International Journal of Health Sciences and Research
www.ijhsr.org ISSN: 2249-9571

*Original Research Article*

# Reduced Ventilatory Muscle Strength- A Risk Associated With Low Back Pain- A Case-Control Study

**Isha Shripad[1], Razia Nagarwala[2], Ashok K. Shyam[3], Parag K. Sancheti[4]**

[1]MPT, [2]MPT, HOD and professor,
Sancheti Institute College of Physiotherapy, Pune, Maharashtra, India.
[3]MS.Ortho, Research Officer, [4]MS.Ortho, Chairman,
Sancheti Institute for Orthopedics and Rehabilitation, Pune, Maharashtra, India.

Corresponding Author: Razia Nagarwala

## ABSTRACT

**Background:** Non-specific low back pain, which is not attributed to any recognizable cause, is the most common form of low back pain. When this pain persists, it becomes chronic and tends to develop compensatory patterns. These biomechanical alterations have shown to have an association with the respiratory system which has been documented in many studies. However, due to the dearth of literature and contrasting evidences, the present study aimed to find out an objective relationship between the presence of low back pain and reduced ventilatory muscle strength using a reliable and non-invasive technique such as MIP and MEP.

**Methods:**
Using convenient sampling technique, 60 subjects who fulfilled the inclusion criteria were recruited and were divided into two groups of 30 each. Group A included individuals with mechanical low back pain and group B included healthy individuals. Each individual was subjected for the assessment of Maximum Inspiratory Pressure (MIP) and Maximum Expiratory Pressure (MEP)

**Results:** The results were obtained using Chi-Square test for presence of low back pain and reduced ventilatory muscle strength which did not show a significant difference with $p = 0.69$ for MIP and for MEP, $p=0.67$ with $\alpha$ set at 95%.

**Conclusion:** The findings of the study suggest that the respiratory muscle strength is not affected in patients with non-specific, chronic mechanical low back pain.

***Keywords:*** mechanical low back pain, maximal inspiratory pressure, respiratory muscle strength

## INTRODUCTION

Low back pain is found to affect majority of the masses. This disabling condition has various origins. Non-specific low back pain (NSLBP) is low back pain that is not attributable to a recognizable cause or a known specific pathology. [1] Usually, Non-specific low back pain is sub-grouped into 3 categories: acute, sub acute and chronic low back pain. It is subdivide depending on the duration of low back. Low back pain lasting for more than 12 weeks is considered as chronic LBP. [2] It is a highly prevalent musculoskeletal condition and is the most common type of pain reported, with one in four adults reporting the experience of LBP in the past 3 months. [3] [4] Although it is a believed notion that most cases of acute LBP tend to resolve within a relatively short time frame, some individuals tend to develop chronic back pain. [5] Data from a systematic review revealed a percentage of individuals (44-78%) experience a relapse of LBP and some individuals (42-75%) still report LBP after 1 year. [6] Cook et al (study ongoing 2015) studied risk factors for LBP among which the most common factors were standing or walking for more than 2 hours/day, frequent lifting more than 25 lbs, female preponderance, obesity, increased driving time, manual jobs and awkward postures. All these factors are mechanical causes which put excessive demand on the back musculature.

NSLBP has many causative factors, one of them being lumbar instability. Diaphragm begins to contribute to both functions, respiratory and postural, from the first 28 days of life. These non-respiratory functions of the diaphragm emerge as postural anti-gravity role develops. This postural-respiratory function of the diaphragm is an important prerequisite for trunk stabilization followed by locomotor movement of the upper and lower extremities. [7] A systematic review identified, the deep muscle system, also traditionally termed as 'core, which includes diaphragm, the back lumbar extensors (paraspinal and multifidus) along with the abdominal (Transversus Abdominis), glutei and leg musculatures are important for spinal stabilization. The causation of low back pain can be attributed to a major role of these muscles. With inspiration, diaphragm descends caudally and flattens while maintaining its sagittal plane position. The muscle work of diaphragm is different from other muscles. [8] It is hypothesized that transverse abdominis act like a canister with the diaphragm and pelvic floor muscles. The intra-abdominal pressure increases by co-contraction of these muscles which creates an extension moment at the spine. Rotational segmental stability may be provided by multifidus. This mechanism increases spinal stability via its thoracolumbar fascial connections. [9] During any postural activity, where all other muscles involved contract eccentrically, diaphragm and pelvic floor muscles contracts concentrically. The descent of the diaphragm occurs below, pelvic floor muscles ascend above and muscles of the chest wall acting from lateral sides; all increase the intra-abdominal pressure by pressurizing the abdominal contents and thus stabilize the spine. This normal mechanism is impaired in individuals with LBP. Pathological coordination between the diaphragm, abdominals and pelvic floor shows a different picture. Such changes in the posture influence breathing profoundly. The link between breathing and posture is mainly the diaphragm. [10]

