Cross-Sectional Study

Influence of the Generation of Motor Mental Images on Physiotherapy Treatment in Patients with Chronic Low Back Pain

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Background: Patients with nonspecific chronic low back pain (NCLBP) have greater difficulty generating kinesthetic and visual motor imagery.

Objectives: The main aim of this study was to determine whether the ability to generate mental motor imagery (MIab) influences psychological, motor, and disability variables in patients with NCLBP. The secondary aim was to determine whether an approach based on therapeutic exercise (TE) and therapeutic education (TEd) could improve the MIab in those patients with less ability to perform it.

Study Design: Cross-sectional and quasiexperimental study.

Setting: Physical Therapy Unit of primary health care center in Madrid, Spain.

Methods: A total of 68 patients were divided into 2 groups according to a greater (n = 34) or lesser (n = 34) MIab. Treatment was based on TEd and TE for the group with less ability to generate kinesthetic and visual motor imagery. The outcome measures were imagery requested time, self-efficacy, disability, pain intensity, lumbar strength, psychological variables, and MIab.

Results: The group with lesser MIab showed lower levels of self-efficacy ($P = 0.04$; d, –0.47) and lower levels of lumbar strength and extension strength ($P = 0.04$; d, –0.46 and $P = 0.02$; d, –0.52, respectively). After the intervention with TE and TEd, MIab (both kinesthetic and visual) improved significantly, with a moderate to large effect size ($P \leq 0.01$; d, –0.80 and $P \leq 0.01$; d, –0.76, respectively), as did pain intensity, lumbar strength, disability, and psychological variables ($P < 0.05$), but not levels of self-efficacy ($P > 0.05$). Based on the results, the patients with NCLBP with lesser MIab achieved lower levels of self-efficacy and lower strength levels.

Limitations: The results of this study should be interpreted with caution because of its quasiexperimental design and a bias selection.

Conclusions: A clinical TE approach, coupled with a TEd program, resulted in significant improvement in MIab (both kinesthetic and visual), reduced pain intensity, increased lumbar strength, reduced disability, and improved psychological variables, but it did not significantly improve self-efficacy levels in the patients with NCLBP.

Key words: Chronic low back pain, motor imagery, disability, lumbar strength

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Nonspecific chronic low back pain (NCLBP) is one of the most prevalent musculoskeletal disorders and causes a high rate of disability and work absenteeism (1). NCLBP is considered a multifactorial problem, given that it presents affective-motivational, sensory-discriminative, and cognitive-evaluative impairment (2) .

Patients with NCLBP have greater difficulty generating kinesthetic and visual motor imagery (3). In other chronic pain conditions, it has been observed that primary motor cortex activity is reduced after periods of immobility, as is the primary somatosensory cortex, which results in maladaptive changes at the cortical level, thereby affecting the planning and execution of movement. We can therefore deduce that the ability to form kinesthetic and visual imagery can also be affected as a result. Similarly, studies have observed that amputee patients have a reduced ability to form kinesthetic and visual imagery, not only because of the lack of the limb but also because of the presence of pain and other symptoms associated with the problem, which causes maladaptive neuroplastic changes (4). Research studies have suggested that this situation could be due, on one hand, to the influence of the posterior parietal cortex in participating, along with the premotor cortex, in anticipating movement and in performing or imagining an action and, on the other hand, to a series of neurobiochemical changes, which are directly proportional to the process of chronicity and the influence of psychological variables, including anxiety and depression (5,6).

Moreover, previous studies of patients with NCLBP have grouped their samples based on psychological variables (7). Studies have observed that intervention programs based on a multimodal approach result in significant medium-term improvement in muscle strength, postural stability, disability, and pain intensity (8,9).

We therefore conducted a cross-sectional analysis whose main objective was to determine whether the ability to generate kinesthetic and visual motor imagery affects psychological, motor, and somatosensory variables. The secondary objective was to determine whether an approach based on therapeutic exercise (TE) and therapeutic education (TEd) can improve the ability to generate kinesthetic and visual motor imagery.

Methods

Study Design

A cross-sectional study with a nonprobabilistic sample was conducted to assess intensity of pain, functional and psychological variables of patients with NCLBP based on the ability to generate kinesthetic and visual motor imagery. The study was conducted in accordance with Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement (10). Second, we proposed a single-blind quasiexperimental study with a nonprobabilistic sample of a single group (Appendix 1). We evaluated the effect of a treatment based on TEd and TE in the group with less ability to generate kinesthetic and visual motor imagery on the study variables. The study protocol follows the checklist to improve reporting of group-based behavior-change interventions.

The study followed the principles of the Declaration of Helsinki and was approved by the Ethics Committee for Clinical Research of one University Hospital (PI-2567), a public reference hospital in Madrid (Spain). Written informed consent was obtained from all patients.

