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Effectiveness of Core Stability and Diaphragmatic Breathing V/S Core Stability Alone on Pain and Function in Mechanical Non-Specific Low Back Pain Patients: A Randomised Control Trial

Shruti Shah[1], Sridhar Shirodkar[2], Medha Deo[3]

[1]Masters in Cardiovascular and Respiratory Sciences (2nd year), Lokmanya Tilak Municipal and Medical College, Sion, Mumbai
[2]Associate Professor, Terna Physiotherapy College, Nerul, Navi Mumbai
[3]Principal, Terna Physiotherapy College, Nerul, Navi Mumbai

Corresponding Author: Shruti Shah

ABSTRACT

AIM and Objective: To evaluate the effectiveness of Diaphragmatic breathing DBEx on improvement of pain and function and abdominal holding time as measured on NPRS, Modified Oswestry disability index and PBU pressure holding time.
Methodology: 46 eligible patients in age group between 35-55 years with non-specific mechanical low back pain were recruited with incidental sampling over the period of 1 year duration and randomly allocated to Core stability and Diaphragmatic breathing (DBEx)(N=23) and Core stability (N=23) treatment groups. Core stability exercises consisting 6 progressive levels were given to both the treatment groups. 5 sets of 10 repetitions of Diaphragmatic breathing (DBEx) were additionally given to Experimental group. Baseline core stability level was determined and practised for 4 weeks at home. At the end of 4th week, the progress in level was checked again and progressed further. However, post treatment data was collected at the end of 4th week for pain, function, stability level and holding time.
Results: Intergroup comparison showed highly significant statistical change for pain ($p > 0.05$) and significant for in all the aforementioned outcome measures for the experimental group.
Conclusion: The study establishes the effectiveness of home exercise based core stability and Diaphragmatic breathing exercise program in chronic low back pain patients.

Key Words: Core Stability, Diaphragmatic breathing Exercise, Mechanical Non-Specific Low Back Pain, Breathing Exercise

INTRODUCTION

Pain in the lumbar region for greater than 3 months having its source in the spinal joints, vertebrae, discs, or soft tissues classified as mechanical in origin. Non-specific low back pain is tension, soreness and/or stiffness in the lower back region for which it is not possible to identify a specific cause of the pain. [1] The most important symptoms of non-specific low back pain are pain and disability [2] LBP has a lifetime prevalence of 84%.[3] Prevalence increases and peaks between the ages of 35 and 55. [4] It has been found that individuals with a particular Respiratory disorder report higher rates of LBP and vice versa. [3]

Several authors have reported altered breathing patterns in persons with chronic, non-specific low back pain, including differences in lung capacity and diaphragm mechanics. [5,6,7] The role of diaphragm as a muscle in rehabilitation of mechanical non-specific low back pain is ignored. Traditional approaches for non-surgical treatment of chronic, non-specific low back pain have focused on exercise and manual therapy interventions, with limited evidence that this approach is slightly effective at reducing pain and increasing function. [8] Complimentary or alternative therapies such as breathing exercises may offer an additional approach to the treatment of chronic, non-specific low back pain. [9] Core stability is been promoted as a preventive regimen, as a form of rehabilitation in treatment of chronic low back pain. The transverse abdominis (TrA), multifidus, diaphragm, and the muscles of the pelvic floor have been considered as the main stabilizers of the low back. [10, 11] They play a role in postural control and are associated with eccentric deceleration or resisting momentum. The transverse abdominis (TrA) is been shown to activate before limb movement in healthy people, theoretically to stabilize the lumbar spine, whereas patients with LBP have a delayed activation of the transverse abdominis. [7]

The TrA, multifidus, muscles of the pelvic floor and diaphragm work synergistically via their contraction to provide postural and trunk stability. [6] This is done by increasing intra-abdominal pressure (IAP). [13] The diaphragm flattens during inspiration to increase intra-abdominal pressure (IAP), increase thoracic volume, and lower intra-thoracic pressure. [14] In patients with LBP, the diaphragm is limited in the ability to descend thus lacking ability to create IAP. [12,16,17] In order for intra-abdominal pressure (IAP) to be reached via contraction of the abdominal muscles, the diaphragm needs to contract prior to limb movement. [15] Ventilatory challenges on the body may cause further diaphragm dysfunction and lead to more compressive loads on the lumbar spine. [18] Thus, diaphragmatic breathing techniques may be an important part of a core stability program.