It has been observed that in chronic low back pain individuals, the paraspinal and multifidus muscle are significantly smaller than in healthy controls. There occurs abdominal muscles weakness and erector spinae hyperactivity i.e. the paraspinal muscle which cause postural malalignment such as anterior pelvic tilt and malposition of the axis of the diaphragm and pelvic floor making the axis of action oblique. This malposition does not allow for ideal postural coordination hence affecting spinal stabilization. This chronic adaptation in low back pain patients puts the diaphragm in a mechanical disadvantage. [11] Adding to this alteration, the intra-thoracic pressure generation may be affected. [12]

The change in the pressure generation can be measured using a Maximum Inspiratory and Expiratory Pressure. Maximum static inspiratory pressure that a subject can generate at the mouth (MIP) or the maximum static expiratory pressure (MEP) measurement is a simple way to measure inspiratory and expiratory muscle strength, mainly diaphragm. [13] MIP is indicative of ventilatory capacity and development of respiratory insufficiency. It is useful in assessing degree of abnormality and in monitoring inspiratory muscle weakness in an individual overtime.

To understand the different components of respiratory breathing patterns contributing to as constituents of NSLBP, this study was performed to find out whether there is an association of respiratory muscle strength with chronic non-specific low back pain using a non-invasive and clinically reliable method such as MIP and MEP measurement. The present study aimed at providing an insight regarding approach to the assessment and management of NSLBP.

## METHODS

The ethical approval was obtained from the ethics approval committee. The inclusion criteria for recruitment of subjects was age between 18-45 years both males and females those with and without chronic mechanical low back pain. "Low back pain" has been defined as pain that is not due to a specific injury and that could be classified as chronic i.e. lasting at least 3 months. Individuals with existing respiratory or cardiac disease, any spinal deformity, who have undergone spinal surgery and neural deficits and radiculopathy, were excluded from the study. Subjects were recruited according to the inclusion criteria. An informed written consent was obtained from all subjects. Using convenient sampling, 60 subjects were allocated in two groups of 30 each, group 1 without back pain (controls) and group 2 having back pain (cases). All subjects were subjected for the assessment of Maximum Inspiratory Pressure and Maximum Expiratory Pressure. Annexure – A was filled by the therapist who recorded all the parameters.

Maximum inspiratory and expiratory pressure was measured by MicroRPM™ device. The subjects were made to sit with trunk at an angle of 90 degrees to the hip and feet on the ground. Subject used the nose clip during all the manoeuvres. A nose clip and mouth piece was worn ensuring that there was no leak around the mouth piece. For MIP measurement, the subjects were asked to exhale completely and make a maximal inspiratory effort starting from residual volume (RV) and held for minimum of 1 second. For MEP, patient was asked to take a maximal deep breath in and exhale forcefully from total lung capacity (TLC) through the mouth piece. All the subjects performed three manoeuvres with effort and best of all the 3 readings was taken according to American Thoracic Society (ATS) guidelines (figure 1) [14] The data obtained from the assessment was transformed into nominal data based on the adult values of MIP and MEP for the Indian population. [15]

Data analysis was done using the Statistical Package for the Social Sciences (SPSS) version 21 software. The measurement variables were subjected to descriptive and inferential analysis. The type of data used was nominal for low back pain and respiratory muscle strength. Chi-square test was used for nominal data.

