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Evaluation of the relationship between respiratory muscle strength and disability due to low back pain, fatigue and cardiorespiratory fitness in individuals with chronic low back pain

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ABSTRACT

Aims: It has been suggested that the incidence of low back pain is higher in individuals with respiratory disorders compared to healthy individuals. In this study, it was aimed to calculate the relationship between respiratory muscle strength and low back pain-related disability, fatigue and cardiorespiratory fitness in individuals with chronic low back pain.

Methods: The study included 36 individuals (21F, 15M, 46.61±10.19) aged 18-65 years with low back pain. Respiratory muscle strength was measured with Pocket-Spiro MPM100 device. Disability due to low back pain was assessed by Oswestry Function Questionnaire and fatigue was assessed by fatigue severity scale. For cardiorespiratory fitness, a 6-minute walk test was performed.

Results: No significant correlation was found between maximum inspiratory pressure (MIP) and maximum expiratory pressure (MEP) values and disability status due to low back pain and fatigue ($p>0.05$). There was a significant, positive and moderate correlation between MIP and MEP values and 6 minute walk test ($p<0.05$).

Conclusion: The number of studies in the literature investigating the relationship between low back pain and respiration is limited and no general consensus has been reached. The generally accepted view is that inadequate functioning of the diaphragm may lead to impaired intra-abdominal pressure modulation, which may reduce spinal stabilisation and increase low back pain. However, no data confirming a direct relationship between respiratory muscle strength and low back pain were found in this study. More comprehensive studies are needed in this field.

Keywords: Low back pain, respiratory muscle strength, fatigue

INTRODUCTION

Low back pain is a pain that starts from the bottom of the costal region to the upper part of the gluteal lines and can be characterized by tension, stiffness and localized pain in the muscles, with or without the pain reflected in the leg.[1] It is one of the most common musculoskeletal diseases, with a prevalence reaching 80% worldwide, that restricts the social life of individuals by causing difficulty in performing daily vital activities. Its effects are not just physical; It also negatively affects individuals psychologically.[2,3] Ignoring low back pain negatively affects individuals' integration into society, living standards and financial well-being.

An important topic focused on in the etiology of low back pain is trunk stabilization. The muscles responsible for maintaining trunk stabilization are core stabilization muscles. Core stabilization system; It includes the trunk and pelvic muscles, which are responsible for ensuring the stability of the pelvis and spinal colon and facilitate the transfer of energy from large parts of the body to small parts during many activities.[4] However, these muscles do not work alone; they play a role in providing stabilization as active systems. There are two sub-systems, local and global. The local system includes the transversus abdominus, multifidus, quadratus lumborum, diaphragm and pelvic floor muscles whose origo and insertion are located in the vertebrae and is responsible for coordinated movement of body segments, control of the cavity in the lumbar region and stabilisation in

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the lateral and sagittal planes. The global system is responsible for the transmission of force from the pelvis and thoracic cage to the arms and legs. The global system includes the erector spinae, psoas major, rectus abdominus and external oblique muscles, which have large cross-sectional areas and long moment arms.[4-6] The diaphragm muscle, which is one of the muscles in the local system, has the anatomical role of separating two major cavities within our body, while its primary physiological function is respiration. However, as mentioned above, the diaphragm also plays a role in spinal stabilization. The diaphragm, which plays a role in trunk stabilization especially during postural activities, performs this function by adjusting intra-abdominal pressure.[5,7,8] The diaphragm, which originates from the L1-L3 vertebrae, is also in relationship with the lumbar region in terms of its origin region. Although the correct breathing pattern is always important for us, correct breathing while in motion is more important to ensure the continuity of stability in the spine. If the diaphragm does not function adequately and does not work symmetrically, a problem occurs in the intra-abdominal pressure required for stabilization, and to compensate for this, the workload of the lumbar region muscles increases. In other words, these differences in the course of decrease in diaphragm activation cause increased muscular activation of the paraspinal muscles in the lumbar region, resulting in regional spasm and an increase in low back pain.[7-9] Decreased spinal proprioception is mentioned in individuals with inadequate inspiratory muscle function.[10,11]

In this study, we aimed to determine the relationship between respiratory muscle strength, low back pain-related disability, fatigue and cardiorespiratory fitness in individuals with chronic low back pain.

