T. C.
YEDİTEPE UNIVERSITY
INSTITUTE OF HEALTH SCIENCES
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THE EFFECT OF 10-MINUTE FLEXION-INDUCING CYCLING WITHOUT FIXED RESISTANCE ON PAIN QUALITY OF LIFE AND FUNCTIONALITY IN PATIENTS WITH SPINAL CANAL STENOSIS

MASTER'S THESIS

SARİYE NUR KARACA, PT. MSc

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ONAY

Bu tez Yeditepe Üniversitesi Lisansüstü Eğitim-Öğretim ve Sınav Yönetmeliğinin ilgili maddeleri uyarınca yukarıdaki jüri tarafından uygun görülmüş ve Enstitü Yönetim Kurulu'nun ……. tarih ve ………. sayılı kararı ile onaylanmıştır.

Prof. Dr. Bayram YILMAZ

Sağlık Bilimleri Enstitüsü Müdürü

DECLARATION

I hereby declare that this thesis is my own work and that, to the best of my knowledge and belief. It contains no material previously published or written by another person, nor material which has been accepted for the award of any other degree except where due acknowledgment has been made in the text.

SARİYE NUR KARACA

DEDICATION

I dedicate my thesis to my friend Hasan Şimşek, who has always believed in me, trusted and supported me

SARİYE NUR KARACA

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ABBREVIATIONS

LSS : Lumbar Spinal Stenosis

NSAID: Nonsteroidal Anti-Inflammatory Drugs

ABSTRACT

Karaca, S. (2022). The effect of 10-minute Flexion-inducing Cycling Without Fixed Resistance on Pain, Quality of Life and Functionality in Patients with Spinal Canal Stenosis.Yeditepe University, Institute of Health Sciences, Department of Sports Physiotherapy and Rehabilitation, Master Thesis. Istanbul.

In this study, it was aimed to determine the effect of 10-minute non-resistance cycling exercise on quality of life and low back pain in patients with spinal stenosis. The study was carried out in the Tuzla Private Gisbir Hospital. A total of 20 patients diagnosed with canal narrowing was included in the study. Patients aged 65 and over, those with chronic diseases, and pregnant women were not included in the study. The ages of the patients with spinal stenosis included in the study ranged from 19 to 48, and the mean age was 31.60±9.38 years. Of the spinal stenosis patients included in the study, 11 (55%) were male and 9 (45%) were female. There was no significant relationship between the quality of life of patients with spinal stenosis and their age before and after 10 minutes of non-resistance cycling exercise ($p>0,05$).Although female patients with spinal stenosis achieved higher scores in all sub-dimensions of quality of life before and after 10 minutes of non-resistance cycling exercise, the difference in the quality of life by gender was significant here was no relationship between age and low back pain before and after 10 minutes of non-resistance cycling exercise.($p>0,05$) Although there was no significant difference between the low back pain levels of male and female patients with spinal stenosis before 10 minutes of non-resistance cycling exercise ($p>0,05$), it was observed that male patients had a significantly higher level of low back pain after exercise than female patients. Physical role difficulty($p=0,024$), social function ($p=0$) and pain level ($p=0$) were significantly higher after cycling exercise. In addition, it was observed that the total quality of life of the participants after 10 minutes of non-resistance cycling exercise increased significantly compared to before the cycling exercise ($p<0,05$). It was observed that the level of low back pain after cycling exercise decreased significantly compared to before exercise ($p<0,001$). Again, as a result of the study, it was seen that 10 minutes of non-resistance cycling exercise provided a significant improvement in the quality of life of the patients and a significant decrease in VAS scores.

As a result, it has been seen that non-resistance cycling exercise improves the quality of life and reduces the severity of pain in patients with spinal stenosis, which shows that non-resistance cycling exercises can be used to increase the quality of life and reduce the level of pain in patients with spinal stenosis.

Keywords: Spinal Stenosis, Non-Resistance Cycling Exercise, Quality of Life, Pain

ÖZET

Karaca, S.(2022). 10 Dakikalık Dirençsiz Bisiklet Çevirme Egzersizinin Ağrı, Yaşam Kalitesi ve Fonksiyonellik Üzerine Etkisinin İncelenmesi. Yeditepe Üniversitesi Sağlık Bilimleri Enstitüsü, Spor Fizyoterapisi ABD. , Yüksek Lisans Tezi. İstanbul.