Patients

The consecutive nonprobabilistic convenience sample consisted of 68 patients with NCLBP. Patients were classified as having “high” or “low” kinesthetic and visual motor imagery ability based on a median score split on the Movement Imagery Questionnaire-Revised (MIQ-R). Group 1 consisted of 34 patients who registered low kinesthetic and visual motor imagery ability, and group 2 was composed of 34 patients who registered high kinesthetic and visual motor imagery ability. The sample was recruited from a primary health care center in Madrid, Spain.

Inclusion Criteria

Patients were selected for cross-sectional study if they met all the following inclusion criteria: (1) persistent low back pain in at least the prior 3 months; (2) low back pain of nonspecific nature; and (3) men and women aged 18 to 65 years. The evaluator asked the study patients not to take medication 24 to 48 hours before the evaluation. Then patients with low kinesthetic and visual motor imagery ability and who consented to their participation in the second part of the investigation were included in the quasiexperimental study.

Exclusion Criteria

Patients were excluded if they met one of the following exclusion criteria both for the first part of the investigation and for the second part: (1) neurologic signs (such as weakness perceived in the lower limbs); (2) specific spinal pathology (e.g., malignancy, inflammatory joint or bone diseases); (3) having undergone back surgery; (4) any cognitive disability that hinders visual and kinesthetic movement imagery ability; (5) illiteracy; (6) understanding or communication difficulties; and (7) insufficient Spanish language comprehension to follow study instruction. The patients were referred from the primary care medical service after an evaluation that included imaging tests if necessary.

Primary Outcomes

Self-Efficacy

Self-efficacy was assessed through the Spanish version of the Chronic Pain Self-Efficacy Scale (CPSS), which has been demonstrated as having acceptable psychometric properties (11). The CPSS presented a reliability of 0.88, 0.87, and 0.90 for pain management subscale, physical function subscale, and coping with symptoms subscale, respectively (12).

Visual and Kinesthetic Motor Imagery Ability

MIQ-R is an 8-item self-report inventory with adequate internal consistency (Cronbach's alpha coefficients ranging above 0.84 for the total scale, 0.80 for the visual subscale, and 0.84 for the kinesthetic subscale). It was used to assess visual and kinesthetic motor imagery ability. Four different movements are including in this test, and the inventory is composed of 4 visual and 4 kinesthetic items. For each item, patients read a description of the movement. They then physically performed the movement before performing the mental task, which was to imagine the movement visually or kinesthetically. A score between 1 and 7 is assigned, with 1 representing difficulty in picturing the motor image or difficulty in feeling the movement previously made, and 7 representing the maximum ease. The time to perform each item also was evaluated (13).

Secondary Outcomes

Imagery-Requested Time

An imagery-requested time evaluation was also used to measure the patients motor imagery ability with a stopwatch. The time recorded corresponded to the interval between the command to start the task and the moment the task had been concluded (14).

Pain Intensity

The Visual Analog Scale (VAS) was used to measure pain intensity before and after each treatment. The VAS is a 100-mm line with 2 endpoints representing the extreme states of "no pain" and "the maximal pain imaginable." It has been shown to have good retest reliability (r, 0.94; $P < 0.001$) and a minimal detectable change of 15.0 mm (15,16).

Low Back Disability

Physical disability due to low back pain was assessed using the Spanish version of the Roland-Morris Disability Questionnaire (17). It has been demonstrated as having acceptable psychometric properties with a Cronbach's alpha ranging between 0.84 and 0.93, and test–retest reliability ranging between 0.72 and 0.91 (18).

Fear of Movement

Fear of movement was assessed using the 11-item Spanish version of the Tampa Scale of Kinesiophobia, whose reliability and validity have been demonstrated (internal consistency, Cronbach's alpha = 0.78) (19,20). The final score can range between 11 and 44 points, with higher scores indicating greater perceived kinesiophobia (20).

Anxiety and Depression

The anxiety and depression state were assessed with the Hospital Anxiety and Depression Scale (HADS). The scale has 2 subscales of 7 items each that measure anxiety and depression (21). The HADS presented an internal consistency (Cronbach's alpha) at 0.80 to 0.93 for the anxiety, and 0.81 to 0.90 for the depression subscales (22).

Lumbar Strength

The strength of the lumbar region was be measured by means of a foot dynamometer (Takei TM 5420, Takei Scientific Instruments CO. Niigata City, Japan). It is a valid and reliable test to measure the muscular strength of the lumbar region. It has been shown to have a good reliability (r, 0.91; $P < 0.001$) (23).

