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Research Article / Araştırma Makalesi

Lower Limb Muscle Strength is Associated with Disability in Non-Specific Chronic Low Back Pain

Non-Spesifik Kronik Bel Ağrısında Alt Ekstremite Kas Kuvveti Dizabilite ile İlişkilidir

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Abstract: Low back pain is one of the most common health problems that affects daily living activities of most people at some time in their lifetime. Non-specific chronic low back pain (NS-CLBP) can be seen in 85-95% of the population. Although it is known that disability and lower limb muscle strength are affected in patients with NS-CLBP, no study investigated the relationship between these variables. The aim of this study was to identify association between disability and lower limb muscle strength in these patients. 79 patients with NS-CLBP were enrolled. The strength of knee extensor and ankle dorsiflexor muscles were measured using a hand-held dynamometer. The disability was assessed using Oswestry Disability Index (ODI). Spearman correlation analysis revealed that there were negative significant correlations between ODI score and right knee extensor muscle strength, left knee extensor muscle strength and left ankle dorsiflexor muscle strength ($r=-0.290$, $p=0.009$; $r=-0.408$, $p<0.001$; $r=-0.285$, $p=0.011$, respectively). This study showed that lower limb muscle strength was associated with disability in patients with NS-CLBP. Physiotherapy interventions such as resistance training to increase the strength of knee extensor and ankle dorsiflexor muscles may be beneficial in improving disability in patients with NS-CLBP.

Keywords: Low back pain, Disability, Muscle strength, Lower limb.

Öz: Bel ağrısı çoğu insanın hayatının bir döneminde karşılaştığı, günlük yaşam aktivitelerini etkileyen en yaygın sağlık sorunlarından biridir. Spesifik olmayan kronik bel ağrısı (SO-KBA) toplumun %85-95'inde görülebilmektedir. SO-KBA'lı hastalarda özürlülük ve alt ekstremite kas kuvvetinin etkilendiği bilinmesine rağmen bu değişkenler arasındaki ilişkiyi araştıran bir çalışma bulunmamaktadır. Bu çalışmanın amacı bu hastalarda dizabilite ile alt ekstremite kas kuvveti arasındaki ilişkiyi belirlemekti. SO-KBA'lı 79 hasta çalışmaya alındı. Diz ekstansör ve ayak bileği dorsifleksör kas kuvvetleri elle tutulur dinamometre ile ölçüldü. Dizabilite, Oswestry Dizabilite İndeksi (ODI) kullanılarak değerlendirildi. Spearman korelasyon analizi sonuçlarına göre ODI skoru ile sağ diz ekstansör kas kuvveti, sol diz ekstansör kas kuvveti ve sol ayak bileği dorsifleksör kas kuvveti arasında negatif anlamlı korelasyon vardı (sırasıyla; $r=-0.290$, $p=0.009$; $r=-0.408$, $p<0.001$; $r=-0.285$, $p=0.011$). Bu çalışma, SO-KBA'lı hastalarda alt ekstremite kas kuvvetinin dizabilite ile ilişkili olduğunu gösterdi. Diz ekstansör ve ayak bileği dorsifleksör kaslarının kuvvetini arttırmaya yönelik, dirençli egzersiz eğitimi gibi fizyoterapi uygulamaları, SO-KBA'lı hastalarda dizabilitenin azaltılmasında faydalı olabilir.

Anahtar Kelimeler: Bel ağrısı, Dizabilite, Kas kuvveti, Alt ekstremite.

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Introduction

Low back pain (LBP) is one of the most common health problems that affects daily living activities of most people at some time in their lifetime. LBP with no identifiable cause or pathology and lasting more than 12 weeks is diagnosed as "non-specific chronic low back pain" (NS-CLBP) and can be seen in 85-95% of individuals (Andersson, 1999; Popescu & Lee, 2020). LBP may cause disability, decreased quality of life and functional limitation (Fujii & Matsudaira, 2013).

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LBP is now the leading cause of disability and productivity loss worldwide ("Global, regional, and national incidence, prevalence, and years lived with disability for 310 diseases and injuries, 1990-2015: a systematic analysis for the Global Burden of Disease Study 2015," 2016; Popescu & Lee, 2020). The level of disability in LBP has long been regarded as a core outcome and associated with pain intensity. It also affects the ability of patients with NS-CLBP to perform maximum muscle function of lumbar region (Verbrugghe et al., 2020). In order to understand the complexity of disability in LBP, the biopsychosocial model has been used as a main framework. It is known that social, psychological, genetic and biophysical factors such as muscle strength can play a role in disabling LBP (Öncü, Ilişer, & Kuran, 2016).

