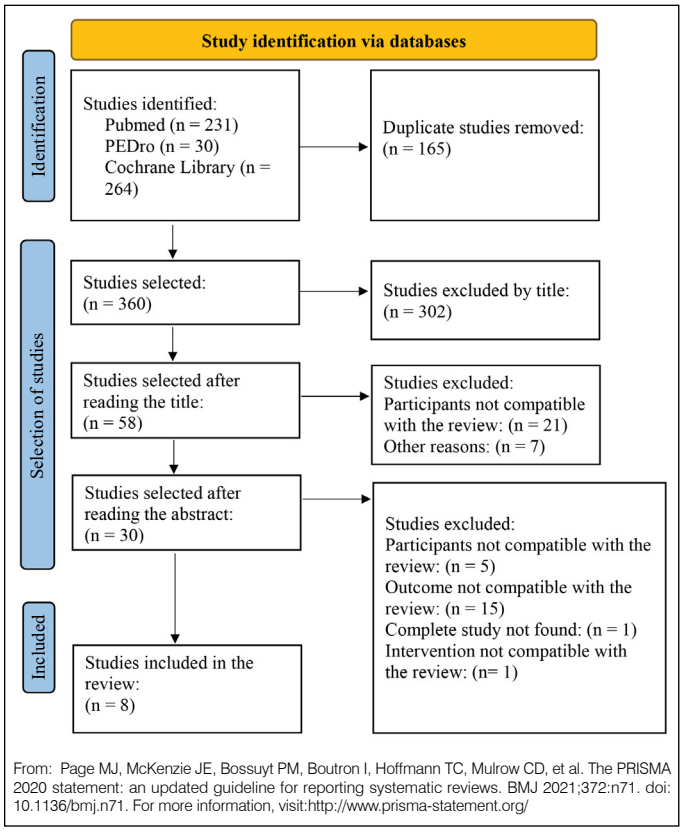
Table 1. Description of the descriptors and search process.

Database	Keywords	Filters
PubMed	Back muscle OR Muscle activity OR muscle activation OR trunk muscles OR abdominal contraction OR spine stability OR Erector spinae AND Electromyography OR EMG AND Low back pain.	Only clinical trials
Physiotherapy Evidence Data base (PEDro)	Muscle* Electromyography* "Low back pain"	Only clinical trials
Cochrane Library	Part #1: Back muscle OR Muscle activity OR muscle activation OR trunk muscles OR spine stability.	Only clinical trials
	Part #2: Electromyography OR EMG.	
	Part #3: Low Back Pain.	
	Search: #Part 1 AND #Part 2 AND #Part 3.	

RESULTS

Literature search and selection

The biographical search identified 525 records, 165 of which were removed as duplicates. After screening the titles, abstracts, and complete textof the remaining 360 articles, 352 were excluded and 8 articles were included in this review. Figure 1 illustrates the search and study selection process in accordance with the PRISMA statement.[6]



From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi: 10.1136/bmj.n71. For more information, visit:http://www.prisma-statement.org/

Figure 1. PRISMA flowchart.

Data extraction

The data extracted is shown int Tables 2, 3, and 4.

Participant characteristics

The selected studies had a total of 438 participants, 211 men and 175 women, although two studies[8,14] did not specify the sex of the sample. The smallest study sample had 13 participants[12] and the largest had 188 individuals,[11] yielding a mean of 25.76 individuals per study.

A total of 159 individuals, with a mean age of 35.56 years, suffered from chronic low back pain. One study[8] did not specify the mean participant age. Seven studies[7-10,12-14] included only individuals with chronic low back pain and one study[11] divided the low back pain group into two subgroups, one without symptoms lasting less than 6 weeks and the other with symptoms lasting more than 3 months. Only the results from patients with chronic low back pain were considered.

A total of 279 individuals, with a mean age of 33.41years belonged to the control groups, although one study[8] did not specify the mean age of its participants. In all the studies, the individuals were required to be free from low back pain and to have no history of the injury for a period specified by each study.

Muscles evaluated

The erector spinae muscles were evaluated in all studies,[7-16] the multifidus in four studies,[7,9,11,13] the external oblique in two studies,[7,8] the rectus abdominis in two studies,[7,8] and the internal oblique in two studies.[7,12] The remaining stabilizing muscles were not evaluated in any of the studies.