Extensor Endurance

Extensor endurance was evaluated with the Ito test. The patients were positioned in prone decubitus while holding the sternum off the floor (24). The patients were instructed to maintain this position as long as possible, to a maximum of 300 seconds (24,25). Patients with chronic low back pain (CLBP) produced test–retest r values of 0.93 and 0.95 for men and women, respectively, and an intraclass correlation coefficient of 0.93 for both genders (24).

Procedure

The study consisted of 2 phases. In the first phase and after consenting to participate, all recruited patients were given a sociodemographic questionnaire to complete on the day of the assessment, which recorded the patients' gender, date of birth, marital status, and educational level. Next, each participant completed a set of self-report measures and completed the MIQ-R, which evaluated, among other variables, the time spent accomplishing the questionnaire's tasks. The Spanish-validated version of these questionnaires were employed, and this procedure was the same for both groups. Once the sample was divided based on their ability to generate mental motor imagery (MIab; kinesthetic and visual), we observed whether there were differences in the study variables.

In the second phase, we conducted a TE and TEd intervention on the group with the lesser ability, and observed whether it resulted in changes in the ability to generate kinesthetic MIab 1 month after the intervention.

The intervention consisted of 8 sessions of TEd and TE, twice per week, with 48 to 72 hours between sessions. The patients had to complete 7 sessions of therapy.

TEd

The objective of the theoretical-practical TEd protocol was to provide each patient with strategies for changing their maladaptive beliefs and increase their self-efficacy through lessons on active coping strategies. All skills were taught in a practical manner, using techniques based on observing actions and kinesthetic motor imagery. Each session lasted 25 minutes and was conducted individually with a physiotherapist specialized in chronic pain. The entire intervention is summarized in Appendix 2.

TE

The TE program was based on training the lumbar-pelvic motor control through deep muscle exercises (transverse abdominis, multifidus muscle, and pelvic floor). The exercise sessions were also performed individually and after the TEd session, with each session lasting 20 to 25 minutes. As control measures, each patient was warned that the exercises would progressively increase in difficulty and intensity and that they should tell the responsible physiotherapist if they felt pain. The patients were also told to perform these exercises at least twice per week at home (Appendix 3).

Sample Size

The sample size was estimated with G*Power 3.1.7 for Windows (University of Dusseldorf, Dusseldorf, Germany). Self-efficacy was assessed through the Spanish version of the CPSS and was chosen as the primary outcome measure in this study. Calculations were based on data obtained from the difference in means between both groups of a pilot study conducted in 15 patients with NCLBP. Performing a comparison of independent samples, an alpha level of 0.05, and an effect size of 0.61, this generated a sample size of 34 patients for the study to have 80% power to identify an effect.

Statistical Methods

We employed the Statistical Package for Social Sciences Version 22 (IBM Corporation, Armonk, NY) for the statistical analysis. The level of significance for all tests was $P < 0.05$. In the data analyses, we used descriptive statistics to show the data on the continuous variables, which are presented as mean and standard deviation, 95% confidence intervals, and relative frequency (percentage). We employed the χ^2 test to compare differences between the categorical variables (nominal). The Shapiro–Wilk test was used for the normality tests. In addition, the Student t-test for independent samples was applied as a statistical test to compare the variables between groups. We calculated the effect size (Cohen's d) to compare the study variables. Based on the Cohen method, the effect was considered small (0.20–0.49), medium (0.50–0.79), or large (> 0.8) (26).

The Pearson correlation coefficient was used to analyze the association between the pain-related disability, psychology, and physical variables in patients with CLBP. The Pearson correlation coefficient greater than 0.60 indicates a strong correlation, a coefficient between 0.30 and 0.60 indicates a moderate correlation, and coefficient below 0.30 indicates a low or particularly low correlation.

Results

Patients and Descriptive Data

The sample was composed by 68 patients divided into 2 groups of 34 patients in each one: (1) lower kinesthetic and visual motor imagery ability, and (2)

Table 1. *Descriptive, demographic data and control variables.*

	Group 1 (n = 34)	Group 2 (n = 34)	*P*-value
Agea (years)	43.1 ± 13	41.6 ± 12.1	0.57
BMI[a] Weight [kg]/high [m^2]	25.9 ± 5.6	25.3 ± 3.6	0.55
Symptoms duration (months)[c]	60 [97.5]	36 [43.5]	0.09
Pain frequency[a] (days/months)	22.7 ± 7.3	22.6 ± 7.8	0.94
Medication frequency (days/months)[c]	2.5 [10]	1.5 [11]	0.92
Education level[b]			0.23
Primary Education (%)	9 (26.5)	7 (20.6)	
Secondary education (%)	8 (23.5)	4 (11.8)	
College education (%)	17 (50.0)	23 (67.6)	
Medication intake[b]			0.82
Yes (%)	18 (52.9)	19 (55.9)	
No (%)	16 (47.1)	17 (44.1)	

