

# The relationship between balance, trunk muscular endurance, and functional level in individuals with chronic low back pain

Sabiha Bezgin<sup>1</sup>, Saniye Aydogan Arslan<sup>1</sup>, Meral Sertel<sup>1</sup>, Ozge Vergili<sup>1</sup>, Ayse Abit Kocaman<sup>1</sup>, Muhammet Ayhan Oral<sup>1</sup>, Tezel Yildirim Sahan<sup>2</sup>, Cevher Savcun Demirci<sup>3</sup>, Kubra Ugurlu<sup>1</sup>, Birol Onal<sup>4</sup>, Esra Dilek Keskin<sup>5</sup>

<sup>1</sup>Kirikkale University, Faculty of Health Sciences, Department of Physiotherapy and Rehabilitation, Kirikkale, Turkey

<sup>2</sup>Saglik Bilimleri University, Gulhane Faculty of Health Sciences, Department of Physiotherapy and Rehabilitation, Ankara, Turkey

<sup>3</sup>Balikesir University, Faculty of Health Sciences, Department of Physiotherapy and Rehabilitation, Balikesir, Turkey

<sup>4</sup>Hacettepe University, Faculty of Physical Therapy and Rehabilitation, Department of Physiotherapy and Rehabilitation, Ankara, Turkey

<sup>5</sup>Kirikkale University, Faculty of Medical Sciences, Department of Physical Medicine and Rehabilitation, Kirikkale, Turkey

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## Abstract

**Aim:** This study was planned to investigate the relationship between trunk muscular endurance, balance, and functional level in individuals with chronic low back pain.

**Material and Methods:** Sixty-three individuals, aged 18-65 years and having chronic low back pain for the last six months, were included in the study. Sociodemographic data of the individuals were recorded. The static and dynamic endurance of trunk muscles was evaluated by the curl-up test and modified Sorenson test. In order to evaluate the dynamic balance, the Timed Up and Go test was performed. The functionality level related to the low back pain of individuals was evaluated by the Oswestry Low Back Pain Disability Questionnaire.

**Results:** Forty-one female (65%) and twenty-two male (35%) individuals were included in the study. The mean age of the individuals was  $40.50 \pm 16.75$  years, and the mean body mass index was  $26.51 \pm 5.34$  kg/m<sup>2</sup>. A moderate negative correlation was found between trunk flexor and extensor muscle endurance with both dynamic balance and functional level ( $p < 0.05$ ).

**Conclusion:** It was determined that there is a significant relationship between balance, trunk muscular endurance, and functional level. The presence of this relationship may guide the planning of exercise therapy in individuals with chronic low back pain.

**Keywords:** Balance; chronic low back pain; endurance; functional level

## INTRODUCTION

Chronic low back pain is a symptom such as dizziness and headache rather than an illness. It can be caused by many factors such as postural disorder, heavy work, pregnancy, obesity, lifestyle habits, improper sitting and resting positions. It can emerge due to spinal pathology and nerve root pain, or it may also emerge in non-specific situations, in other words, in situations not associated with a diagnosis (1, 2). Low back pain is a common symptom that can be observed throughout the world at any age (3, 4). Non-specific chronic low back pain is its most common type, and it causes functional disability in individuals and affects the quality of life adversely. The evaluation of the causes and consequences of chronic low

back pain and revealing the related symptoms are critical in terms of planning the treatments of patients (2, 5).

In individuals with chronic low back pain, changes in both balance and trunk stabilization are common. This situation may be caused by many factors such as mechanical posture disorders, false proprioceptive feedback, muscle imbalance, muscle weakness, lack of muscular endurance, and pain memory (6). The studies have demonstrated that postural control is effected in individuals with chronic low back pain (7,8). Furthermore, structural changes in the muscles of these individuals and the decrease in proprioceptive sensation have also been reported (6). Therefore, determining the changes that occur with the alteration in trunk muscular endurance in

