Review Article: Altered Respiratory Function in Patients With Low Back Pain: A Review Article

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ABSTRACT

Introduction: Low Back Pain (LBP) is a major musculoskeletal complaint and a multidimensional problem. This study aimed to answer whether patients with LBP have an altered pattern or a reduced rate of respiration compared to healthy people.

Materials and Methods: Two reviewers searched the PubMed, ScienceDirect, and Google Scholar databases from 2000 to 2020 using the search terms "low back pain" OR "low backache" OR "lumbago" AND "breath" OR "respiration". The methodological quality of articles generated by the search was appraised using the modified version of the Newcastle-Ottawa scale.

Results: A total of 7 studies were selected for the final review, with two examining respiratory parameters, one investigating the effects of cognitive tasks on respiratory function, two determining the impact of performing a task on respiratory function, and two observing breathing patterns during different tasks.

Conclusion: Respiratory function is sub-optimal in chronic patients with LBP. Thus, respiratory rehabilitation is crucial to managing LBP problems.

Keywords: Low back pain, Lumbago, Low backache, Breath, Respiration

1. Introduction

Low Back Pain (LBP) is a common musculoskeletal problem in the health system [1, 2], with a prevalence of about 23%. It reduces the quality of life, causes disability, and incurs high socio-economic costs [3]. LBP is a multidimensional problem [4] with several etiopathogeneses. It may not be considered just as a musculoskeletal disorder [5]. A sign of disability in patients with Chronic Low Back Pain (CLBP) is respiratory dysfunction and its various parameters [6, 7]. Patients with respiratory disorders are more likely to have LBP [8]. LBP is directly associated with respiratory diseases, obesity, and physical activity impairment, and among them, it has the most substantial relationship with respiratory disorders [6].

In humans, the primary muscle contributing to inspiration is the diaphragm [9]. The trunk is mainly controlled

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by the activity of the transverse abdominis and multifidus muscles. Additionally, the diaphragm, with its attachment to the lumbar [10], plays a significant role in trunk stability [9]. It has been argued that , increased demand on one of its functions (an inspiratory loading task) will complicates its contribution to the other function [11]. In healthy individuals, the diaphragm performs respiration and trunk control functions properly, even when there is a problem in trunk control [12]. In other words, in the absence of disease, diaphragm and the transverse abdominis participate in partial stabilization of lumbar and breathing patterns [13]. However, when pain is felt, the Central Nervous System (CNS) uses altered strategies to control trunk muscles [14]. Studies have shown that LBP patients are more susceptible to diaphragm fatigue compared to healthy controls [15]. Dysfunction of the diaphragm as the primary respiratory muscle causes breathing pattern disorders [16]. Studies have shown that 50% to 60% of CLBP patients lack a proper breathing pattern during the trunk stability test [17]. An improper breathing pattern is defined as a condition in which breathing is shallow and rapid [18]. When changes in respiratory patterns become chronic, symptoms such as dyspnea, breathlessness during exercise, and hyperventilation may develop [18, 19]. This study aimed to review changes in the respiration rate or pattern among LBP patients.

2. Materials and Methods

The study intended to review studies performed on respiratory function in LBP patients. To this end, two reviewers independently searched the PubMed, ScienceDirect, Google Scholar databases from 2000 to 2020 using the search terms "low back pain" OR "low backache" OR "lumbago" AND "breath" OR "respiration". Relevant studies written in English were included, and conference papers and abstracts were eliminated. Studies investigating respiratory muscles only with magnetic resonance imaging, electromyography, and ultrasonography were also eliminated because these tests are not functional or clinical tests in the field of respiration.

Quality assessment

Two reviewers assessed the quality of the included articles with the Newcastle-Ottawa Scale (NOS) [20]. This methodological tool is used to appraise observational studies and is based on selection, comparability, and outcome or exposure. The modified version of the NOS was used according to the purposes of the research [21]. A total score of 3 or less signifies low-, 4-6 moderate-, and 7-10 high-quality studies [22].

3. Results

Data extraction

The abstracts of 769 potentially relevant studies were assessed for eligibility. Finally, 7 articles were identified that investigated respiratory parameters in LBP patients [17, 23-28]. Figure 1 shows the search flow diagram for the selection process of the included studies.