Values are presented as mean ± standard deviation, (median ([interquartile range]) or number (%). BMI: Body Mass Index. Group 1: lower kinesthetic and visual motor imagery ability; Group 2: Higher kinesthetic and visual motor imagery ability.
[a]Independent Student's t test.
[b]Chi-square test
[c]U-Mann Whitney
*$P < 0.05$.

higher kinesthetic and visual motor imagery ability. The median of the results obtained from the total MIQ-R was calculated with the purpose of classifying the total sample (me, 46.5). The mean and standard deviation of the sample was 37.68 ± 5.22 for the lower kinesthetic and visual motor imagery ability group, and 50.69 ± 3.03 for the higher kinesthetic and visual motor imagery ability group. Statistically significant differences were found between groups with a large effect size (*P* < 0.001; d, –3.04). Table 1 shows all of control variables, such as body mass index, frequency of pain, symptoms duration, frequency of medication use, educational level, and medication intake.

Comparison Between Groups

The Student t-test for independent measures showed significant statistical differences in the hypothesis contrast for self-efficacy level (t, –2.02; *P* = 0.04; d, 0.47) between study groups. As it is presented in Table 2, there was significant statistical differences between patients with lower kinesthetic and visual motor imagery ability versus patients with higher kinesthetic and visual motor imagery ability in lumbar strength (t, –2.06; *P* = 0.04; d, 0.46) and in the extensor endurance (t, –2.27; *P* = 0.02; d, 0.52). However, the variables of disability, fear of movement, depression, and pain intensity showed no significant statistical differences (*P* > 0.05), except the variable of anxiety (t, 2.06; *P* = 0.04; d, 0.47).

Correlation Analysis

The Pearson correlation coefficient showed moderate and significant statistical correlations for some variables segmented by study group. In patients with lower kinesthetic and visual motor imagery ability, the strongest significant statistical correlations were between fear of movement and medication intake (r, 0.42; *P* < 0.01), between fear of movement and self-efficacy (r, –0.44; *P* < 0.01), between self-efficacy and depression (r, –0.51; *P* < 0.01), and finally between self-efficacy and lumbar strength (r, 0.49; *P* < 0.01).

In patients with higher kinesthetic and visual motor imagery ability, the strongest significant statistical correlations were presented between self-efficacy and depression (r, –0.39; *P* = 0.02), and between lumbar strength and extensor endurance (r, 0.55; *P* < 0.01).

Time Factor Comparisons (Lower Kinesthetic and Visual Motor Imagery Ability)

The Student t-test for dependent measures showed significant statistical differences in time factor in kinesthetic (t, –4.27; *P* < 0.01; d, 0.80) and visual motor imagery (t, –4.17; *P* < 0.01; d, 0.76) ability as presented

Table 2. *Comparative data between groups*

	Group 1 (n = 34)	Group 2 (n = 34)	Mean Differences (95% CI); Effect size (d)
Pain intensity	4.8 ± 1.5	4.7 ± 1.4	0.21 (-0.65 to 0.69) d = 0.07
Self-efficacy level	135.2 ± 33.2	149.9 ± 28.5	-14.67 (-29.15 to -0.19)* d = 0.47
Low back disability	6.3 ± 3.9	6.3 ± 4.8	-0.05 (-2.03 to 1.93) d = 0.01
Fear of movement	27.9 ± 6.1	25.8 ± 5.8	2.07 (-0.64 to 4.79) d = 0.35
Anxiety	8.1 ± 4.4	6.2 ± 3.7	0.93 (0.06 to 3.77)* d = 0.47
Depression	4.5 ± 3.9	3.1 ± 2.9	1.36 (-0.20 to 2.94) d = 0.41
Lumbar Strength	41.9 ± 18.9	52.8 ± 27.7	-11.21 (-22.05 to -0.38)* d = 0.46
Extensor endurance (seconds)	32.9 ± 22.9	45.6 ± 25.7	-12.77 (-23.96 to -1.58)* d = 0.52
MIQR-KT	25.5 ± 15.1	14.9 ± 5.1	10.60 (5.38 to 15.82)** d = 0.94
MIQR-VT	21.6 ± 12.2	13.7 ± 6.1	7.96 (3.51 to 12.41)** d = 0.82

Group 1: lower kinesthetic and visual motor imagery ability; Group 2: Higher kinesthetic and visual motor imagery ability. MIQ-R: Revised Movement Imagery Questionnaire; MIQR-VT: Time employed in Visual subscale; MIQR-KT: Time employed in Kinesthetic subscale.
**P*-valor <0 .05; ***P*-valor < 0.01