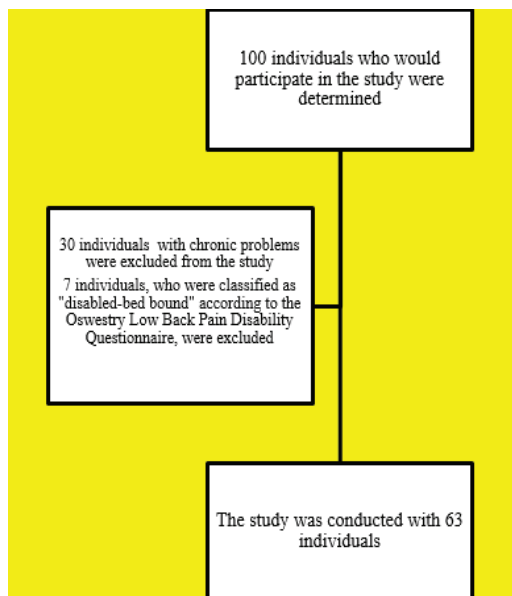
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Corresponding Author: Sabiha Bezgin, Kirikkale University, Faculty of Health Sciences, Department of Physiotherapy and Rehabilitation, Kirikkale, Turkey E-mail: sabihisahilog@gmail.com

individuals with chronic low back pain and their reflections on the functional level are very important for both patients and physiotherapists in terms of establishing an effective treatment program. In the literature, there are studies investigating trunk muscular endurance, balance or functional level in individuals with chronic low back pain separately. However, there are limited number of studies examining trunk muscular endurance, balance, and functional level together in individuals with chronic low back pain. Therefore, our study aims to investigate the relationship between balance, trunk muscular endurance, and functional level in individuals with chronic low back pain.

## MATERIAL and METHODS

The study included 100 individuals aged 18-65 years who applied to Kırıkkale University Physical Medicine and Rehabilitation Clinic with the complaint of chronic low back pain for the last six months and volunteered to participate in the study. All patients were referred to the study with the diagnosis of chronic low back pain following a clinical and radiological evaluation by a physical therapy and rehabilitation specialist. According to the Oswestry Low Back Pain Disability Questionnaire, 60% and over were not included in the study.



**Figure 1.** The study flow diagram

Who had tumors effecting the spine, who had metabolic or inflammatory diseases, who had undergone a surgery in the lower extremity or columna vertebralis, who had uncontrolled hypertension, exercise contraindication and spinal fracture, radiculopathy symptoms such as muscular weakness, sensory defisits, chronic diseases such as hypertension, diabetes, and pain effecting the muscle strength test and according to these criteria thirty individuals were excluded from the study. Seven individuals who were classified as "disabled-bed bound," according to the Oswestry Low Back Pain Disability

Questionnaire in terms of their functional status were excluded from the study. The study was completed with 63 individuals (Figure 1).

After the sociodemographic data of the individuals were recorded, the Timed Up and Go test (TUG) was used to evaluate the dynamic balance, the curl-up and modified Sorenson tests were used to evaluate the endurance of trunk muscles, and functional disability that occurred due to low back pain was evaluated by the Oswestry Low Back Pain Disability Questionnaire.

The TUG test is a simple, objective, and reliable test used to evaluate functional mobility together with balance. When the "stand up" command is given, the person is asked to stand up out of the chair, which has arm and back supports, walk 3 m, turn around a target, walk back to the chair, and sit down. In our study, after determining the 3 m distance with the help of a tape measure, a chair was placed at one end of this distance, and an indicative mark was placed at the other end. The test protocol was explained to individuals, and the duration of the test was recorded in seconds (9).

The curl-up test is used to determine the endurance of abdominal muscles. The individual was laid in the 'supine hook lying' position. It was ensured that the soles of the feet contacted the ground. In the evaluation of dynamic muscular endurance, the individual was requested to extend his/her arms forward and to curl up to the scapula. The number of correct repetitions performed during 1 minute was recorded. In the evaluation of static endurance, in the 'supine hook lying' position, the individual was requested to extend his/her arms forward, curl up to the scapula and remain in this position in a correct form. The duration of staying correctly in this position was recorded in seconds (10,11).

