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Forced Expiratory Volume in the first second [FEV_1] in patients with chronic low back pain

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ABSTRACT

Low back pain is a common musculoskeletal complaint for people of all age and is a major health and socioeconomic problem. In chronic low back pain [cLBP], there will be weakness of trunk and abdominal muscles. These muscles play a vital role in optimizing the lung volumes and pressures as well as in maintaining the airflow. Thus cLBP patients may also have poor respiratory function. The purpose of this study is to find the alteration of pulmonary function especially the FEV_1 in patients with cLBP and the factors responsible for it. 100 patients with cLBP fulfilling the selection criteria's were recruited. Age, gender, weight, height and duration of the symptom is recorded for demographic values. Forced Expiratory Volume in the first second was measured by Spirometer [Welch Allyn – Schiller (SP-1)]. Average of 3 repetitions is documented for analysis. Correlation coefficient with $r=0.82$ [$P<0.01$] shows a positive correlation between the patient value and expected value. In this study, the 't' value of 65.0114 [$P< 0.0001$] shows that there is a statistically significant reduction in FEV_1 among the chronic LBP adult patients when compared with their expected value. Chronic low back pain patients have reduced respiratory function [FEV_1]. Core muscle dysfunction along with the pain and kinesiophobia associated with cLBP are the factors responsible for this pulmonary dysfunction.

Key words: chronic low back pain, FEV_1, lung volumes, pulmonary function, spirometry.

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INTRODUCTION

Low back pain [LBP] is a common health problem, cause more morbidity and socioeconomic loss in the community [1]. Researchers estimated about 70 – 85% of the population in United States of America [USA] is affected by low back pain atleast once in their lifetime with an annual prevalence of 15-45% [2,3]. Similarly, higher prevalence rate of back pain is documented from 2 community surveys done in Britain with the rate between 36.4% to 49.1% [4]. LBP is the most prevalent musculoskeletal disorder which affects everyone sometime in their life and also one of the primary reasons of an individual visit to a primary physician [5]. Acute LBP gradually improves and recovers completely or near completely in more than 90% of the patients. Usually with any treatment this acute pain subsides in 1 or 2 months. But the recurrence of back pain is very common affecting 40% of the patients within a period of 6 months and approximately around 10% of the patients with acute LBP develop chronic LBP [6]. Anderson GB defined chronic low back pain [cLBP] as the persisting pain for more than 3 months, stated as the reason for sick leave and it has a slow and uncertain recovery rate [3]. In people younger than 45 years, LBP is the most common cause of activity limitation [7,8]. Research evidences suggested the strong relationship between the lumbar lordosis, pelvic tilt and abdominal muscle function [9-12]. Abdominal muscle mainly the transverse abdomen is [TrA] and oblique muscle weakness leads to exaggerated lumbar lordosis and these postural changes can alter the maximal inspiratory pressure [MIP] as well as maximal expiratory pressure [MEP]. This group of muscles also plays a vital role in the stabilization of the spine and forced expiration [13].

In respiratory system, ventilation is the process by which the lung exchanges air into the blood and this is controlled by the respiratory muscles [14]. In neuromuscular weakness, the respiratory muscles fails to reach the maximal level of air flow and lung pressure [15]. Respiration provides oxygen for activities of daily living (ADL); as a result, respiratory disturbances influence patients' ADL. Therefore, respiratory problems are crucial factors in the rehabilitation and survival of stroke patients [16].

Spirometry is the most common assessment for pulmonary function and it provides information about both obstructive and restrictive lung diseases [17]. Forced Expiratory Volume in the first second [FEV_1] is the volume of air that is exhaled during the first second of the forced vital capacity [FVC] and reflects the airflow in the large airways [18]. Though the significant reduction in FEV_1 is associated with a higher mortality rate among both sexes, the documents shows that there is more association with male subjects [19,20]. We hypothesis that there will be a reduced FEV_1 in patients with chronic low back pain primarily due to the spinal instability, abdominal muscle weakness and delayed recruitment of the abdominal muscle. Pain and kinesiophobia associated with the cLBP may also contribute to the reduction of pulmonary function.

MATERIALS AND METHODS

After informing about the objective and scope, procedures, risks and benefits of the research, all participants gave their signed written consent. Participation was voluntary and withdrawal from this study was permitted at any time. Research was approved by the Ethical committee, Maharashtra Institute of Physiotherapy, Latur. All the patients underwent a standardized interview regarding their medical history, pain history, occupation, and duration of the symptoms and the data are recorded for the descriptive statistics.