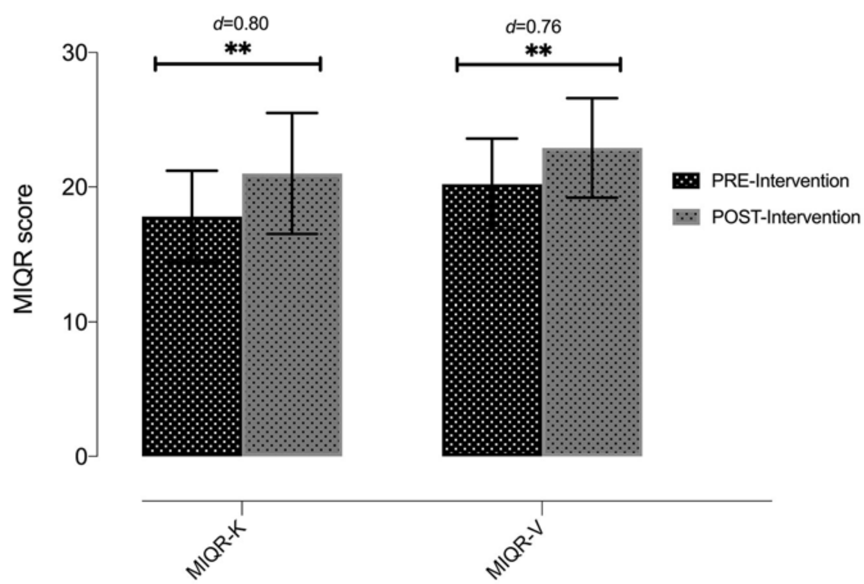

Fig. 1. ***Bar and box plots of the Visual and Kinesthetic Motor Imagery Ability with the corresponding Cohen's effect sizes (d) and the significance was determined by using a Student t test (*P < 0.05; **P < 0.001). Error bars represent standard deviations. Legend: MIQR-K: kinesthetic motor imagery ability subscale; MIQR-V: visual motor imagery ability subscale..***

in Fig. 1. Also, asignificant statistical differences in time factor were found in lumbar strength (t, –7.11; $P < 0.01$; d, 0.71), extensor endurance (t, –9.34; $P < 0.01$; d, 1.12), and pain intensity (t, 12.56; $P < 0.01$; d, 1.99). However, no significant statistical differences in time factor were found for self-efficacy level (t, –1.45; $P = 0.15$; d, 0.26). Figure 2 represented the results of the Visual and Kinesthetic Imagery requested time.

Finally, the variables of disability, fear of movement, anxiety, and depression showed significant statistical differences in time factor with a medium to large effect size (Table 3). No adverse effects from the

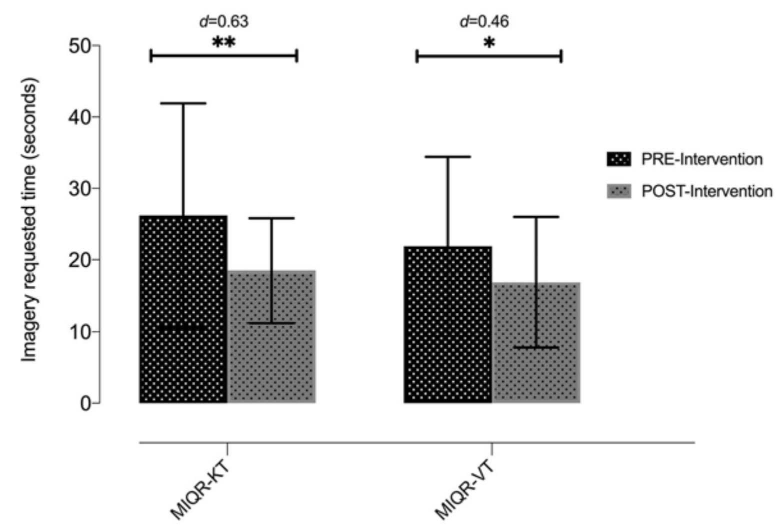

Fig. 2. *Bar and box plots of the Visual and Kinesthetic Imagery requested time with the corresponding Cohen's effect sizes (d) and the significance was determined by using a Student t test (*P < 0.05; **P < 0.001). Error bars represent standard deviations. Legend: MIQR-KT: Time employed in Kinesthetic subscale; MIQR-VT: Time employed in Visual subscale.*

Table 3. *Comparative data of the lower kinesthetic and visual motor imagery ability group pre and post intervention.*