METHODS

A total of 36 individuals with low back pain, 21 women and 15 men with an average age of 46.61 between the ages of 18-65, were included in our study. The inclusion criteria were to be diagnosed with chronic low back pain, to be in the appropriate age range, not to have undergone surgical operation in the last 6 months, not to have undergone surgical operation in the lumbar region, not to be pregnant, not to have orthopedic problems that may prevent the 6-min walk test, not to have cognitive and mental problems that may prevent the study, and to volunteer to participate in the study.

Ethics committee approval for our study was received by Kırıkkale University Non-interventional Clinical Researches Ethics Committee on 21.12.2022 with decision number 2022.12.04. Participants were asked to read the case information form first. Afterwards, approval to participate in the study was obtained and they were included in the study. All evaluations were made in accordance with the principles of the Declaration of Helsinki and ethical committees.

The evaluation started by obtaining demographic information. In the demographic information section, age, occupation, education level, height, weight, BMI, cigarette and alcohol use, medication and assistive device use, and comorbidities were noted. The age of onset of individuals' back pain, the type of back pain, and the duration of back pain recurrences were also recorded.

Respiratory muscle strength measurement was made using the Pocket-Spiro MPM device. This device is an electronic oral pressure measuring device. This method is a non-invasive evaluation method frequently preferred in clinics to measure respiratory muscle strength. Maximal inspiratory pressure (MIP) and maximal expiratory pressure (MEP) values were measured for respiratory muscle forces. MIP refers to the maximum voluntary inspiratory pressure against a closed airway. MIP measurement was performed while the patients were in a sitting position, and firstly, the patients were asked to perform maximum expiration. Then, the airway was closed with the help of a valve and the patients were asked to take maximum inspiration and maintain this for 1-3 seconds. MEP refers to the maximum pressure required to empty the alveoli of the total lung capacity. MEP measurement was also performed while the patients were in a sitting position. Patients were first asked to take maximum inspiration and then to make maximal expiration against the closed airway for 1-3 seconds. Measurements were repeated at least 3 times. The highest value was recorded care was taken to ensure that there was no difference of more than 10% between the two highest values.[12]

Oswestry disability index (ODI) was used to determine disability due to low back pain. This index was created to determine the functional disability caused by low back pain in individuals. It consists of 10 questions in total and each question has 6 options. The severity of pain, lifting weights, sitting, standing, walking, sleeping, personal care, travel, social life and the degree of change in pain are questioned. During the calculation, the options in each question are calculated based on the answered questions by giving a value between 0-5 points. The score the patient receives is divided by the maximum possible score and multiplied by 100. The maximum possible score for the patient who answers all questions is 50. A deduction of 5 points applied for each unanswered question. Interpretation is made according to the resulting percentage value. 0%-20% low back pain does not cause a significant problem in the patient's life, 20%-40% it slightly restricts daily life, 40%-60% severely restricts daily life, 60%-80% completely restricts daily life, 80%-100%. It is interpreted that he is bedridden or that the symptoms are exaggerated.[13]

6-minute walk test was used to assess cardiorespiratory fitness. The 6-minute walk test is an easy-to-apply physical performance test that reflects functional capacity and can be applied by trained individuals. The test was carried out in a closed area at a distance of 30 meters. People were asked to walk quickly without running. Encouraging suggestions were given in 1-minute intervals. Rest was allowed during the test. The test result was recorded in meters. Average values for healthy individuals are between 400-700 meters.[14,15]

Fatigue severity scale-FSS, whose Turkish validity and reliability have been established, was used to evaluate fatigue. This scale is used to measure the fatigue experienced by people in the last week, including the current day. The scale, consisting of a total of 9 items, questions the effect of fatigue on activities such as motivation, physical function, exercise and social life. Individuals are asked to give a score between 0-7 for each option. In the calculation part, all points are added and divided by 9. If the result is less than 2.8, there is no fatigue; if it is greater than 6.1, it is interpreted as chronic fatigue syndrome.[16]

Analysis of all data obtained was made using IBM SPSS 23.0 program. Mean standard deviation and median values were used to indicate continuous data, and number and percentage values are used to indicate discrete data. The

Shapiro Wilks test was used to examine whether the data showed normal distribution. Relationships between scales were analyzed with Spearman correlation coefficient. P<0.05 was accepted as the limit of statistical significance.