Characteristics of the exposures

The studies evaluated muscular activation using different types of exercise in different regions of the body. Two studies[8,10] evaluated it by means of lower limb exercise; two[7,13] by means of trunk exercises;one study[9] through functional tasks, such as jumping, squatting, picking

Table 2. Part 1 – Participant characteristics.

Author/year	Participant characteristics				
	Groups	Sample	Age	Sex	Diagnosis
ERSHAD N. et al.[7]	Low back pain	10	24.7	10 women	Lumbar or lumbosacral pain with or without proximal radicular pain, current pain episode longer than 3 months.
	Healthy	10	25.4	10 women	With abdominal skinfold thickness < 25 mm.
LOMOND KV. et al.[8]	Low back pain	15	Not specified	Not specified	They had a history of chronic low back pain (≥ 12 months) with or without recurrences.
	Control	15	Not specified	Not specified	Absence of neurological, psychiatric, cardiovascular, or musculoskeletal disorders.
LIMA M et al.[9]	Chronic non-specific low back pain	40	35.2	33 men and 7 women	Experience low back pain for more than 3 months.
	Asymptomatic	40	35.9	29 men and 11 women	Never suffered important disability caused by low back pain.
KIM S, HYUN et al.[10]	Chronic low back pain	16	24.06	10 men and six women	Lumbar extension rotation syndrome for more than 7 weeks.
	Without chronic low back pain	14	23.79	8 men and 6 women	Without chronic low back pain.
FINNERAN M T. et al.[11]	Acute low back pain	13	41	7 men and 6 women	A current episode less than 6 weeks of duration.
	Chronic low back pain	25	47	12 men and 13 women	Chronic back pain.
	Control	163	34	51 men and 112 women	No current back pain and no back pain for the last 12 months.
BALASUBRAMANIAN V, JAYARAMAN S.[12]	Low back pain	7	26.58	7 men	History of low back pain for at least 1 year and no more than 3 years.
	Control	6	26.58	6 men	No history of low back pain for at least 1 year and up to 3 years.

Table 2. Part 2 – Participant characteristics.

Author/year	Participant characteristics				
LARIVIÈRE C, et al.[13]	Healthy	20	38	20 men	No back problems or physical disability presented.
	Unilateral low back pain	14	40	14 men	Lumbar or lumbosacral pain with or without proximal radicular pain (limiteddistally to the knees) and the presence of chronic pain, defined daily or almost daily pain for at least 3 months.
	Midline low back pain	21	38	21 men	
HEALEY EL, et al.[14]	Chronic low back pain	11	33	Not specified	Suffered from low back pain for more than 6 months.
	Asymptomatic	11	30.5	Not specified	They were excluded if they had experienced back pain during the past year.

Table 3. Study objective and muscles evaluated.

Author/year	Study objective	Muscles evaluated
ERSHAD N. et al.[7]	The current study focused on the pattern of trunk muscle recruitment in patients with low back pain and subjects without low back pain during load bearing.	Rectus abdominis, external oblique, internal oblique, erector spinae, and multifidus muscles.
LOMOND KV et al.[8]	To measure self-rated disability, pain, range of muscle activation, and application of force during supported and unsupported leg raise tasks in people with and without low back pain.	Erector spinae, external oblique, internal oblique, and rectus abdominis muscle.
LIMA M. et al.[9]	Analyzed the activity of the back muscles during five functional tasks in patients with chronic lumbar painand compared it to asymptomatic controls.	Erector spinae and multifidus.
KIM S, HYUN, et al. [10]	To compare the activity of the erector spinae muscles, and the amount and onset of lumbar movement during standing knee flexion among the subjects.	Erector spinae.
FINNERANMT. et al.[11]	To determine if the data differs by type of patient.	Multifidus,erector spinae, and quadratus lumborum.
BALASUBRAMANIAN V, JAYARAMAN S.[12]	To examine whether aerobic cyclingcauses any difference in muscle activity between the control and low back pain groups using electromyography.	Erector spinae.
LARIVIÈRE C. et al.[13]	Evaluated different measurement properties (influence of the control of asymmetrical forces and of the level of strength, the reliability, and sensitivityto the lumbar status) of the electromyography imbalance parameters.	Multifidus and erector spinae.
HEALEY EL. et al.[14]	To determine whether the paravertebral muscle activity of individuals with and without chronic low back pain can be altered by assuming different load bearing positions and if this has any impact after recovery of stature.	Erector spinae.