	Mean ± SD pre intervention	Mean ± SD post intervention	Mean Differences (95% CI); Effect size (d)
Pain intensity	4.8 ± 1.5	1.6 ± 1.7	3.2 (2.57 to 3.56)** d = 1.99
Self-efficacy level	135.2 ± 33.2	146.4 ± 51.6	-11.2 (-27.48 to 4.51) d = 0.26
Low back disability	6.3 ± 3.9	1.8 ± 1.7	4.5 (3.26 to 5.51)** d = 1.50
Fear of movement	27.9 ± 6.1	16.8 ± 6.5	11.1 (8.12 to 14.04)** d = 1.76
Anxiety	8.1 ± 4.4	5.7 ± 3.8	2.4 (1.12 to 3.27)** d = 0.58
Depression	4.5 ± 3.9	2.8 ± 3.3	1.7 (0.44 to 2.56)** d = 0.47
Lumbar Strength	41.9 ± 18.9	57.4 ± 24.5	-15.5 (-19.31 to -10.72)** d = 0.71
Extensor endurance (seconds)	32.9 ± 22.9	62.2 ± 28.9	-29.3 (-33.66. to -21.62)** d = 1.12

**P*-valor < 0.05; ***P*-valor < 0.01

intervention were recorded. There were also no losses or dropouts from treatment.

Discussion

Differences in the Ability to Generate MIab

In 1996, motor imagery was defined as a dynamic mental process of internally representing an action, without the actual motor movement (27,28). It is about the mental recreation of an experience that implies the sensory, perceptual, and affective participation, so within a motor imagery process there will be a cognitive and affective participation (29). Motor imagery can be employed to improve motor performance and learn motor tasks, inducing the activation of various cortical areas, affecting the central nervous system and causing changes in the brain (30). The results of this study show that patients with CLBP and a lesser ability to generate MIab (kinesthetic and visual) had lower levels of self-efficacy compared with those who had a greater ability to generate MIab.

Related to these results, La Touche et al (3) found positive associations between higher levels of self-efficacy and a greater ability to generate MIab. The authors also found negative associations between a lower ability to generate MIab and higher levels of disability and fear of movement.

CLBP is the muscle-skeletal disorder with the highest levels of disability, and a number of studies have found a close relationship between high levels of disability and low self-efficacy (31,32). Duray et al (32) and La Touche et al (33) also found that the presence of higher levels of self-efficacy in patients with CLBP determined better active coping strategies, motivating patients toward better physical condition in terms of higher physical activity levels, higher functional reach, greater active mobility range, and a lower presence of somatosensory disorders.

The results of the present study agree with the findings in the current scientific literature, given that the patients with lesser ability to generate MIab and lower levels of self-efficacy had significantly lower scores in the physical variables, such as lumbar strength and resistance strength, using the extensor resistance test. Self-efficacy therefore appears to not only motivate behaviors toward higher physical activity levels and better physical condition but also appears to be relevant to the ability to generate MIab.

However, the role of somatosensory variables should also be analyzed to extract more solid conclusions, given that Catley et al (34) found a deficiency in tactile acuity in patients with chronic pain, including patients with CLBP. In addition, Moseley et al (35) found that patients with CLBP showed an altered representation of vibrotactile stimulation related to a modified central processing mechanism, thereby suggesting an altered cortical representation of the painful area of the body. It has been proposed that these sensitivity disorders could be a manifestation of a change in body perception related to the cortical changes in patients with CLBP (36). This hypothesis is worth considering because the set of afferents and the integration of somatosensory information are key aspects in the generation of MIab, especially in the kinesthetic modality (37). Patients with lower self-efficacy might also have greater somatosensory disorders than patients with higher levels of self-efficacy. However, the present study did not include the assessment of various somatosensory variables, such as 2-point discrimination and temporal summation, and this should perhaps be considered a limitation.

Approach Based on TE and TEd

The results of this study showed that the patient group that underwent the intervention presented less low back strength, less low back resistance, lower MIQ-R scores, and lower self-efficacy levels when compared with the patient group with a greater ability to generate kinesthetic and visual motor imagery.

The treatment based on 8 sessions that combined TEd and TE was shown to be effective 1 month after the intervention in increasing strength and low back resistance, as well as MIQ-R scores.

In addition to the strategies for modifying beliefs and increasing self-efficacy, techniques such as motor imagery and the observation of actions, were included in the TEd. Action observation is defined as a technique that evokes real-time internal motor simulation of the movements that the individual perceives visually (38). These techniques are employed when patients present limitations of movement, pain, and/or fear of movement. These techniques activate the same neurocognitive mechanisms (planning and execution) that are engaged in real-life actions.

In line with the results of this study, Losana-Ferrer et al (39) recently concluded that motor imagery and action observation, combined with a hand grip strength program, were effective techniques for increasing strength when compared with a control group that included only the hand grip strength program. The authors found no articles in the literature regarding patients with NCLBP, but did find one on chronic pain conditions with central sensitization (40). A recent case report in which the treatment included pain neuroscience education and motor imagery observed a decrease in pain and disability and increased grip strength and range of motion.

In terms of improving endurance and strength in patients with CLBP, it has been observed that exercise programs show a beneficial effect on strength and resistance (41).