Previous studies have proved core stability and breath therapy to be effective in treatment of chronic low back pain. To our knowledge, no studies are been done to compare the effects of both these techniques on pain reduction and improvement of function. Thus, this study is done based on the hypothesis that there will be some difference in the effect of core stability v/s core stability along with diaphragmatic breathing exercise in the treatment of mechanical non-specific chronic low back pain.

PURPOSE OF STUDY:

In this study, a comparison between core stability v/s core stability along with diaphragmatic breathing exercise was done to see the effect of diaphragmatic breathing as an adjunct to conventional core stability program over a period of 4 weeks. The pre and post intervention scores of Modified Oswestry Disability Questionnaire (MODQ) scale and pre and post Pressure Biofeedback Unit (PBU) scores (TrA holds in seconds) were compared after administration of both techniques along with pre and post Numerical Pain Rating Scale (NPRS) scores to assess improvement of function and pain reduction.

AIM:

To compare effectiveness of Core stability and Diaphragmatic breathing (DBEx) vs Core stability alone on pain and function in mechanical non specific low back pain patients

OBJECTIVES:

To evaluate the effectiveness of Diaphragmatic breathing (DBEx) on improvement of pain and function and abdominal holding time as measured on NPRS, Modified Oswestry disability index and PBU pressure holding time.

OPERATIONAL DEFINITONS:

1) Mechanical Non-Specific Low Back Pain: The pain in the low back region having it's source in the vertebrae, soft tissues, or spinal joints with no anatomic causes or structural abnormalities.

2) Diaphragmatic Breathing Exercises: The Diaphragmatic Breathing Exercises are

designed to improve the efficiency of ventilation, decrease work of breathing, increase the descent or ascent of the diaphragm, and improve gas exchange and oxygenation.

MATERIALS AND METHODS

Study Design: Randomised Control Trial.
Type: Experimental study.
Hypothesis:
Null Hypothesis-There will be no difference in effectiveness between the control and interventional group.
Experimental Hypothesis-There will be a better pain reduction and improvement of function with the interventional group than the control group.
GENDER DISTRIBUTION: Both Genders

OUTCOME MEASURES: 1) Pressure Biofeedback unit by Chattanooga - LAB1044H
(Item Code: 9296)
2) Modified Oswestry Disability Questionnaire, 2001
3) Numerical Pain Rating Scale

Sample size:

Fixed Scenario Elements	
Distribution	Normal
Method	Exact
Group 1 Mean	41.27
Group 2 Mean	44.09
Standard Deviation	3.08
Number of Sides	2
Null Difference	0
Alpha	0.05

Computed N Per Group			
Index	Nominal Power	Actual Power	N Per Group
1	0.80	0.806	20
2	0.85	0.859	23
3	0.90	0.910	27

Require sample size for this study: 40
Based on the literature data, Comparison of PBU (mmHg) between pre-test and post-test in each group (Mean ±SD) i.e. For pre-test values are 41.18±1.32 in experiment group and 41.64±1.29 in control group respectively and similarly post-test values are 4.09±3.08 in experiment group and 41.27±0.90 in control group. But in control group there is no statistically significant at 5% level but it is statistically significant in experiment group. For comparison study, choose the mean value of post-test data of experiment and control group and for more variation value, literally used 5% level of significance and 80% power value then required sample size will be 20 and for comparison, both groups will consider 20 samples each i.e., 20+20=40.
Materials used: Pressure Biofeedback Unit, Consent form, Use of statistical software to calculate sample size = SAS 9.1.3. Medcal-PC software to calculate Modified Oswestry Disability Questionnaire scores, Pressure Biofeedback unit scores and Numerical Pain Rating Scale scores.

INCLUSION CRITERIA:

- Patients with chronic LBP (more than 12 weeks) with/without respiratory pathology
- Patients with chronic LBP having any respiratory pathology
- Individuals willing to participate in the study

EXCLUSION CRITERIA:

- Patients below 35 years and above 55 years
- Patients underwent any abdominal and/or thoracic surgery
- Smokers
- Traumatic LBP

✓ Control group - Core stability exercise which includes

	Progressive Limb Loading		
	A) Lift bent leg 90° hip flexion	B) Slide heel to extend knee	C) Lift straight leg to 45°
Level 1: Deep segmental muscle activation	Draw in and hold 10 seconds		
Level 2:	Opposite LE on mat ; bent leg fall out		
Level 3: A, B, or C	Opposite LE is on table		
Level 4: A, B, or C	Hold opposite LE at 90° of hip flexion with UE		
Level 5: A, B, or C	Hold opposite LE at 90° of hip flexion (no UE assistance)		
Level 6: A, B, or C	Bilateral LE movement		

- ✓ Interventional group - Core stability exercises given in the control group along with diaphragmatic exercise.