Lower limb muscle strength is an essential component of mobility and performing daily functional activities. Improving muscle strength is a key linking mobility function (Kato et al., 2021). Knee extensor and ankle dorsiflexor muscles are also crucial for functional activities such as walking, standing and for maintaining balance during these activities (de Sousa et al., 2019). Dorsiflexor and knee extensor muscle strength have shown to be impaired in patients with NS-CLBP, however, underlying mechanism is unknown. Pain, kinesiophobia and/or increased disability may cause impaired lower limb muscle strength and physical activity level. Furthermore, improvement in lower limb muscle strength is useful for the effectiveness of treatment in patients with NS-CLBP.

Previous studies mostly revealed the correlation of pain and disability with the muscle strength of abdominal trunk muscle groups in patients with LBP (Hu et al., 2017; Kato et al., 2021). On the other hand, a significant difference in isokinetic muscle strength of the knee extensors and hip abductor/extensors was found between participants in the healthy control group and the LBP group in different studies (de Sousa et al., 2019). Although it is known that disability and lower limb muscle strength are affected in individuals with NS-CLBP when compared to healthy individuals, no study, to our knowledge, reported the relationship between pain, disability and knee extensor and ankle dorsiflexor muscle strength in patients with NS-CLBP. Therefore, the aim of the present study was to identify association between disability and knee extensor and ankle dorsiflexor muscle strength. The hypothesis was that there would be correlations between these variables. The results of this study may assist clinicians to have theoretical and clinical basis on better evaluation or treatment to combat increased disability of individuals with NS-CLBP.

Materials and Methods

Design

This research was designed as cross-sectional study. Data was acquired between January 2019 and January 2020. The study followed the principles of the Declaration of Helsinki and was approved by the local university ethics committee. All participants provided written informed consent.

Participants

Patients who applied to the neurosurgery clinic with complaints of LBP were included in the study. After verbal and written information had been given about the procedure by physiotherapists, patients eligible and willing to participate in the study were enrolled in accordance with the inclusion criteria.

Inclusion criteria were: (i) age between 18 and 65 years, (ii) LBP with no identifiable cause or pathology, (iii) LBP lasting more than 12 weeks. Exclusion criteria were: (i) presence of perceived weakness, motor deficit or paraesthesia in the lower limbs, (ii) specific spinal pathologies/diseases such as disc herniation, malignancy, inflammatory joint and bone diseases, vertebral fracture, scoliosis, (iii) previous history of back surgery, (iv) neurologic, metabolic, and cardiovascular disorders, (v) mental and cognitive disorders that could affect cooperation, and (vi) pregnancy.

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Procedure

Sociodemographic characteristics were noted. Patients were asked to complete the Numeric Pain Rating Scale (NPRS) and the Oswestry Disability Index (ODI).

Hand-held dynamometer (MicroFET 3, Hoggan Health Industries, UT, USA) was used to assess knee extensor and ankle dorsiflexor muscle strength. Patients were seated on the edge of the treatment table bedside (height 100 cm) with hip and knee at 90° flexion for knee extensor muscle strength assessment whereas they were lying on the bed with ankle in neutral position for ankle dorsiflexor muscle strength assessment. Dynamometer was placed just above the malleolus and over the metatarsal heads on the dorsum of the foot, respectively. Patients pushed against the dynamometer for 5 s with their maximum force as much as they could do for each condition. Dynamometer was hold with both hands to resist against patient’s movement force and extremity was stabilized during each test. Strength values were normalised for size differences by dividing by the 2/3 power of body mass in kilograms and expressed as body weight-normalised peak torque (N/kg) (Jaric, Radosavljevic-Jaric, & Johansson, 2002). Measurements were repeated three times and the highest score was used for analysis. Hand-held dynamometry was reported to have good to excellent reliability and validity for measures of lower extremity muscle strength (Kimura et al., 2018; Mentiplay et al., 2015).

Self-reported pain both in rest and in activity were assessed using the NPRS. Individuals were asked to choose a number between 0 (indicating no pain) and 10 (indicating the worst pain) that expresses their pain intensity (Childs, Piva, & Fritz, 2005).

The pain-related disability was assessed using the validated Turkish version of the ODI. The ODI was shown to have good psychometric properties and suit to assessment of patients with LBP. This index includes 10 questions and each of them was scored between 0 and 5. Total point of index were calculated as 100 points. Higher scores reflect higher level of disability (Yakut et al., 2004).

Statistical Analysis

All data were analyzed using the IBM SPSS software (version 23.0 for Windows; IBM Corp, Armonk, NY). Shapiro-Wilk Test, histograms and probability plots were used to examine the normality of the data. Variables were presented as median (min - max) and interquartile range (25% - 75%) since most of the variables were not normally distributed. Spearman test was used to calculate the correlation coefficients and their significance. Strength of correlation was defined as very weak for r values between 0.00–0.19, weak for r values between 0.20–0.39, moderate for r values between 0.40–0.69, strong for r values between 0.70–0.89, and very strong for r values over 0.90 (Streiner, Norman, & Cairney, 2014). To infer statistical significance, an overall 5% type-I error level was used ($p < 0.05$).