Cognitive behavioral therapy that includes education has been suggested as a means to block pain from entering the consciousness through the activation of the frontal limbic attention system to inhibit the transmission of pain impulses in the tertiary neurons (thalamus to cortical structures), showing that central nervous system activity changes in response to changes in thought patterns (42). It is therefore possible that adding these treatment techniques to TE can improve low back strength and resistance.

Finally, one issue to consider is the estimation of the cost that this type of intervention may entail. In this regard, a recent meta-analysis in relation to the topic determines that more economic evaluations are needed to determine a more specific cost-utility estimate. What has been observed is that intervention in this population through TE is not more cost-effective than the usual intervention (43).

Limitations

The present study has a number of limitations that should be considered. First, the study had a quasiexperimental design and a bias selection; however, the study's objective consisted of performing a nonprobabilistic sampling. It would have been interesting to assess the somatosensory variables to more conclusively analyze the relationship between these variables and self-efficacy, the physical variables, and their influence on the ability to generate MIab, especially in the kinesthetic modality.

One of the main problems we are facing is adherence to exercise. In this study, we have not evaluated the medium and long term, but a study published this year in which a similar intervention was performed showed that patients who received TEd and TE maintained the same benefits at 3 months of follow-up (44). In addition, another recent study in the same population with an intervention, such as what was described in this research, observed an improvement in disability but not pain at 6 months and 12 months of follow-up of the patients (45).

Conclusions

Based on the results, the patients with NCLBP with lesser ability to generate MIab achieved lower levels of self-efficacy and lower strength levels. The most relevant association was found between lower levels of self-efficacy and lower lumbar strength in the group with a lesser ability to generate MIab. In conclusion, a clinical TE approach, based on stabilization exercises and lumbar-pelvic motor control, in addition to a TEd program, resulted in significant improvements in the ability to generate motor imagery (both kinesthetic and visual), as well as reduced pain intensity, increased lumbar strength, reduced disability, and improved psychological variables, but no significant improvements in self-efficacy levels in the patients with NCLBP.