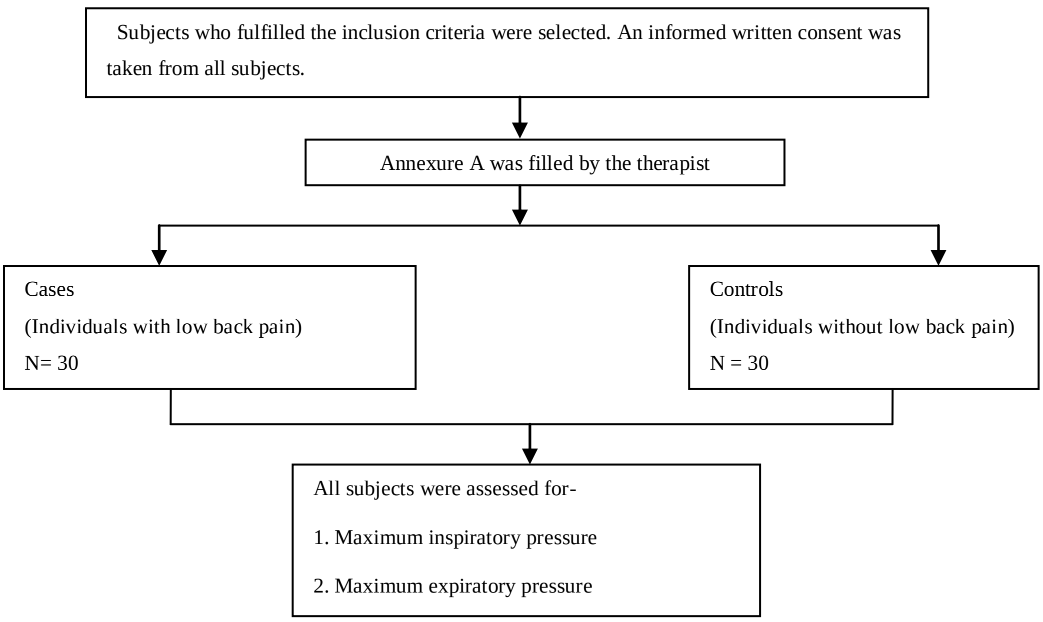


**Figure 1: STROBE flow chart**

## RESULTS

Sixty subjects were recruited for the study, in which 30 were cases (individuals with low back pain) and 30 were healthy controls (individuals without low back pain). 30 low back pain subjects (15 males and 15 females) had a mean age, height, weight of 28.26 ± 7.41 years, 162.93 ± 8.85 cms and 62.33 ± 11.34 kgs respectively. 30 healthy controls (15 males and 15 females) had a mean age, height and weight of 28.26 ± 7.43 years, 164.36 ± 9.13 cms, 64.51 ± 10.24 kgs respectively. The demographic details are presented in table 1.

**Table 1: Demographic data of controls and cases (mean ± sd)**

| Group | Age | Gender | Height | Weight |
|---|---|---|---|---|
| Controls | 28.26 ± 7.41 | M-15/F-15 | 162.93 ± 8.85 | 62.33 ± 11.34 |
| Cases | 28.26 ± 7.43 | M-15/F15 | 164.36 ± 9.13 | 64.51 ± 10.24 |

When finding association between presence of low back pain and MIP, the degree of freedom and the chi-square value was found to be $x^2$ (1) = 3.300, p = 0.69 which is not significant. (Table 2.a)

**Table 2.a: Contingency table for LBP and MIP**

| Variables | No low back pain | Low back pain |
|---|---|---|
| Normal MIP | 20 | 13 |
| Reduced MIP | 10 | 17 |

For association between presence of low back pain and MEP, the degree of freedom and chi-square $x^2$ (1) = 3.360, p = 0.67 which is not significant. (Table 2.b)

**Table 2.b: Contingency table for LBP and MEP**

| Variables | No low back pain | Low back pain |
|---|---|---|
| Normal MEP | 21 | 14 |
| Reduced MEP | 9 | 16 |

The above results proved that there is no association between presence of low back pain and reduced ventilatory muscle strength. (Table 2.c)

**Table 2.c: Table showing no association between LBP and VMS**

| | p-value | df | $\chi^2$ |
|---|---|---|---|
| MIP | 0.69 | 1 | 3.300 |
| MEP | 0.67 | 1 | 3.360 |

## DISCUSSION

"Non-specific low back pain" has been defined as pain that is not due to a specific injury and that could be classified as chronic i.e. lasting more than 3 months. It is a leading contributor to disease burden and is found to affect people of all ages. As non-specific low back pain does not have any patho-anatomical cause, treatment given is symptomatic. [2] This study aimed to whether there is an association between the presence of low back pain and reduced ventilatory muscle strength.