General characteristics of the studies

Among the 7 included articles, 2 examined respiratory parameters between healthy individuals and LBP patients, 1 investigated the effects of cognitive task on respiratory function and made a comparison between healthy individuals and LBP patients, 2 determined the effects of performing a task on the Vital Capacity (VC) in LBP patients, and 2 observed breathing patterns in LBP patients during different tasks. Table 1 provides summaries of these studies. Table 2 gives an analysis of the quality assessment analysis.

1. The inclusion/exclusion criteria were well defined.

2. Consecutive or obvious representative series of patients (e.g. random sample) were observed.

3. Both groups of patients and controls were selected from the same community.

4. The control group was considered "healthy" without a history of LBP in the previous 6 months.

5. The patient and control groups were adequately matched for age and gender.

6. The patient and control groups were adequately matched for another factor.

7. The measure of respiratory function had been documented as reliable.

8. The measure of respiratory function had been documented as valid.

9. The sample size was justified, or sample size calculation had been described.

10. The statistical analysis was clearly defined and was appropriate.

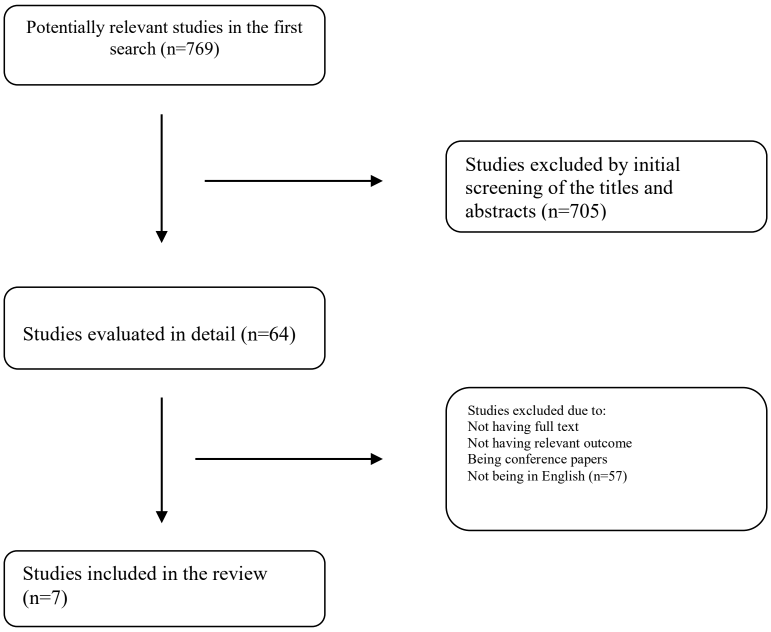

Figure 1. The flowchart for the study selection process

4. Discussion

The present study reviewed changes in the respiration rate or pattern among LBP patients. The NOS was used to evaluate the methodological quality of the selected studies and yielded scores between 4 and 9. From the quality assessment, five and two studies were ranked as having "high" and "moderate" quality, respectively.

There are two types of muscles in the spine: local and global muscles. Local muscles originate from the vertebral column and thus provide stabilization. The co-contraction of these muscles with increasing the Intra-Abdominal Pressure (IAP) creates extension moments and spinal stabilization, especially by attaching to the thoracolumbar fascia. In other words, IAP is produced by the abdominal, diaphragm, and pelvic floor muscle contraction [29].

Large muscles that make up the global muscle system are not directly connected to the vertebrae, and the contraction of these muscles produces movement [29, 30]. If deep intrinsic (local) spinal muscles cannot control the segmental motion, there are other ways to compensate for it. First, the movement of the lumbar spine and pelvis may be uncontrolled. Second, the global muscle system is activated, resulting in an approximate rather than a precise control in the lumbopelvic region. Third, the diaphragm works to provide stability, which can have a negative effect on respiration as its other function that leads to respiratory disorders, such as decreased diaphragmatic movements [31].