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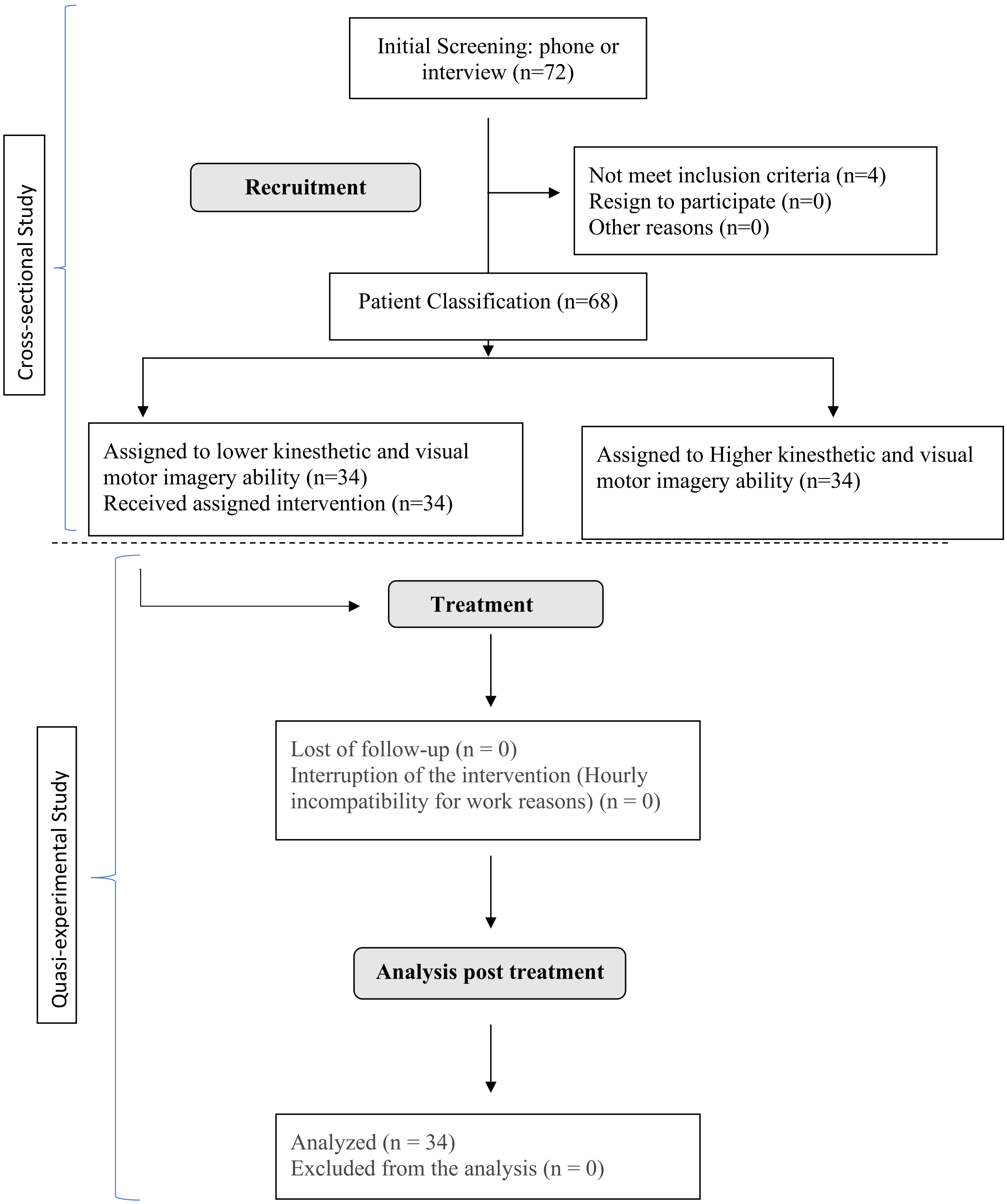
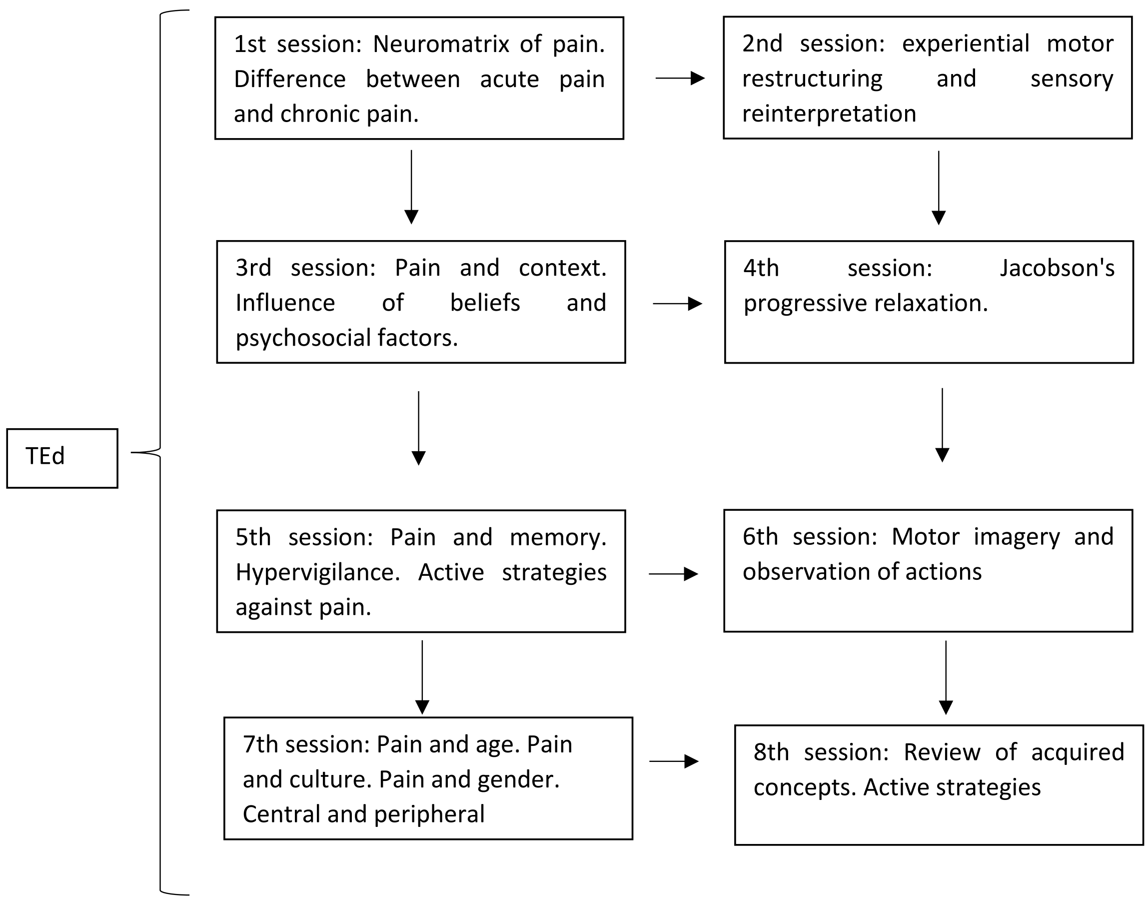
Appendix 1: Flow diagram.



Appendix 2. TEd training protocol



Appendix 3. Therapeutic Exercise Protocol