Results

121 patients with LBP assessed for eligibility. 32 patients who did not meet the inclusion criteria (low back pain less than 12 weeks, specific spinal pathologies, etc.) and 10 patients who declined to participate were excluded. A total of 79 patients (55 females, 24 males) with NS-CLBP were enrolled (Table 1).

Table 1. Distribution of patients with non-specific chronic low back pain according to gender.

	n	%
Gender, %		
Female	55	69.6
Male	24	30.4

Table 2 shows the demographic and clinical characteristics of patients with NS-CLBP. Values were presented as median, minimum, maximum and interquartile ranges (25% - 75%).

Spearman correlation analysis revealed that ODI score was significantly correlated with pain – activity, right knee extensor muscle strength, left knee extensor muscle strength and left ankle dorsiflexor muscle strength ($p<0.05$). There was a

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weak and positive relationship between ODI score and pain – activity (r = 0.324, p = 0.004). A weak and negative correlation was found between ODI score and right knee extensor muscle strength (r = -0.290, p = 0.009). Left knee extensor muscle strength was moderately and negatively correlated with ODI score (r = -0.408, p < 0.001). While right ankle dorsiflexor muscle strength did not significantly correlate with ODI score (p = 0.073), there was a weak, negative, significant correlation between left ankle dorsiflexor muscle strength and ODI score (r = -0.285, p = 0.011) (Table 3).

Table 2. Demographic and clinical characteristics of patients with non-specific chronic low back pain

	Median	**min**	**max**	**IQR (25% - 75%)**
Age, years	44.0	18.0	74.0	18.0 (37.0 - 55.0)
BMI, kg/m^2	26.7	18.9	39.1	4.8 (24.1 - 28.9)
Pain (NPRS)				
Pain - Rest	4.0	0.0	10.0	5.0 (2.0 - 7.0)
Pain - Activity	8.0	3.0	10.0	3.0 (7.0 -10.0)
Muscle Strength				
R-Knee Extensor, N/kg	2.22	1.02	4.39	1.16 (1.74 - 2.90)
L-Knee Extensor, N/kg	2.17	0.95	4.49	1.22 (1.65 - 2.87)
R-Ankle Dorsiflexor, N/kg	2.27	0.5 1	4.39	1.23 (1.70 - 2.93)
L-Ankle Dorsiflexor, N/kg	2.32	0.48	3.99	1.10 (1.77 - 2.87)
Disability				
ODI score	28.0	5.0	80.0	17.0 (20.0 - 37.0)

BMI Body mass index, *L* Left, *NPRS* Numeric pain rating scale, *ODI* Oswestry disability index, *R* Right.

Table 3. Correlation matrix between disability and assessed variables

	Age	**BMI**	**Pain - rest**	**Pain - activity**	**R-Knee Extensor MS**	**L-Knee Extensor MS**	**R-Ankle Dorsiflexor MS**	**L-Ankle Dorsiflexor MS**
ODI score	r = 0.136	r = 0.141	r = 0.177	**r = 0.324**	**r = -0.290**	**r = -0.408**	r = -0.204	**r = -0.285**
	p = 0.231	p = 0.216	p = 0.118	**p = 0.004***	**p = 0.009***	**p < 0.001***	p = 0.071	**p = 0.011***

**Spearman Correlation Analysis: p<0.05*
BMI Body mass index, *L* Left, *MS* Muscle strength, *ODI* Oswestry disability index, *R*

Discussion

In this study, we tried to find out whether disability is related to lower limb muscle strength or not in patients with NS-CLBP. Our findings revealed that disability was related to both left and right knee extensor muscle strength and left ankle dorsiflexor strength in a negative way in patients with NS-CLBP. While there was a moderate relationship between disability and only left knee extensor muscle strength, all the other correlations were weak. On the other hand, right ankle dorsiflexor strength was not significantly correlated with disability. Besides, pain in activity was significantly and positively correlated with disability in patients with NS-CLBP.

Until now, to our knowledge, there is only one study investigated the relationship between disability and any indicators of lower limb muscle strength in individuals with NS-CLBP (Shin, 2020). Shin examined the association between

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maximum voluntary isometric contraction asymmetry of hip extensor muscles and the disability of sixty-one office workers with NS-CLBP. Results showed that there were no significant correlations between left/right hip extensor strength asymmetry and disability in NS-CLBP (Shin, 2020).