The modified Sorenson test was used to determine the endurance of trunk extensors. In the evaluation of dynamic muscular endurance, the individual was laid face down, and he/she was asked to perform trunk extension, with the arms on the side. The number of correct repetitions performed during 1 minute was recorded. In the evaluation of static endurance, the time in which proper trunk extension was maintained was recorded in seconds (10-13). The patients were informed about the test protocol. They were informed that the maximum number of repetitions and maximum time that they could stop were the evaluation criteria. However, there were no pain complaints during the effort to achieve maximum performance during the tests. Endurance tests were performed after balance assessment because it caused more fatigue in the patient. Endurance tests were performed randomly the next day as shown in the literature to avoid fatigue (14).

The Oswestry Low Back Pain Disability Questionnaire is a scale, which was developed to measure individuals' low back and low back-related leg complaints and which consists of ten sub-parameters. It is used frequently in the case of low back pain disability. It evaluates the condition

of the individual during daily life and physical activities. Each question is scored on a scale of 0–5 with the first statement being zero and indicating the least amount of disability and the last statement is scored 5 indicating most severe disability. Unanswered questions are not included in the evaluation. The evaluation is made according to the total score, and the total score is calculated as follows by taking the answered questions into account. Total score = (Individual's score / maximum possible score) x100. The interpretation of the percentage values obtained is as follows: 0% - 20% - minimal disability, 20% - 40% - moderate disability, 40% - 60% - severe disability, 60% - 80% - disabled, 80% - 100% - bed bound (15, 16). The scoring was performed according to the answers of the individuals, and the values were recorded as a percentage. Individuals with a score of 60% and lower were included in the study.

### Statistical analysis

Statistical analyses of the study were performed using the Statistical Package for Social Sciences (SPSS) Version 21.0 (SPSS Inc., Chicago, IL, USA). Whether the variables were normally distributed was examined by visual (histogram and probability graphs) and analytical methods (Kolmogorov-Smirnov / Shapiro-Wilk tests). Continuous variables were given as mean  $\pm$  standard deviation, while categorical variables were given as number and percentage. The correlations between continuous variables were examined by Spearman's correlation analysis. The value of  $p < 0.05$  was considered statistically significant in all analyses. 0.05-0.30 low correlation, 0.30-0.40 low moderate correlation, 0.40-0.60 moderate correlation, 0.60-0.70 good correlation, 0.70-0.75 very good correlation, shows excellent correlation between 0.75-1.00. The G\*Power program (version 3.0.10 Universität Düsseldorf, Düsseldorf, Germany) was used for post-hoc power analysis. In the post-hoc power analysis, when the statistical significance of alpha was found to be 5% and the confidence interval was taken as 95%, the

power ( $1-\beta$ ) of the study was found to be 99%.

## RESULTS

Age, height, weight, and gender of the individuals were recorded. Forty-one female (65%) and twenty-two male (35%) individuals participated in the study. The mean age of the individuals was  $40.50 \pm 16.75$  years. The mean body mass index of the individuals participating in the study was  $26.51 \pm 5.34$  kg/m<sup>2</sup>. The demographics and clinical information of the individuals was presented in Table 1.

When the results of the tests evaluating the trunk muscular endurance were examined, a low significant correlation was found between static and dynamic endurance of abdominal muscles ( $r = 0.380$ ,  $p = 0.002$ ). A moderate ( $r = 0.609$ ,  $p = 0.001$ ) significant correlation was found between static and dynamic endurance of back extensors. A moderate ( $r = 0.631$ ,  $p = 0.001$ ) significant correlation was detected between static endurance of abdominal muscles and back extensors, and a moderate ( $r = 0.557$ ,  $p = 0.001$ ) significant correlation was detected between their dynamic endurance (Table 2).

**Table 1. Sociodemographic and clinical information of individuals**

Gender (n,%)	Female	41 (65)
	Male	22 (35)
Mean age (years)		40.50 $\pm$ 16.75
Mean body mass index (kg/m <sup>2</sup> )		26.51 $\pm$ 5.34
Curl-up Static (sec)		24.17 $\pm$ 17.22
Curl-up Dynamic (repetition)		11.54 $\pm$ 11.07
Modified Sorenson Static (sec)		26.99 $\pm$ 18.57
Modified Sorenson Dynamic (repetition)		16.31 $\pm$ 12.25
Balance (sec)		10.85 $\pm$ 5.02
Functionality (%)		40.22 $\pm$ 16.10