RESULTS

In this study, the relationship between respiratory muscle strength and the oswestry disability index, 6-minute walk test and fatigue severity scale was examined. The average age of the patients participating in the study was 46.61±10.19 years, their average height was 168.22±11.18 cm, their weight was 78.61±14.52 kg, and their body mass index was 27.89±5.25 kg\m². The demographic information of the participants is shown in Table 1.

Table 1. Demographic structure of individuals with chronic low back pain and their knowledge about low back pain

Variables		Mean ± SD/ %
Age(year)		46.61 ± 10.19
Height(cm)		168.22 ± 11.18
Weight (kg)		78.61 ± 14.52
Body mass indeks (kg/m2)		27.89 ± 5.25
Participant gender	Women	21 (58.3%)
	Man	15 (41.7%)
Participant's smoking use case	Unavailable	25 (69.4%)
	Available	11 (30.6%)
Participant's alcohol use case	Unavailable	31 (86.1%)
	Available	5 (13.9%)
Age at which low back pain complaints begin		36.97 ± 11.93
Description of low back pain	Local	19 (52.8%)
	Pain referred to the leg	15 (41.7%)
	Reflected in the leg + tingling, numbness	2 (5.6%)
	None	0 (0%)
Frequency of participant's low back pain constant		5 (13.9%)
	1-2 times week	2 (5.6%)
	1-2 times a month	11 (30.6%)
	every 2-3 months	5 (13.9%)
	Every 6 months	9 (25%)
	1 time per year	4 (11.1%)
	No back pain	0 (0%)

Maximum inspiratory pressure (MIP) and maximum expiratory pressure (MEP), Oswestry disability index, fatigue severity scale and 6-minute walk test results are shown in Table 2.

Table 2. MIP, MEP, oswesrty disability index, fatigue severity scale and 6 minute walk test results for chronic low back pain

Variables	Mean ± SD
MIP	78.36 ±18.92
MEP	115.33 ± 35.5
Oswesrty Scale	16.52 ±17.85
FSS	3.54 ±1.64
6 min. walk test	549.74 ±97.72

MIP average result is 78.36 cm H_2O, MEP average result is 115.33 cm H_2O, Oswestry scale average result is 16.52, FSS average result is 3.54, 6-minute walk test average result is 549.74 m.

No significant correlation was found between MIP result and age (p>0.05), but a significant, negative, moderate correlation was found between MEP value and age (p<0.05). No correlation was found between MIP and MEP values and BMI (p>0.05). There was a statistically significant, negative and weak correlation between MEP and age at onset of low back pain (p<0.05). It was observed that low back pain frequency values did not have a statistically significant relationship with MIP and MEP examinations (p>0.05) (Table 3).

Table 3. The relationship between respiratory muscle strength and demographic structure and low back pain information

	MIP		MEP	
	r	P	r	p
Age	-0.303	0.072	-0.524	0.001
BMI	0.135	0.431	-0.070	0.687
Age at which low back pain complaints begin	-0.242	0.154	-0.382	0.022
Frequency of lower back pain	0.054	0.755	0.008	0.962
VAS	-0.172	0.315	-0.080	0.642

r: Correlation coefficient
The p value is less than 0.05

No significant correlation was found between Oswestry function questionnaire and MIP and MEP values (p>0.05). No significant correlation was found between fatigue severity scale and MIP and MEP values (p>0.05). 6min walk test value and MIP and MEP examinations were found to have statistically significant, positive and moderate correlations (p<0.05) (Table 4).

Table 4. Relationships between respiratory muscle strength and Oswerty, fatigue and 6 minutes individuals with chronic low back pain

	MIP		MEP	
	r	P	r	p
Oswestry	-0.033	0.849	-0.177	0.303
Fatigue	0.204	0.232	0.009	0.959
6 min.	0.406	0.014	0.538	0.001

r: Correlation coefficient
The p value is less than 0.05

DISCUSSION

In our study in which we examined the relationship between respiratory muscle strength and low back pain-induced disability status, fatigue and cardiorespiratory fitness in individuals with non-specific chronic low back pain, no significant relationship was found between respiratory muscle strength and low back pain-induced disability status and fatigue, but a significant relationship was found between respiratory muscle strength and cardiorespiratory fitness.

Low back pain is a health problem with a very high prevalence that negatively affects the quality of life of individuals and prevents them from social life. Epidemiological studies indicate that women are more affected by low back pain, and our study also supports this situation.[17-19]

When we look at the literature, high BMI value; It is considered a risk factor for low back pain due to the extra load on the spine, increased mechanical demand and

the metabolic consequences of obesity. However, there is insufficient evidence for this view.[20] Normal BMI values are between 18.5-24.5. The average BMI value of the individuals with low back pain who participated in our study was 27.89, which can be interpreted as a BMI value above normal may be a risk factor for low back pain.