Table 4. Exposure procedures and results.

Author/year	Exposure procedures	Results
ERSHAD N. et al.[7]	The subjectheld a box at three levels: 0 kg (holding a 370-g paper boxalmost considered as 0 kg), 6 kg, and 12 kg (holding a wooden box). The functional tasks were holding loads at two different trunk posture levels and three levels of external loads.	Activation of the internal oblique in patients with chronic low back pain is lower than in healthy individuals while bearing loads of 6 and 12 kg in the neutral trunk position. The chronic low back pain group had significantly greater external oblique muscle activation during the 12 kg loading on the flexed trunk than the control group. There were no significant differences in the activation of the erector spinae and multifidus muscles between patients with chronic low back pain and control groups.
LOMOND KV. et al.[8]	The individuals rested each foot on separate force plates while they were in dorsal decubitus and performed 4 repetitions of 2 voluntary movements of the left leg: a leg raise with support (SLR) and a leg raise without support (ULR).	During the MOVE phase, individuals with low back pain demonstrated greater muscle activation of the bilateral external oblique, erector spinae, internal oblique, and the rectus abdominis muscles than the individuals without pain.
LIMA M. et al.[9]	To perform five functional tasks: pick an object up off the floor, place an object on the floor, sit down, get up, and walk up the stairs. The tasks were repeated three times.	Greater electromyographic activity was observed in patients with chronic low back pain, except for the multifidus muscle during the task of picking a ball up off the ground.
KIM S. HYUN et al.[10]	The subject lifted the foot and flexed the knee at 90°. Then the subject was asked to maintain the knee flexion posture for 5seconds. The test was repeated 3 times.	Individuals with lumbar extension rotation syndrome had less electromyographicactivity of the contralateral erector spinae during standing knee flexion.
FINNERAN MT. et al.[11]	The flexion position required the participant to stand up with the feet shoulder-width apart with trunk flexion of 20°.Theweighted position required the participant to remain in a vertical position holding two 3-pound weights, one in each hand.	The control population demonstrated symmetrical lumbar muscle function, while those with back pain did not.
BALASUBRAMANIAN V, JAYARAMAN S.[12]	The subjects rode an aerobic bicycle and were instructed to maintain a comfortable posturewhile cycling at an average speed of 25-30 km/h for 30 minutes.	There was no statistical difference observed between the groups.
LARIVIÈRE C. et al.[13]	The subject performed static extension efforts using L5/S1 in real time with visual feedback.	Healthy individuals had lower absolute mean square root values than individuals with chronic low back pain.
HEALEY EL. et al. [14]	Subjects walked at a self-selected rhythm on a treadmill for 20 minutes wearing a weighted vest (10% of body mass).	No significant difference was found between the right and left erector spinae muscle activity (normalized) in any group at the start or during recovery. The activity of the paraspinal muscle was greater in the chronic low back pain group at the beginning of the study and during all four recovery periods.

an object up off the floor, among others; two[12,14] using aerobic exercises; and one study[11] that used two exercises for their assessment, one of trunk flexion and the other of shoulder elevation.

The muscle contractions evaluated were different among the studies: four studies[7,8,10,13] evaluated them via isometric contraction, three studies[9,12,14] used different types of contraction in the same task, and one study[11] evaluated them by means of exercises that required either concentric isotonic contraction or isometric contraction.

Level of muscular activation

In five studies,[8,9,11,13,14] the erector spinae muscles presented a higher activation level in the chronic low back pain group, while, in two studies,[7,12] there was no statistically significant difference between the groups and, in another study,[10] the erector spinae activation level was lower in the low back pain group. The multifidus muscles were evaluated in four studies. In three of these,[9,11,13] the low back pain group had a higher activation level compared to the control group, and in the other[7] there was no statistically significant difference between the groups.

In the study by Finneran, M. T.,[11] 188 participants were evaluated in two exercises, one of trunk flexion and the other of shoulder elevation with concentric isotonic and isometric contraction. His results showed that the patients with chronic low back pain presented significantly higher maximum mean square root values than normal individuals for the erector spinae, multifidus and quadratus lumborum muscles.