**Table 2. The relationship between trunk muscular endurance, balance, and functionality**

		Curl-Up Static	Curl-Up Dynamic	Modified Sorenson Static	Modified Sorenson Dynamic	Balance	Functionality
Curl-Up Static(sec)	r		0.380**	0.631**	0.465**	-0.502**	-0.460**
	p		0.002	0.001	0.001	0.001	0.001
Curl-Up Dynamic(repetition)	r	0.380**		0.322*	0.557**	-0.409**	-0.355**
	p	0.002		0.01	0.001	0.001	0.004
Modified Sorenson Static(sec)	r	0.631**	0.322*		0.609**	-0.523**	-0.441**
	p	0.001	0.01		0.001	0.001	0.001
Modified Sorenson Dynamic (repetition)	r	0.465**	0.557**	0.609**		-0.607**	-0.319*
	p	0.001	0.001	0.001		0.001	0.011
Balance (sec)	r	-0.502**	-0.409**	-0.523**	-0.607**		0.293*
	p	0.001	0.001	0.001	0.001		0.020
Functionality (%)	r	-0.460**	-0.355**	-0.441**	-0.319*	0.293*	
	p	0.001	0.004	0.001		0.020	

\*\* $p < 0.05$ , \* $p < 0.01$

There was a moderate negative significant correlation between dynamic balance and static and dynamic endurance of abdominal muscles ( $r = -0.502$ ,  $p = 0.001$ ;  $r = -0.409$ ,  $p = 0.001$ ) and static and dynamic endurance of back extensors ( $r = -0.523$ ,  $p = 0.001$ ;  $r = -0.607$ ,  $p = 0.001$ ) (Table 2).

When the relationship between the functionality level and static and dynamic endurance of abdominal muscles was examined, a moderately negative ( $r = -0.460$ ,  $p = 0.001$ ;  $r = -0.355$ ,  $p = 0.004$ ) significant correlation was found, and a moderately negative ( $r = -0.441$ ,  $p = 0.001$ ;  $r = -0.319$ ,  $p = 0.001$ ) significant correlation was found between the functionality level and the static and dynamic endurance of back extensors. When the relationship between the functionality level and balance was examined, a low positive significant correlation was observed ( $r = 0.293$ ,  $p = 0.020$ ) (Table 2).

## DISCUSSION

Many studies have shown that trunk muscular endurance in chronic low back pain is reduced, balance is impaired and functional level is effected (17,18). However, the studies revealing the relationship between these parameters are limited. As a result of this study, muscular endurance and balance and functional level were shown to be related. Balance control requires a well-controlled voluntary movement and activation of muscles that respond to this appropriately (19). The ability of the body to maintain its balance without falling in the face of an unexpected effect depends on the rapid adaptation and response of the muscles. However, in individuals with chronic low back pain, the ability of the body to postural maintains adjustments and to produce balance reactions decreases with the decrease in stabilization (20). Barati et al. reported a relationship between trunk muscular endurance and balance as a result of the study they conducted with healthy university students (21). Individuals with chronic low back pain are known to have poor balance compared to healthy individuals (22). Our results indicating a relationship between the dynamic and static endurance of trunk muscles and balance are consistent with the literature. Due to the atrophied and deteriorated muscle structure, effective contraction cannot occur, and impairments in the balance of the individual are observed. As a result of our study, it was determined that as the trunk muscular endurance decreased, the duration of completing the TUG test by individuals was prolonged. Furthermore, we think that this is a quite guiding result in the selection and implementation of exercises to be used in the treatment programs of individuals with chronic low back pain.

Pain and the resulting movement restriction prevent the correct and effective functioning of muscles and cause functional restriction (23). Chronic pain is one of the reasons for changes that occur in the structure of muscles and soft tissues over time. As a result of the