In recent years, the causes of low back pain have been focused on the decrease in the activation of the multifidus, transversus abdominus, and pelvic floor muscles, which are the muscles of the core region. Fewer studies have addressed the diaphragm. In the study conducted by Hodges et al.[8] in 1997, they showed that there was no change in the diaphragm during small distal extremity movements, but the diaphragm was activated before the extremity movements involving large muscle groups and stated that the diaphragm played an important role in postural control. One of the similar studies is the study of Kolar et al.[7] in 2012 in which the effect of diaphragm on postural function was investigated. In the study, the researchers observed the movements of the diaphragm during isometric contractions of the upper and lower extremities and stated that in individuals with chronic low back pain, there was restriction of movement in the anterior and medial part of the diaphragm during isometric muscle contraction and that the diaphragm moved asymmetrically during inspiration.

Maintaining an upright posture during daily activities requires dynamic stabilization. While healthy individuals apply spine-centered, multi-part, flexible postural control strategies to maintain balance; It has been observed that individuals with low back pain use a strict ankle strategy rather than spine-centered control.[21]

It is known that muscle fatigue has a negative effect on proprioceptive feedback. Respiratory corrective plays a role in postural control. However, it is stated that people with lower back pain cannot fully achieve this. Janssens et al.[22] in their study conducted in 2010, where they examined the effect of inspiratory muscle fatigue on postural control in patients with low back pain, they showed that inspiratory muscle fatigue negatively affected postural control. In 2015, Janssens et al.[22] in their study where they examined the effect of inspiratory muscle training on postural control, they divided individuals with low back pain into two groups and applied high-intensity inspiratory muscle training to one group and low-intensity inspiratory muscle training to the other group. And they observed that in the group in which high-intensity inspiratory muscle training was applied, ankle synergies of postural control decreased and spine-centered synergies increased. In other words, thanks to this training, the participation of the trunk in postural control has increased in individuals with low back pain, as in healthy individuals. They also stated that the severity of low back pain decreased more in this group.[23]

In a study conducted by Dülger et al.[24], in which they compared the respiratory functions of individuals with low back pain and healthy individuals, no significant difference was found between the two groups.

In our study, we evaluated the relationship between respiratory muscle strength and the state of being affected by low back pain. However, we could not find a relationship between low back pain involvement and respiratory muscle strength. One of our limitations in this study is that all patients were diagnosed with chronic low back pain, but not all of them had active pain at the time of evaluation. We think that this situation affected the result of the study.

In our study, no relationship was found between fatigue and MIP and MEP values. We thought that the fatigue severity scale, which we used to evaluate fatigue, did not provide comprehensive enough results because it only addressed fatigue in the last week. A significant positive relationship was found between cardiorespiratory fitness and respiratory muscle strength. This conclusion supports the literature.

Our study has some limitations. Firstly, although the study was conducted on individuals with chronic low back pain, some individuals had pain during the evaluation, while some individuals did not have active pain. We did not consider these individuals in different groups during the statistical analysis. This was not taken into consideration in most studies in the literature. We think that whether individuals have active pain at the time of evaluation affects the results. Another limitation is that this study only looked at respiratory muscle strength. Considering all parameters of breathing will give more comprehensive results. Although there is no control group in this study, the study is being continued and the values compared to the control group will be examined.

CONCLUSION

There was no significant relationship between MIP and MEP values and disability and fatigue due to low back pain. A significant, positive and moderate relationship was found between MIP and MEP values and the 6-minute walk test. The generally accepted view is that inadequate functioning of the diaphragm may lead to impaired intra-abdominal pressure modulation, reducing spinal stabilization, and this may increase low back pain. It is recommended that the sample size be larger, all respiratory parameters are addressed, and evaluations are made during acute pain.

ETHICAL DECLARATIONS

Ethics Committee Approval: The study was carried out with the permission of Kırıkkale University Non-interventional Clinical Researches Ethicshics Committee Decision (Date: 21.12.2022, Decision No: 2022.12.04).

Informed Consent: All patients signed and free and informed consent form.

Referee Evaluation Process: Externally peer-reviewed.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

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