Cai&Kong investigated low back and lower limb muscle performance in male and female recreational runners with CLBP (Cai & Kong, 2015). They compared knee extensor, hip extensor and hip abductor strength between male and female runners with CLBP and healthy runners. Results showed that runners with CLBP exhibited diminished knee extensor strength compared to healthy runners, whereas no differences were found in terms of hip extensor and abductor strength. Although the interrelation between disability and knee extensor strength was not evaluated in their study, these results indicate that CLBP negatively affects knee extensor strength (Cai & Kong, 2015). Taken into consideration with the results of our study, the diminished knee extensor strength in CLBP could be one of the reasons of the occurred disability in these patients.

In most studies examined the association between disability and muscle strength in patients with CLBP, strength of lumbar region muscles has been evaluated rather than that of lower limb muscles (Hu et al., 2017; Iwai, Nakazato, Irie, Fujimoto, & Nakajima, 2004; Pranata et al., 2017; Shin, 2020; Steele et al., 2019; Verbrugghe et al., 2020). One study reported that disability was negatively correlated with the ratio of the lumbar extensor and flexor strength in office workers with CLBP and suggested that improving the ratio of the lumbar extensor and flexor strength might be important in order to improve disability (Shin, 2020). Supporting this, Hu et al investigated correlations between lumbar neuromuscular function and pain, lumbar disability in patients with NS-CLBP. Both lumbar flexor and extensor muscles strength had a correlation with pain and function in different flexion and extension angles. Results suggested that the decrease of lumbar muscle strength leads to an increase in pain intensity and lumbar disability (Hu et al., 2017). Another study also examined the relationship between isokinetic trunk muscle strength and the functional disability level of NS-CLBP in collegiate wrestlers. Significant correlations between lumbar extensor parameters in different angles and disability were found. However, none of the trunk flexor parameters were significantly correlated with the disability. These results suggested that the relatively low strength of trunk extensors might be one of the factors related to disability level of NS-CLBP in collegiate wrestlers (Iwai et al., 2004). On the other hand, a more recent study reported that neither abdominal nor back muscle strength was associated with disability in NS-CLBP (Verbrugghe et al., 2020).

Pranata et al reported that lumbar extensor muscle force control was associated with disability in people with CLBP. They recruited 33 CLBP and 20 healthy people and compared force control of the lumbar extensors of the two groups. They found out that lumbar extensor muscle force control was compromised in CLBP group as compared to healthy individuals. In addition, the inability to accurately control muscle force production alone explained 19% of the variance of self-reported disability in CLBP group. Therefore, they concluded that the ability to control lumbar extensor muscle force is a significant predictor of self-reported disability in people with CLBP (Pranata et al., 2017). Another study published in 2019 showed that isolated lumbar extension strength was weakly correlated with disability in participants with CLBP, suggesting that improvements in isolated lumbar extension strength might be related to positive and meaningful clinical outcomes such as disability (Steele et al., 2019).

Some studies examined whether lumbar muscle strength training was able to increase the strength of lumbar muscles, thereby decreasing the disability level. Steele et al applied isolated lumbar extension resistance training at a frequency of once a week for 12 weeks in order to improve the strength of the lumbar extensors in participants with CLBP. Results of the study showed that

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isolated lumbar extension resistance training increased the strength of the lumbar extensors, thereby improving disability and pain in CLBP (Steele, Bruce-Low, Smith, Jessop, & Osborne, 2020). Similar to this study, Helmhout et al applied a progressive 11-week lumbar extensor strength training program, once a week to patients with CLBP and measured disability, pain intensity and sagittal lumbar mobility before and after the treatment. At the end of 11th week, statistically significant 23% to 36% decrease in disability and 28% decrease in pain was found. They concluded that specific lumbar strengthening showed clinically relevant improvements in disability and pain, whereas those improvements did not necessarily relate to improvements in lumbar mobility (Helmhout et al., 2017).

The major strength of this study is that, to the best of our knowledge, this is the first study to investigate the relationship between disability and the strength of knee and ankle joint muscles in patients with NS-CLBP.

There were some limitations to this study. We found that only right ankle dorsiflexor strength was significantly correlated with disability, not left ankle dorsiflexor strength. Lower limb dominance may be a contributing factor for the relationships between disability and lower limb muscle strength. Unfortunately, this variable was not examined in this study. Another limitation could be the use of hand-held dynamometry test instead of isokinetic muscle strength test, the "gold standard" method for evaluating muscle strength, because our department did not have an isokinetic dynamometer. A self-reported questionnaire, ODI, was used to assess disability in the present study. Although using self-reported questionnaires is an easy, quick, and apprehensible method, it should be remembered that results can be subjective.

In conclusion, the results of this study showed that lower limb muscle strength was associated with disability in patients with NS-CLBP. Physiotherapy interventions such as resistance training to increase the strength of knee extensor and ankle dorsiflexor muscles may be beneficial in improving disability in patients with NS-CLBP.

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