A comfortable position such as a semi Fowler's position is given.

The Therapist's hand will be placed on the rectus abdominis below the anterior costal margin and patient will be asked to breathe in slowly, deeply through the nose.

The patient will then be asked to relax, exhale slowly through mouth.

Practice this three to four times and rest.

The patient will then be asked to keep his hand below the anterior costal margin and feel the movement.

The patient's hand should rise slightly during inspiration and fall during expiration.

DURING THE TRIAL - DBE and assessing the contractions of TrA with the PBU

Fig-1 Performing Diaphragmatic Breathing Exercise

Fig-2 Accessing contractions of Tranverse Abdominus Muscle with a Pressure Biofeedback Unit

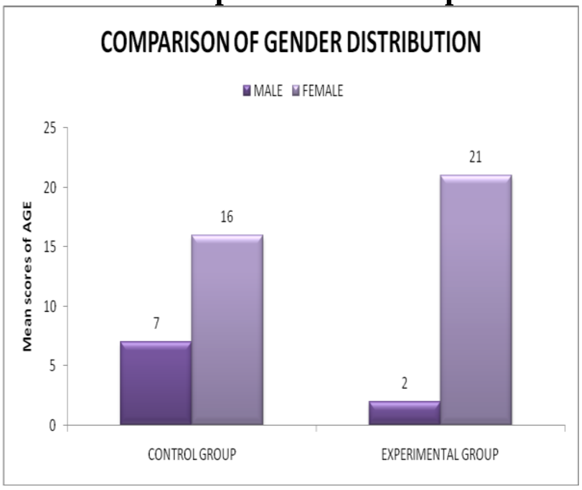
Statistical Analysis:

1) Non parametric test- Wilcoxon Test to compare pre and post values within same group for MODQ scale and NPRS. Mann Whitney test to compare post intervention scores for MODQ and NPRS scale.

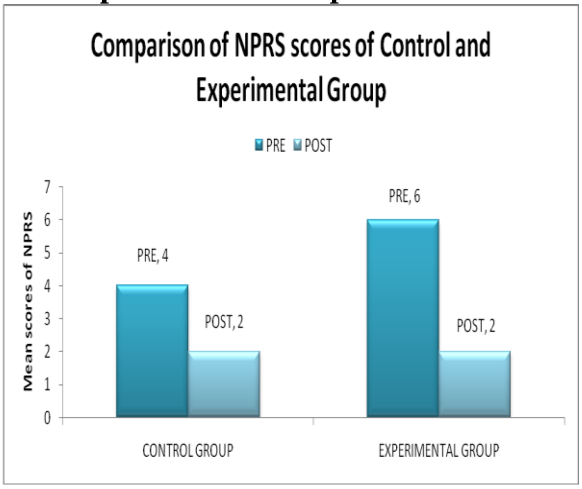
2) Parametric test- Related t test to compare pre and post values within same group for PBU scores. Unrelated t test to compare post intervention values for PBU scores

Graphs:

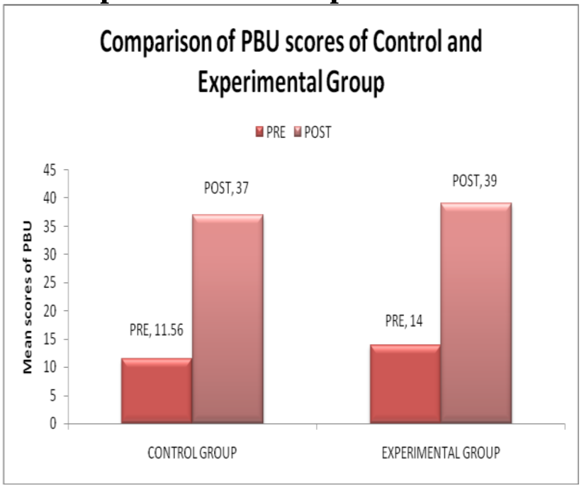
Comparison of Gender Distribution of Control and Experimental Group