The study by Lima M.[9] evaluated 80 individuals using five functional tasks: picking an object up off the floor, placing an object on the floor, sitting and getting up, and walking up the stairs.The results were like those of the previous study, demonstrating greater electromyographic activity for the erector spinae and multifidus muscles in all the tasks for the patients with chronic low back pain, except for the multifidus muscles during the task of picking a ball up off the floor.

Corroborating with the previous studies, the study by Larivière C.[13] also reported results in which the chronic low back pain group presented greater maximum mean square root values than the control group for the erector spinae and multifidus muscles in the isometric contraction of trunk extension. Lomond K.V.[8] had the same results in their study of 30 individuals who performed four repetitions of two voluntary movements of the left leg: a supported leg raise and an unsupported leg raise. The chronic low back pain group showed a higher activation level for the erector spinae, internal oblique, external oblique, and rectus abdominis muscles.

The study by Healey E.L.[14] selected 22 participants to be evaluated during a 20-minute walk on the treadmill while wearing a weighted vest (10% of the body mass). The level of erector spinae muscle activity was higher in the chronic low back pain group throughout the walk.

The results of the study by Ershad N.,[7] which evaluated 20 individuals exposed to isometric exercises that involved holding boxes weighing 370 grams, 6 kg, and 12 kg at two different trunk posture levels, conflict with those of the studies above. The results showed that activation of the internal oblique muscle in the patients with chronic low back pain was lower than in the healthy individuals during the loading of 6kg and 12 kg in the neutral trunk position. The low back pain grouphad a significantly higher external oblique activation level during 12 kg loading with the trunk flexed than in the control group and there were no significant differences in erector spinae or multifidus muscle activation between patients with chronic low back pain and the control group.

The study by Balasubramanian V. and Jayaraman, S.[12] evaluated 13 participants who were instructed to maintain a comfortable posture while riding an aerobic bicycle at an average speed of 25-30 km/h for 30 minutes. The results did not show any statistical difference between the groups for the erector spinae muscles.

The only study where the low back pain demonstrated a lower level of erector spinae muscle activation than the control group was that by Hyun K. S.,[10] with 30 individuals who performed a 5-second isometric 90º knee flexion exercise three times.

DISCUSSION

The results of this review showed that, comparing the chronic low back pain and control groups, the level of erector spinae muscle activation was higher in patients with chronic low back pain in five studies, lower in one study, and without any difference in two studies. There was disagreement between two studiesfor the internal oblique muscle results. The external oblique, rectus abdominis, and quadratus lumborum muscles activated more among the patients with chronic low back pain than among the healthy individuals. As regards the multifidus muscles, three studies reported that individuals with low back pain activate more than healthy individuals, while one study observed no difference between the groups.

This review was the first to analyzeelectromyographical studies of the lumbar spine stabilizer muscles in patients with chronic low back pain, encompassing all types of exposure procedures for evaluation. However, we had a few limitations, such as the lack of a risk of bias assessment and the small sample size of most of the selected articles.

Our results are consistent with another review that studied lumbar spine stabilizer muscle activation. The objective of the systematic review by Ghamkhar L. and Kahlaee, A. H.[15] was to identify differences in the patterns of trunk muscle activation during walking in people with chronic low back pain. Their results demonstrated that the levels of activation of the multifidus, erector spinae, external oblique, and rectus abdominis muscles were higher in subjects with low back pain than in the control group.

With the results presented, patients with chronic low back pain have a different pattern of muscle activation than healthy people. Through this review we were not able to determine whether this pattern is the cause or one of the consequences of low back pain. We believe that it is difficult for us to understand the cause of low back pain, but, considering the results found, we think that the insistence of health professionals that these patients contract the stabilizer muscles or stay in a more upright position when performing some movements is totally unnecessary, since the contraction of these muscles is occurring beyond the normal pattern and demanding the reinforcement of this contraction is harmful to the patient. It can cause kinesiophobia, inappropriate beliefs, a reduced quality of life, and disregard for the symptoms.

Considering a biomechanical rationale for the standard solution, we can perform motor control exercises (MCE). According to a systematic review,[16] there is very weak to moderate evidence that MCEs have a clinically relevant effectwhen compared to minimal interventions for chronic low back pain, but MCEs are not superior to the other forms of therapeutic exercise.

CONCLUSION

We conclude that patients with chronic low back pain have a higher level of lumbar spine stabilizer muscle activation than healthy people.

All authors declare no potential conflict of interest related to this article.

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