It was found that when the individual was made to perform a maximal inspiratory and expiratory pressure manoeuvre, the difference between the respiratory muscle pressure generation between cases and controls was not significant (table no. 2.c). These findings suggested that the strength of the respiratory muscle was not affected in individuals with low back pain as compared to healthy individuals. Due to the maximal airflow in and out of the lungs, diaphragm is always active. It is composed of both 50% slow and 50% of fast twitch fibres. The pressure generation is performed by type 1 fibres of the respiratory muscles. When performing the maximal inspiratory manoeuvre, the individual was seated with trunk erect and was made to inhale through mouth maximally and hold for 1 second for MIP and exhale forcefully for MEP. [14] This increased the intra-abdominal pressure for a brief period of time and the subjects were able to perform the manoeuvre without undue fatigue. Most of the studies performed previously have focused more on the respiratory muscle endurance than strength. The method employed in the present study focused on the strength of the diaphragm muscle.

A study was performed by Paul et al in which co-ordination between respiratory and postural functions of the diaphragm was investigated during repetitive upper limb movement in standing. [16] The present study attempted to check maximal pressure generation with one second hold. This one second hold was not enough to challenge the diaphragm till fatigue which is different from the previous study by Paul et al that emphasized on the repetitive movement causing fatigue. This might be the reason for some disagreement with the previous study done.

A study was conducted by Simon et al in which the authors found that intra-abdominal pressure was in proportion to the reactive forces from the movement increased during the period of limb movement. These results showed a sustained increase in intra-abdominal pressure due to co-activation of the diaphragm and abdominal muscles, whereas opposing activity of the diaphragm and abdominal muscles was observed during inspiration and expiration which vary the shape of the pressurized abdominal cavity. This weakening can affect the key inspiratory and expiratory muscles. [17] This suggests that the strength of the diaphragm muscle is not affected significantly by alterations in the mechanics but the endurance, that is, the holding capacity of the diaphragm gets altered due to low back pain owing to the increased demands on it. This is in agreement to the present study which did not find a significant association between VMS and LBP.

The statistical test performed was the Chi-square analysis on nominal data where absence of low back pain was referred by "0", presence of low back pain as "1" and reduced MIP and MEP values as "2" and normal MIP and MEP values as "3". When the values of MIP and MEP were converted to nominal data for the analysis, though there was an approaching significance seen, it was found that majority of the patient performed within the normative ranges described for Indian population. [18] This could be attributed to the fact that the mean value defined for every decade has large standard deviation because of which most of the individuals fell within the normal range even if their values were either upper or lower limits of the range. This could be one of the causes that no major difference was present between the maximum inspiratory and expiratory pressure generation by the diaphragm in both the groups.

In the present study, the method used for determination of MIP and MEP was a non-invasive technique. The respiratory pressure meter is a pressure gauge device. The study employed different method to measure the level of respiratory impairment we have used MicroRPM™ which measures the strength of all the respiratory muscles combined and not specific diaphragm strength, thus explaining the variation in the results. [9,17,19,20]

The limitations to the study were the duration from the onset of low back pain was not considered. Only the patients who had episodes of low back pain for more than three months were included in the study.

## CONCLUSION

From the findings of the present study, it can be concluded that despite having altered biomechanics in mechanical low back pain population, there is no significant association found between presence of low back pain and reduced ventilatory muscle strength.