Sampling Criteria [Inclusion / Exclusion]:
100 patients [Male = 50] with the mean age of 37.312 ± 9.49, suffering from low back pain for more than 3 months from the age group of 20 – 50 years are included. Both genders are included in this study. Patients with history of the known pulmonary diseases such as pulmonary fibrosis, emphysema, bronchial asthma, cardiothoracic surgery, chronic bronchitis, lung cancer were excluded. We also excluded the patients with specific cause for their back pain such as spondylolisthesis, fracture spine, due to any medical condition like tumour, pregnancy; complex conditions eg., sciatica, spinal stenosis, previous spinal surgery. Mean age, weight, height, duration of CLBP was recorded and documented for descriptive statistics [Table 2].

Evaluation

Forced Expiratory Pressure in the 1 second [FEV_1]
Forced Expiratory Volume in the first second was measured by Spiro meter [Welch Allyn – Schiller (SP-1)]. Subject was advised to sit straight in the chair with head slightly extended. Allow him to relax for a while. Apply the nose clip firmly. Breathe in maximally. Hold the mouthpiece between the teeth and then apply the lips for an airtight seal. Breathe out as hard and as fast as possible. Advise the patient to exhale out, until the lungs are empty. Repeat the procedure for 3 times and the best reading is selected. FEV_1 is the volume of the air expelled in the first second of a forced expiration [Fig. 1].

Fig. 1: Measuring FEV_1 using Welch Allyn – Schiller [SP-1] spirometer

RESULTS

SPSS version 16.0 is used for analyzing the data. Descriptive statistics were documented as mean ± standard deviation [Tab. 1]. Pearson's Correlation was used to find the correlation between the patients scored PEFR and their expected PEFR. Correlation coefficient r = 0.823 ($P<0.01$) shows that there is a strong positive correlation between patient value and expected value. The R^2 value of 0.677 defines that 67.7% explained by patient value [Tab. 2] and the scattered plot shows all the readings fall on the straight line [Fig.2]. Student 't' test is used to analyze whether the decrease in PEFR is statistically significant. Thecalculated 't' value of 65.0114 [$P< 0.0001$] shows that there is a statistically significant reduction in FEV_1 among the chronic LBP adult patients [Tab. 3].

P value and statistical significance: The two-tailed P value is less than 0.0001 By conventional criteria, this difference is considered to be extremely statistically significant.

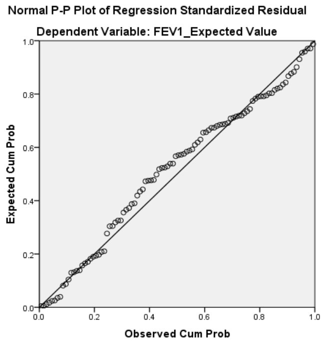

Fig. 2: Scatter plot between the expected and observed FEV_1 value.

DISCUSSION

The present study shows that patients with chronic low back pain has reduced FEV_1 and this reduction may be due to the weakness in the back flexor as well as extensor muscles, intensity of the pain and the fear of movement [Kinesiophobia]. Correlation coefficient r = 0.83(P<0.01) there is positive correlation between patient value and expected value. R^2 =0.683 means that 68.3% explained by patient value [Tab.2] and the scattered plot shows all the readings fall on the straight line [Fig.2]. About 20% of the work of breathing is done by the abdominal muscles thereby alters the pulmonary function [21].

Stabilization of the lumbar spine is partially done by the transverse abdominal muscle [22]. During respiration, the transverse abdominis muscle along with external and internal oblique muscles stabilizes the spine.TrA muscle along with the lumbar multifidus plays a major role in stabilizing the lumbar spine [23]. During inspiration, it is found that the transverse abdominis muscle activates more than the other abdominal muscles [24]. Similarly during expiration, TrA muscle has larger activity compared to the other expiratory muscles like rectus abdominis, internal and external oblique muslces [25]. In chronic low back pain there will be weakness of the core muscles, and this trunk muscle weakness will lead to impairment in respiration [26].

Lopes EA et al found that weakness of the abdominal muscle will increase the lordosis in children by altering the oblique and transverse length of the abdominal muscles, which plays an important role in stabilizing the vertebra and also in forced expiration [13]. In this study, the 't' value of 65.0114 [P< 0.0001] shows that there is a statistically significant reduction in FEV_1 among the chronic LBP adult patients which is in line with the previous study [13] among children [Tab. 3]. Previous researches done in patients with chronic neck pain showed reduced respiratory muscle strength [27] as well as changes in their blood chemistry [28]. In stroke patients, Lanini et al. observed significant decrease in maximal respiratory pressure as compared with healthy control subjects [29].