The diaphragm accounts for about 70% to 80% of inspiration during quiet breathing. It is a circular set of muscle fibers that comes from the sternum, costal cartilages, ribs, and vertebral bodies [32]. Recent evidence confirms that CNS coordinates the activities of different parts, including the diaphragm that has two functions (respiratory and motor control). The diaphragm performs the functions properly in healthy people [12, 33]. It has been shown that when one performs activities such as weight-bearing or weight-lifting activities, spinal bracing and transdiaphragmatic pressure are elevated [34, 35]. At the same time, IAP increases and intrapleural pressure decreases, and both the anterior and posterior parts contract in the diaphragm [36]. However, these coordinated tasks do not occur in people with LBP or have many changes [37]. Studies show that the respiratory pattern of LBP patients has changed, and these changes are significant, which is not surprising considering the role of the diaphragm in the trunk motor control [17]. Hodges and Grimston stated that an altered respiratory pattern might act as a perturbation to the postural control system in CLBP patients [38]. Researchers and clinicians, therefore, suggest that examining breathing patterns in LBP patients can be helpful, especially if it is done by challenging the motor control at the same time.

The reason is that increasing the diaphragm mobility and holding the breath are bodily strategies to increase stability in the trunk region [23]. Chest and abdominal movements indicate the involvement of the intercostal muscles and the diaphragm during respiration [39]. Costo-diaphragmatic breathing is considered a normal pat-

Table 1. Details of the included studies

Study	Study Objective	Sample	Outcome Measure	Measurement Tool	Result
Supriya G. Shah et al. (2019) [23]	Comparison of respiratory function of healthy and subjects with chronic low back pain (CLBP)	Fourteen participants with CLBP and 14 healthy individuals	Maximal voluntary ventilation (MVV) and end-tidal carbon dioxide (pressure of end-tidal CO2 [PetCO2])	Scenography and spirometry	The mean value of MVV was found to be lower, PetCO2 and respiratory rate were found to be higher in the CLBP group.
Vikram Mohan MPT et al. (2017) [24]	Investigating alterations in respiratory parameters among NSLBP (non-specific low back pain) and healthy participants	Thirty-four patients with NSLBP were matched with34 healthy subjects	Breathing patterns, chest mobility, MVV, maximal expiratory and inspiratory pressure, diaphragmatic mobility, lumbopelvic stability	Total faulty breathing scale, spirometer, respiratory pressure meter, ultrasound imaging, and pressure biofeedback	The results showed faulty breathing, reduced diaphragmatic mobility, respiratory muscle endurance, and chest expansion in the NSLBP group, but respiratory muscle strength and core stability were not significant.
Babak Goosheh et al. (2016) [25]	Comparison of the effect of performance of a cognitive task on the respiratory function between LBP subjects and healthy group	Twenty-four patients with low back pain (LBP) and 24 healthy participants	Inspiratory time, expiratory time, total respiratory cycle time inspiratory time to total respiratory cycle time ratio minute volume, tidal volume, respiratory rate, end-tidal PCO2, vital capacity (VC), resting tidal volume	Scenography and spirometry, custom made software	Possible differences of LBP patients and healthy group may not be elicited under simple non-physically demanding postural conditions.
Eric M. Lamberg et al. (2012) [26]	To determine the effects of low back pain on natural breath control during a lowering task	Thirty-two LBP individual and 30 healthy participants	VC	Silicone facemask	VC and the amount of inspired volume for LBP patients during the lowering task increased compared to those in the NLBP (non-low back pain) group
Marshall Hagins et al. (2011) [27]	To find if, during a lifting task, LBP patients breathe differently than age-matched controls	Thirty-two LBP individuals and 30 healthy participants	Breathing pattern at rest and during clinical motor control tasks	Silicone face mask, the Oswestry low back pain disability questionnaire, the Baecke physical activity questionnaire	LBP patients performed the lifting task with more volume in their lungs. Age significantly affected %VC used during the lift.
Priyanka P. Ostwal et al. (2014) [28]	Observing the breathing pattern of LBP patients both at rest and during motor control tasks	One hundred and fifty patients with LBP (they were subcategorized into acute, sub-acute, and chronic LBP patients)	Breathing pattern at rest and during clinical motor control tasks	Breathing patterns were evaluated by a therapist both visually and via palpation	There were no significant differences at rest, but findings indicated altered breathing pattern in patients with LBP (irrespective of their stage of disease) during motor control tasks
Nathalie Roussel et al. (2009) [17]	Comparison of the breathing pattern in CNSLBP and healthy subjects, both at rest and during motor control tests	Ten healthy individuals and 10 patients with chronic LBP	Breathing pattern at rest and during clinical motor control tasks	Visual inspection and manual palpation, visual analog scales	The results showed that the CNSLBP group had altered breathing patterns during performances, which are not related to pain severity.