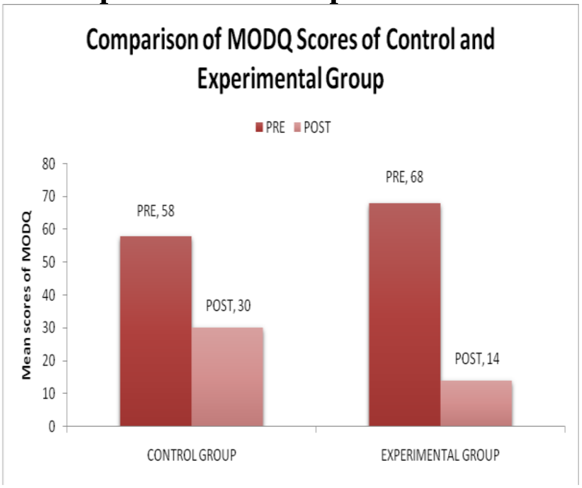
Comparison of NPRS scores of Control and Experimental Group



Comparison of PBU scores of Control and Experimental Group



Comparison of MODQ scores of Control and Experimental Group

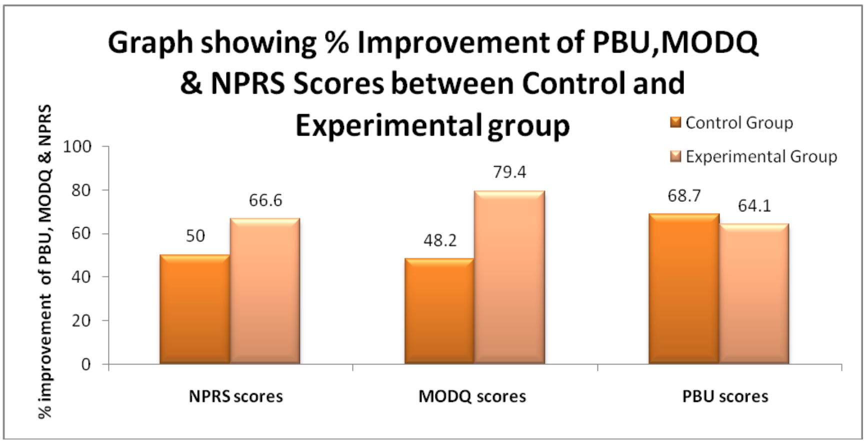


RESULT

Out of 46 individuals who participated in the study, all of them completed the study. No adverse events took place during the course of the study.

An improvement of :

Sr. No	Outcome measure	Control Group	Experimental Group
1)	NPRS(p=0.0001)	50%	66.6%
2)	MODQ (p< 0.0001)	48.2%	79.4%
3)	PBU (p< 0.0001)	68.7%	64.1%



DISCUSSION

The investigation was a randomised clinical trial conducted over 4 weeks to test the effectiveness of core stability v/s core stability along with diaphragmatic breathing exercise on subjects with mechanical non-specific chronic low back pain. The results of this investigation indicated statistically significant improvement in all outcome measures (NPRS,MODQ and PBU scores) for subjects of Group B (core stability along with diaphragmatic breathing exercise) whereas significant improvement was observed in one outcome measure (PBU scores) for subjects in Group A (core stability). The gender predominance was also noted, females being more affected with LBP than males.

The study showed that there was reduction of pain in both the groups. The result was proved to be extremely significant with a p value of 0.0001. Significant improvement was seen in the experimental group (group B) when compared with the control group (group A). The probable reasons for this pain reduction are enhanced activation of the TrA muscle leading to improved stability, protecting the spine and reducing stress impacting the lumbar vertebrae and inter-vertebral discs. Hence, regaining the function of the core as "The natural Brace in humans". Also anxiety and other emotions have been shown to have an effect for functioning of muscles. The costal fibers of diaphragm are considered aerobic and produce ATP thus fueling muscle contractions. Hence, regular exercise by chronic low back pain patients leads to an improved quality of life and positive psychological effects. Improved muscle strength of TrA by core strengthening provides stability to the spine and thus reduced pain as the spine can now withstand the stress encountered on it more effectively.