## REFERENCES

1. Borenstein D. Mechanical low back pain- a rheumatologist's view. Nature Reviews Rheumatology. 2013 Nov;9(11):643.
2. Burton AK, Tillotson KM, Main CJ, Hollis S. Psychosocial predictors of outcome in acute and subchronic low back trouble. Spine (Phila Pa 1976). 1995 Mar 15;20(6):722-8.
3. Strine TW, Hootman JM. US national prevalence and correlates of low back and neck pain among adults. Arthritis Rheum. 2007; 57(4):656–665. [PubMed: 17471542]
4. Airaksinen O, Brox JI, Cedraschi C, for the COST B13 Working Group on Guidelines for Chronic Low Back Pain. Chapter 4: European guidelines for the management of chronic nonspecific low back pain. Eur Spine J. 2006; 15(suppl 2):S192–300.

5. Pengel LH, Herbert RD, Maher CG, Refshauge KM. Acute low back pain: systemic review of its prognosis. BMJ. 2003; 327:323–325. [PubMed: 12907487]
6. Hestbaek L, Leboeuf-Yde C, Manniche C. Low back pain: what is the longterm course? a review of studies of general patient populations. Eur Spine J. 2003; 12(2):149–165. [PubMed: 12709853]
7. Hemborg B, Moritz U, Löwing H. Intra-abdominal pressure and trunk muscle activity during lifting. IV. The causal factors of the intra-abdominal pressure rise. Scandinavian journal of rehabilitation medicine. 1985;17(1):25-38.
8. Hagins M, Lamberg EM. Individuals with low back pain breathe differently than healthy individuals during a lifting task. journal of orthopaedic & sports physical therapy. 2011 Mar;41(3):141-8.
9. Hodges P and Gandevia S. Activation of the human diaphragm during a repetitive postural task. J Physiol (Lond) 522: 165–175, 2000.
10. Vostatek P, Novák D, Rychnovský T, Wild J. Diaphragm postural function analysis using magnetic resonance. InProceedings of the 10th IEEE International Conference on Information Technology and Applications in Biomedicine 2010 Nov 3 (pp. 1-4). IEEE.
11. Chaitow L 2004 Breathing Pattern Disorders (BPD), motor control, and Low Back Pain Journal of Osteopathic Medicine. 7(1):33-40
12. Kolář P, Šulc J, Kynčl M, Šanda J, Čakrt O, Andel R, Kumagai K, Kobesová A. Postural function of the diaphragm in persons with and without chronic low back pain. Journal of orthopaedic & sports physical therapy. 2012 Apr;42(4):352-62.
13. Dudley F Rochester. The respiratory muscles in COPD state of the Art. Chest 1984 June;85 suppl:47-50
14. ATS/ERS Statement on Respiratory Muscle Testing, American journal of respiratory and critical care medicine 2002, Aug 15; 166(4):518-624
15. Veena Kiran Nambiar, Savita Ravindra, Maximal respiratory pressures and their correlates in normal Indian adult population, International journal of physiotherapy and research, 2015; 3(4):1188-96
16. Hemborg B, Moritz U, Löwing H. Intra-abdominal pressure and trunk muscle activity during lifting. IV. The causal factors of the intra-abdominal pressure rise. Scandinavian journal of rehabilitation medicine. 1985;17(1):25-38.
17. Hodges PW, Gandevia SC. Changes in intra-abdominal pressure during postural and respiratory activation of the human diaphragm. Journal of applied Physiology. 2000 Sep 1;89(3):967-76.
18. Dimitriadis Z, Kaprel E, Konstantinidou I, Oldham J, Strimpakos N. Test/retest reliability of maximum mouth pressure measurements with the MicroRPM in healthy volunteers. Respiratory care. 2011 un 1;56(6):776-82.
19. Janssens L, Brumagne S, McConell AK, Hermans G, Troosters T, Gayan-Ramirez G.. Greater diaphragm fatigability in individuals with recurrent low back pain . Respiratory Physiology and Neurobiology 2013 Aug 15;188(2):119-23.
20. Hodges PW, Heijnen I, Gandevia SC. Postural activity of the diaphragm is reduced in humans when respiratory demands increases. The journal of physiology, 2001 Dec;537(3):999-1008.

How to cite this article: Shripad I, Nagarwala R, Shyam AK et.al. Reduced ventilatory muscle strength- a risk associated with low back pain- a case-control study. Int J Health Sci Res. 2019; 9(12):68-73.

******