study, in which Wallwork et al. examined the multifidus muscle with ultrasound in individuals with chronic low back pain, they reported that the muscle thickness was less at the level of L5 compared to healthy individuals and that the contraction mechanism was effected (24). There is a relationship between the weakening of the muscles responsible for the stability of the trunk, being unable to display the adequate working performance, and pain. However, the information on the temporal sequence of this condition is not clear (25). Danneels et al. examined the atrophy of the multifidus muscle in individuals with chronic low back pain by computed tomography and compared it with healthy individuals, and as a result of this study, they reported that atrophy in the multifidus muscle existed before pain became chronic and therefore it was a factor in the formation of chronic low back pain (25). Changes in the activation pattern of deep and superficial trunk muscles and deterioration of spine stability are the factors effective in the emergence of chronic low back pain and its progression (26). The weakness of back extensors is known to be effective in the formation of chronic low back pain (27-29). As a result of the study conducted by Hwango et al. on individuals with chronic low back pain, exercises aimed at improving trunk stabilization were reported to contribute to improved balance (30). Therefore, it should be emphasized that it is essential to include approaches aimed to improve the endurance of trunk muscles and balance in preventive rehabilitation practices. In our study, by observing a relationship between balance, muscular endurance and functionality level, it can be concluded that the approaches applied to improve the trunk muscular endurance and balance of individuals would positively effect the participation of individuals was obtained. Furthermore, when planning treatment programs for individuals with chronic low back pain, we think that exercises aimed at trunk muscles and balance should be definitely added.

## LIMITATIONS

Individuals who suffered from chronic low back pain and whose functionality was affected at a moderate and low level due to chronic low back pain were included in our study. In order to generalize this result, studies with a wider population is recommended for chronic low back pain individuals with severe effects. In addition, only TUG test was used for balance evaluation in our study. It is thought that this test is not supported by other tests and objective methods such as Biodex Balance System is a limitation of our study. In further studies, the balance and muscular endurance can be compared with different functional levels with low back pain individuals.

## CONCLUSION

In this study, we examined the relationship between balance, trunk muscular endurance, and functional level in individuals with chronic low back pain. We concluded that there is a significant relationship between balance, trunk muscular endurance, and functional level. The presence of this relationship may guide the planning of exercise therapy in individuals with chronic low back pain.



*Informed consent: All individuals included in the study were given detailed information about the purpose and methodology of the study, and their consents for participating in the study were obtained.*

*Competing interests: The authors declare that they have no competing interest.*

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*Sabiha Bezgin ORCID: 0000-0002-8459-8956*