Core stability along with diaphragmatic breathing exercise has shown an improvement in the PBU scores (TrA holds in seconds). The probable hypothesis for this result would be that the core muscles also work as accessory muscles of ventilation, the muscle fibres pull ribs and costocartilage caudally in motion of exhalation. [19] By increasing intra-abdominal pressure, they force diaphragm into thoracic cage, increasing speed and volume of exhalation. [19] Tension in abdominal musculature helps decrease intra-abdominal pressure by lowering diaphragm in inspiration. [19] Without sufficient compliance, central tendon could not be stabilised and lateral chest wall expansion cannot occur. [19] Also, increase in intra-abdominal pressure by active abdominal muscles during forced exhalation pushes diaphragm cranially and exerts passive stretch on costal fibres of diaphragm. [20] These changes prepare respiratory system for next inspiration by optimising length tension relationship of muscle fibres of diaphragm. [19] During periods of ventilatory needs, increased muscle activity of abdominal muscles assist in both inhalation and exhalation. [20,21]

Significant improvement was seen in the MODQ scores of the experimental group (group B) when compared with the control group (group A). Evidence suggests that LBP may be caused by a lack of active spinal control since the spine becomes more vulnerable to loading during conditions like lifting and balancing and also due to the disc pressure being higher in these positions. There also occurs diaphragm fatigue in this population as during a lifting task, it appears that individuals with LBP may compensate for a high diaphragm position and greater fatigability, by increasing their lung volume, thereby providing an adequate increase in intra-abdominal pressure. [6] Hence, performing DBE at frequent intervals could increase intra-abdominal pressure and minimize diaphragm fatigue. Recently, Kolar et al. (2012) identified a smaller diaphragm excursion and a higher diaphragm position in individuals with LBP. Moreover, the diaphragm has a direct anatomical connection to the spine via its crural fibres. Hence, retraining the pattern of breathing by DBE. Also, it is known that an increase in intra- abdominal pressure provides ‘relative stiffness’ and thus control of the spine, which is needed during functional tasks. Interestingly, isolated diaphragm contraction, even in the absence of abdominal and back muscles activity, has been shown to contribute to spinal control by the increasing intra-abdominal pressure. This increase can be brought about by DBE.

CONCLUSION

The results of the study prove that core stability along with diaphragmatic breathing exercise is more effective for the reduction of mechanical non-specific chronic low back pain. However, both core stability and core stability along with diaphragmatic breathing exercise show an equally profound effect in a better pain reduction and improvement of function in mechanical non-specific chronic low back pain patients.

AWARDS AND PRESENTATIONS:

This article was presented at:

1. The Lokmanya Tilak Municipal Medical College and General Hospital in affiliation with MUHS - Trinity 2019, An International Medical Students Conference on 8th March 2019.
2. Secured the 3rd position in the MUHS State Level Research Conference 2017-18 (Allied Faculty) (Student Researcher)

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Appendix

Scales:
MODIFIED OSWESTRY PAIN DISABILITY INDEX
The Modified Oswestry Low Back Pain Disability Questionnaire will be used to assess patients with low back pain by determining its impact on the activities of daily living.
Questionnaire description:
• 10 sections describing the pain and its impact
• Please choose a number from 0 to 5. Higher values indicating more severe impact.

Section 1: Pain Intensity
• I can tolerate the pain I have without having to use pain killers. .... [0 points]
• The pain is bad but I manage without taking pain killers. ....[1 point]
• Pain killers give complete relief from pain. .... [2 points]
Pain killers give moderate relief from pain. .... [3 points]
• Pain killers give very little relief from pain. ....[4 points]
• Pain killers have no effect on the pain and I do not use them. .... [5 points]
Section 2: Personal Care
• I can look after myself normally without causing extra pain. .... [0 points]
• I can look after myself normally but it causes extra pain. ....[1 point]
• It is painful to look after myself and I am slow and careful. .... [2 points]
• I need some help but manage most of my personal care. .... [3 points]
• I need help every day in most aspects of self-care. .... [4 points]
• I do not get dressed/wash with difficulty and stay in bed. .... [5 points]

Section 3: Lifting
• I can lift heavy weights without extra pain. .... [0 points]
• I can lift heavy weights but it gives extra pain. .... [1 point]
• Pain prevents me from lifting heavy weights off the floor but I can manage if they are conveniently positioned for example on a table. ....[2 points]
• Pain prevents me from lifting heavy weights but I can manage light to medium weights if they are conveniently positioned. ....[3 points]
• I can lift only very light weights. .... [4 points]
• I cannot lift or carry anything at all. .... [5 points]
Section 4: Walking
• Pain does not prevent me walking any distance. .... [0 points]
• Pain prevents me walking more than 1 mile. .... [1 point]
• Pain prevents me walking more than 0.5 miles. .... [2 points]
• Pain prevents me walking more than 0.25 miles. .... [3 points]
• I can only walk using a stick or crutches. .... [4 points]
• I am in bed most of the time and have to crawl to the toilet. .... [5 points]
Section 5: Sitting
• I can sit in any chair as long as I like. .... [0 points]
• I can only sit in my favorite chair as long as I like. .... [1 point]
• Pain prevents me sitting more than 1 hour. .... [2 points]
• Pain prevents me from sitting more than 0.5 hours. .... [3 points]
• Pain prevents me from sitting more than 10 minutes. .... [4 points]
• Pain prevents me from sitting at all. .... [5 points]
Section 6: Standing
• I can stand as long as I want without extra pain. ....[0 points]
• I can stand as long as I want but it gives me extra pain. ....[1 point]
• Pain prevents me from standing for more than 1 hour ....[2 points]