Table 2. The NOS scoring of the included studies

Study	Patient Definition[1]	Representativeness of Patient[2]	Selection of Controls[3]	Definition of Controls[4]	Age and Gender[5]	Work and Demand[6]	Reliability of Outcome Measure[7]	Validity of OutcomeMeasure[8]	Sample Size[9]	Statistical Method[10]	Total Score
Supriya G. Shah et al. (2019) [23]	1	0	1	1	0	1	1	1	0	1	7 of 10
Vikram Mohan MPT et al. (2017) [24]	1	0	1	1	1	1	1	1	1	1	9 of 10
Babak Goosheh et al. (2016) [25]	1	1	0	1	1	1	1	1	0	1	9 of 10
Eric M. Lamberg et al. (2012) [26]	1	0	1	1	1	1	1	1	0	1	8 of 10
M. Hagins et al. (2011) [27]	1	0	1	1	1	1	1	1	1	1	9 of 10
Priyanka P. Ostwal et al. (2014) [28]	1	1	0	0	0	0	1	1	0	0	4 of 10
Nathalie Roussel et al. (2009) [17]	1	0	0	1	0	0	1	1	0	1	5 of 10

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tern [40, 41] because, in this type of breathing, the lungs expand to the maximum volume, and gas exchange is maximal.

Abnormal breathing patterns include paradoxical breathing, upper costal breathing, mixed breathing, and breath-holding [42], as they may prevent sufficient alveolar ventilation [43]. Altered respiratory patterns have a negative effect on nutrition and the subsequent mechanical behavior of the intervertebral disks through the impact of breathing on intradiscal pressure. Thus, correction is essential for LBP patients who have damaged intervertebral disks [17, 44, 45].

Postural alignment is not correct in most LBP patients, and the flexed spine limits chest expansion and rib excursion [46].

Studies show that respiratory muscles in LBP patients have changes that affect the amount of force produced by them. This condition causes respiratory weakness, respiratory pump dysfunction, and consequently, Maximal voluntary ventilation, which results in reduced muscular endurance and strength in LBP patients [23, 47].

The two most significant synergist muscles for trunk stabilization are the diaphragm and the transverse abdominis that do not work appropriately in CLBP patients. The altered function of the thoracolumbar fascia limits the activity of these muscles and, ultimately, changes the respiratory capacity [10]. Increases in the inspired volume are related to increases in IAP [48, 49], which, in turn, leads to increases in lumbar stability [50, 51]. Thus, respiration above and below tidal volume increases the stiffness of the lumbar spine [50]. Studies have shown that LBP patients have many compensatory strategies. One such strategy is to raise vital capacity against mechanical challenges faced by them [27]. Diaphragmatic mobility is not sufficient in patients with Non-Specific Low Back Pain (NSLBP) because of the reduced strength of the respiratory muscles, which can associate with decreased IAP. This condition becomes especially critical when one cannot generate sufficient IAP, which increases the risk of NSLBP [24, 52].

Recently, it has been identified that the diaphragm is more prone to tiredness in LBP patients. This condition can change other muscles' role in the spine's stability and increase the risk of LBP recurrence [15]. Improving the respiratory function is as important as correcting the posture, joint play, or increasing the endurance of the lumbar extensor [46]. Thus, correct breathing exercises, back strengthening exercises, basic stretching exercises, relaxation techniques, and ergonomic advice can be used to treat LBP complications [28].

5. Conclusion

A review of the related literature indicated a direct association between respiratory disorders and LBP due to the sub-optimal respiratory function in LBP patients. Some researchers even believe that respiratory rehabilitation is crucial to improve LBP. According to these researchers, education and respiratory exercises can improve respiratory parameters such as respiratory muscle endurance, diaphragm mobility, and chest expansion and correction of faulty breathing patterns.

Ethical Considerations

Compliance with ethical guidelines

All ethical principles are considered in this article. The participants were informed of the purpose of the research and its implementation stages.

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Authors' contributions

Conceptualization, Writing – original draft, and Supervision; Zahra Abdollahzadeh; Writing – review & editing, Data collection, and Data analysis: Zahra Abdollahzade and Hanieh Abbasi.

Conflict of interest

The authors declared no conflicts of interest.

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