*Saniye Aydogan ORCID: 0000-0001-5470-9849*

*Meral Sertel ORCID: 0000-0002-7575-9762*

*Ozge Vergili ORCID: 0000-0002-5312-7684*

*Ayse Abit Kocaman ORCID: 0000-0002-6694-3015*

*Muhammet Ayhan Oral ORCID: 0000-0001-8618-9817*

*Tezel Yildirim Sahar ORCID: 0000-0002-4004-3713*

*Cevher Savcun Demirci ORCID: 0000-0002-8786-7496*

*Kubra Ugurlu ORCID: 0000-0001-5819-9380*

*Birol Onal ORCID: 0000-0002-3540-7156*

*Esra Dilek Keskin ORCID: 0000-0001-5300-6391*

## REFERENCES

- Hancock MJ, Maher CG, Latimer J, et al. Systematic review of tests to identify the disc, SIJ or facet joint as the source of low back pain. *Eur Spine J* 2007;16:1539-50.
- Maher C, Underwood M, Buchbinder R. Non-specific low back pain. *Lancet* 2017;389:736-47.
- Hoy D, Bain C, Williams G, March L, Brooks P, Blyth F, et al. A systematic review of the global prevalence of low back pain. *Arthritis Rheum* 2012;64:2028-37.
- Hartvigsen J, Christensen K, Frederiksen H. Back pain remains a common symptom in old age. A population-based study of 4486 Danish twins aged 70–102. *Eur Spine J* 2003;12:528-34.
- Hartvigsen J, Hancock MJ, Kongsted A, Louw Q, Ferreira ML, Genevay S, et al. What low back pain is and why we need to pay attention. *Lancet* 2018;391:2356-67.
- Gill KP, Callaghan MJ. The measurement of lumbar proprioception in individuals with and without low back pain. *Spine* 1998;23:371-7.
- Luoto S, Aalto H, Taimela S, Hurri H, Pyykkö I, Alaranta H. One-footed and externally disturbed two-footed postural control in patients with chronic low back pain and healthy control subjects: A controlled study with follow-up. *Spine* 1998;23:2081-9.
- Radebold A, Cholewicki J, Polzhofer GK, et al. Impaired postural control of the lumbar spine is associated with delayed muscle response times in patients with chronic idiopathic low back pain. *Spine* 2001;26:724-30.
- Gautschi OP, Smoll NR, Corniola MV, et al. Validity and reliability of a measurement of objective functional impairment in lumbar degenerative disc disease: the timed up and go (TUG) test. *Neurosurgery* 2015;79:270-8.
- Simmonds MJ, Olson SL, Jones S, Hussein T, Lee CE, Novy D, et al. Psychometric characteristics and clinical usefulness of physical performance tests in patients with low back pain. *Spine* 1998;23:2412-21.
- Moffroid MT. Endurance of trunk muscles in persons with chronic low back pain: assessment, performance, training. *J Rehabil Res Dev* 1997;34:440-7.
- Bandy WD, Sanders B. Therapeutic exercise for physical therapist assistants: Lippincott Williams & Wilkins; 2007.
- Knudson D. Issues in abdominal fitness: testing and technique. *J Phys Educat, Rec Dance* 1999;70:49-55.
- Kofotolis, Nick, and Eleftherios Kellis. "Effects of two 4-week proprioceptive neuromuscular facilitation programs on muscle endurance, flexibility, and functional performance in women with chronic low back pain." *Physical therapy* 86.7;2006:1001-12.
- Fairbank J, Couper J, Davies J, O'Brien J. The Oswestry low back pain disability questionnaire. *Physiotherapy* 1980;66:271-3.
- Edibe Y, Tulin D, Oksuz C, et al. Validation of the Turkish version of the Oswestry Disability Index for patients with low back pain. *Spine* 2004; 29:581-5.
- O'Sullivan, Peter B., et al. The relationship between posture and back muscle endurance in industrial workers with flexion-related low back pain. *Manual therapy* 2006;11.4:264-71.
- Tsigkanos, Christos, et al. Static and dynamic balance deficiencies in chronic low back pain. *Journal of back and musculoskeletal rehabilitation* 2016;29.4:887-93.
- Fransson P-A, Johansson R, Hafström A, et al. Methods for evaluation of postural control adaptation. *Gait Posture* 2000;12:14-24.
- Borghuis J, Hof AL, Lemmink KA. The importance of sensory-motor control in providing core stability. *Sports Med* 2008;38:893-916.
- Barati A, Safarcherati A, Aghayari A, et al. Evaluation of relationship between trunk muscle endurance and static balance in male students. *Asian J Sport Med* 2013;4:289.
- Alexander KM, Kinney LaPier TL. Differences in static balance and weight distribution between normal subjects and subjects with chronic unilateral low back pain. *J Orthop SportPhys* 1998;28:378-83.
- Franca FR, Burke TN, Hanada ES, et al. Segmental stabilization and muscular strengthening in chronic low back pain: a comparative study. *Clinics* 2010;65:1013-7.
- Wallwork TL, Stanton WR, Freke M, Hides JA. The effect of chronic low back pain on size and contraction of the lumbar multifidus muscle. *Manual Ther* 2009;14:496-500.
- Danneels LA, Vanderstraeten G, Cambier DC, et al. CT imaging of trunk muscles in chronic low back pain patients and healthy control subjects. *Eur Spine J* 2000;9:266-72.
- Ghamkhar L, Kahlaee AH. Trunk muscles activation pattern during walking in subjects with and without chronic low back pain: a systematic review. *PM&R* 2015;7:519-26.

27. Lee J-H, Hoshino Y, Nakamura K, et al. Trunk muscle weakness as a risk factor for low back pain: a 5-year prospective study. *Spine* 1999;24:54-7.
28. Handa N, Yamamoto H, Tani T, et al. The effect of trunk muscle exercises in patients over 40 years of age with chronic low back pain. *J Orthop Sci* 2000;5:210-6.
29. Reid S, Hazard R, Fenwick J. Isokinetic trunk-strength deficits in people with and without low-back pain: a comparative study with consideration of effort. *J Spinal Disord* 1991;4:68-72.
30. Hwangbo G, Lee C-W, Kim S-G, et al. The effects of trunk stability exercise and a combined exercise program on pain, flexibility, and static balance in chronic low back pain patients. *J Phys Ther Sci* 2015;27:1153-5.