• Pain prevents me from standing for more than 30 minutes. .... [3 points]
• Pain prevents me from standing for more than 10 minutes. .... [4 points]
Section 7: Sleeping
• Pain does not prevent me from sleeping well. ....[0 points]
• I can sleep well only by using tablets. .... [1 point]
• Even when I take tablets I have less than 6 hours sleep. .... [2 points]
• Even when I take tablets I have less than 4 hours sleep. .... [3 points]
• Even when I take tablets I have less than 2 hours of sleep. .... [4 points]
• Pain prevents me from sleeping at all. .... [5 points]
• Pain prevents me from standing at all. .... [5 points]
Section 8: Social Life
• My social life is normal and gives me no extra pain. .... [0 points]
• My social life is normal but increases the degree of pain. .... [1 point]
• Pain has no significant effect on my social life apart from limiting my more energetic interests such as dancing .... [2 points]
• Pain has restricted my social life and I do not go out as often. .... [3 points]
• Pain has restricted my social life to my home. .... [4 points]
• I have no social life because of pain. .... [5 points]

Section 9: Traveling
• I can travel anywhere without extra pain. .... [0 points]
• I can travel anywhere but it gives me extra pain. .... [1 point]
• Pain is bad but I manage journeys over 2 hours. .... [2 points]
• Pain restricts me to journeys of less than 1 hour. .... [3 points]
• Pain restricts me to short necessary journeys under 30 minutes. .... [4 points]
• Pain prevents me from traveling except to the doctor or hospital. .... [5 points]
Section 10: Employment/Homemaking
• My normal homemaking/job activities do not cause pain .... [0 points]
• My normal homemaking/job activities increase my pain, but I can still perform all that is required of me ....[1 point]
• I can perform most of my homemaking/job duties, but pain prevents me from performing more physically stressful activities (e.g., lifting, vacuuming)..[2 points]
• Pain prevents me from doing anything but light. .... [3 points]
• Pain prevents me from doing even light duties ....[4 points]
• Pain prevents me from performing any job or homemaking chores .... [5 points]

Total score = SUM ________(points for all 10 sections)
Disability in percent = (total score) / 50 * 100=_________
If not all of the questions are answered then disability in percent = (total score) / (5 * (number of questions answered)) * 100=______________

Interpretation:
• 0%• 0% to 20%: minimal disability: The patient can cope with most living activities. Usually no treatment is indicated apart from advice on lifting sitting and exercise.
• 21%-40%: moderate disability: The patient experiences more pain and difficulty with sitting, lifting, and standing. Travel and social life are more difficult and they may be disabled from work. Personal care, sexual activity, and sleeping are not grossly affected and the patient can usually be managed by conservative means.
• 41%-60%: severe disability: Pain remains the main problem in this group but activities of daily living are affected. These patients require a detailed investigation.
• 61%-80%: crippled: Back pain impinges on all aspects of the patient's life. Positive intervention is required.
• 81%-100%: These patients are either bed-bound or exaggerating their symptoms.

Source:
Fritz JM, Irrgang JJ. A comparison of a modified Oswestry Low Back Pain Disability Questionnaire and the Quebec Back Pain Disability Scale. *Physical Therapy*. 2001;81:776-788.
Modified by Fritz & Irrgang with permission of The Chartered Society of Physiotherapy, from
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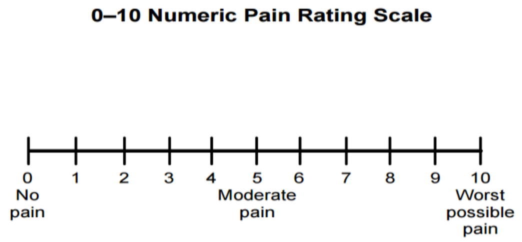
NUMERICAL PAIN RATING SCALE



Source:

McCaffery, M., & Beebe, A. (1993). Pain: Clinical Manual for Nursing Practice. Baltimore: V.V. Mosby Company.

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