Table1: Descriptive statistics of the samples

	N	Mean ± Standard Deviation	Range [Minimum, Maximum value]
Age [years]		37.31 ± 9.490	21 , 50
Weight [kg]		65.19 ± 9.066	45 , 85
Height [cms]	100	160.55± 4.706	150 , 172
Duration of LBP [months]		6.42 ± 2.790	3 , 15

Table 2: Pearson correlation between the patient and expected value with r value.

Correlations		Patient Value	Expected Value	R value	R^2 value	Std error of the estimate
Patient Value	Pearson Correlation	1	.823			
	Sig.(2-tailed)	-	.000			
Expected Value	Pearson Correlation	.823	1			
	Sig.(2-tailed)	.000	-	0.823	0.677	0.19862

Predictors: (Constant): FEV_1 Patient value. Dependent Variables: FEV_1 Expected value.
Correlation coefficient with r=0.82 [P<0.01] shows a positive correlation between the patient value and expected value. R^2 =0.673 means that 67.3 %explained by patient value.

Table 3: Student 't' test between the patient and expected value with r value.

	Patient Value Mean ± SD	Expected Value Mean ± SD	t value	Degree of freedom	Standard error of difference
FEV_1	2.0290±0.2600	3.3246±0.3475	**65.0114**	99	0.020

Weakness of the respiratory muscle and the postural trunk dysfunction may be the cause for this reduced pulmonary function [30].

Pulmonary dysfunction measured by FEV_1 in this present study in cLBP patients is associated with the core muscle weakness, pain and kinesiophobia. Muscle imbalance and the spinal instability due to the Weakness of core muscles especially transverse abdominis and multifidus directly affects the respiratory function [31,32]. Biomechanically these muscles has 2 main respiratory effects, firstly it pulls the rib cage along the margins and secondly it increases the intra-abdominal pressure [32,33]. Failure in these mechanisms alters its ability to generate effective respiratory force, which ends in permanent pulmonary dysfunction due to the plasticity of the tissue [34]. Respiratory muscle weakness also compromises the maximal airflow to inflate the lungs, thus ends in poor performance on expiration [35]. Pain and kinesiophobia may also indirectly inhibit pulmonary function. Pain may change the motor control pattern by limiting the activity of the muscle whereas kinesiophobia may avoid movement in low back during activities [36]. Bruton A stated though these two factors may not contribute to optimal reduction in maximum force production, but in prolonged duration ends in permanent pulmonary dysfunction due to plastic muscle adaptations [34].

Zacharias D et al studied the pulmonary function in patients with chronic neck pain and found a statistically significant reduction in vital capacity, expiratory reserve volume and maximum voluntary ventilation, but the peak expiratory flow, FEV_1 and FEV_1/ FVC ratio were not affected. They also found a significant correlation between the strength of the neck muscle, pain intensity and kinesiophobia with respiratory function [37].

Pulmonary dysfunction in cLBP patients should be considered with clinical importance. Though this reduction is not sufficient to label the patients as having respiratory dysfunction, neuromuscular weakness shows the pattern of restrictive diseases on spirometric analysis. De Troyer A et al in their study about the analysis of lung volume restriction in patients with respiratory muscle weakness concluded that long term decrease in the lung flow and volumes may result in lung tissue pathology, pathomechanical changes in the vertebras and stiffness of the rib cage, which may end with the development of restrictive lung disease pattern [36]. This opens the way for the research study about the neuro-anatomical relation of the spine, its muscle and pulmonary function as well as the biomechanics related with it. Though literature review shows interventions like deep abdominal muscle training [22], abdominal drawing in maneuver [38], abdominal muscle stimulation [39] and inspiratory muscle training [40] were shown to have positive effects such as improvement in pulmonary function, lumbar stabilization program is widely used in clinical practice with abdominal muscle stimulation. The results of this study warrant the need of randomized control trials or case studies to identify the effective intervention to improve the respiratory function also in patients with cLBP.

CONCLUSION

Reduction is pulmonary function [FEV_1] is recorded in patients with chronic low back pain and this shows a similar pattern of restrictive lung disease due to neuromuscular weakness. We believe that this dysfunction is primarily due to the core muscle dysfunction and secondarily due to the pain and kinesiophobia associated with cLBP.

Ethical Approval: This study was approved by the ethical committee and research department of the Maharashtra Institute of Physiotherapy, Latur, India.

Conflict of Interest: There is no funding agency / research support / conflict of interest for this study.

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