Bu çalışmada spinal stenoz hastalarında 10 dakikalık dirençsiz bisiklet egzersizinin ağrı, yaşam kalitesi ve fonksiyonellik üzerindeki etkisinin belirlenmesi amaçlanmıştır. Çalışma Tuzla Özel Gisbir Hastanesi'nde gerçekleştirilmiştir. Çalışmaya kanal daralması tanısı konulan toplam 20 hasta dâhil edilmiştir. 65 yaş ve üzerindeki hastalar, kronik rahatsızlığı olanlar, gebeler çalışmaya dâhil edilmemiştir. Çalışmaya alınan spinal stenozlu hastaların yaşları 19 ile 48 arasında değişmekte olup, yaş ortalaması 31.60±9.38 tır. Çalışmaya 11(%55) erkek, 9 (%45) kadın spinal stenozlu hasta dâhil edilmiştir. Spinal stenozlu hastaların yaşam kalitesi ile 10 dakikalık dirençsiz bisiklet egzersizi öncesi ve sonrası yaşları arasında anlamlı bir ilişki bulunmamıştır ($p>0,05$). Spinal stenozlu kadın hastalar, 10 dakikalık dirençsiz bisiklet egzersizi öncesi ve sonrasında yaşam kalitesinin tüm alt boyutlarında daha yüksek puanlar elde etmesine rağmen, cinsiyete göre yaşam kalitesi farkı anlamlı bulunmuştur. 10 dakikalık dirençsiz bisiklet egzersizi öncesi ve sonrası yaş ile bel ağrısı arasında bir ilişki saptanmamıştır. Spinal stenozlu kadın ve erkek hastaların 10 dakikalık dirençsiz bisiklet egzersizi öncesi bel ağrı düzeyleri arasında anlamlı bir fark olmamasına rağmen, erkek hastaların egzersiz sonrası bel ağrısı düzeyinin, kadın hastalardan anlamlı düzeyde yüksek olduğu gözlenmiştir. Bisiklet egzersizi sonrası fiziksel rol güçlüğü ($p=0,024$), sosyal fonksiyon ($p=0$) ve ağrı düzeyi ($p=0$) anlamlı olarak daha yüksek çıkmıştır. Ayrıca katılımcıların 10 dakikalık dirençsiz bisiklet egzersizi sonrası toplam yaşam kalitelerinin bisiklet egzersizi öncesine göre anlamlı düzeyde arttığı gözlemlenmiştir ($p<0,05$). Bisiklet egzersizi sonrası bel ağrısı düzeyinin egzersiz öncesine kıyasla anlamlı şekilde düştüğü görülmüştür ($p<0,001$) Yine çalışma sonucunda 10 dakikalık dirençsiz bisiklet egzersizinin hastaların yaşam kalitelerinde anlamlı bir iyileşme sağladığı, VAS skorlarında da anlamlı düşüş sağladığı görülmüştür.

Sonuç olarak dirençsiz bisiklet egzersizinin spinal stenozlu hastalarda yaşam kalitesinde iyileşme sağladığı, ağrı şiddetini de azalttığı görülmüş olup bu da dirençsiz bisiklet egzersizlerinin spinal stenozlu hastalarda yaşam kalitesini artırmak ve ağrı düzeyini azaltmak için kullanılabileceğini göstermiştir.

Anahtar Kelimeler: Spinal stenoz, Dirençsiz Bisiklet Egzersizi, Yaşam Kalitesi, Ağrı

1. INTRODUCTION AND PURPOSE

In the world and in our country, low back pain is one of the reasons why patients often apply to hospitals and physical therapy units. Spinal stenosis is one of the diseases that cause low back pain. This disease, which significantly reduces the quality of life of patients, makes it difficult for people to continue their work and social life. In addition, it affects the psychology of people negatively. Patients who come to the Tuzla Private Gisbir Hospital with the complaint of low back pain, diagnosed with spinal stenosis by certain methods, were examined by the physical therapy physician of the hospital and started physical therapy sessions. Patients were taken for an average of 1 hour sessions every weekday for about 3 weeks. In addition to the classical physical therapy treatment methods, the patients were asked to cycle for 10 minutes without resistance. In spinal stenosis, in the flexion movement of the spinal vertebrae, in the canal there is a 19% enlargement, which increases the exercise tolerance of the patients. For this reason, the cycling exercise that encourages flexion was preferred. At the beginning of the 15-session treatment, the patients were asked to fill out a personal information form, an information form describing the study, and the sf36 short form to evaluate the patients' quality of life in the study, the oswestry low back pain disability questionnaire to evaluate its functionality, and the vas visual analog score questionnaire for pain assessment. At the end of 15 sessions, the questionnaires were repeated. Accordingly, the patients' pain, functionality and quality of life were compared before and after 15 sessions of non-resistance cycling exercise (30).

Spinal stenosis is one of the most common health problems, especially in older adults. Spinal stenosis, which significantly affects the quality of life of patients, continues to be one of the major causes of morbidity, disability and loss of productivity. In addition, it is one of the important spinal diseases that constitute a heavy burden for social security systems (1,2).Conservative or surgical methods are used in the treatment of spinal stenosis (3-5).

There is no clear veri on the effectiveness of surgical methods used in the treatment of spinal stenosis. When non-surgical conservative treatment methods are compared (3). In some studies on the subject, it has been reported that there is no significant difference between non-surgical and surgical methods. In the treatment of spinal stenosis in terms of long-term effectiveness, and most researchers state that non-surgical methods should be the primary option in the treatment of the disease (6).

Non-surgical treatment options for spinal stenosis include drug therapy, epidural injections, exercises, physiotherapy, lifestyle changes, etc. In a study conducted by Goren et al (7) on 45 patients with spinal stenosis, it was reported that there was a significant decrease in leg pain and disability levels in patients treated with exercise.

In another study conducted by Fang (8) on 50 patients with spinal stenosis, it was reported that the pain levels of patients who underwent lumbar extension exercise decreased and the Japanese orthopedic relationship score increased significantly.

Similarly, in the studies conducted by Hamerich (9), Lee and Sung (10), it was reported that exercise application in the treatment of spinal stenosis gives satisfactory results.

As can be understood from the explanations above, spinal stenosis is a health problem that causes pain in individuals and negatively affects functionality and quality of life. Although studies have been conducted on its treatment, it has been observed that studies on the effectiveness of non-surgical methods are limited.

Spinal stenosis is one of the important health problems that significantly reduce the quality of life and reduces functionality in individuals. Therefore, it causes a significant loss of workforce, especially in business life. In this study, it was aimed to determine the effect of non-resistance cycling exercise on functionality, pain and quality of life in patients with spinal stenosis, and in this context, important data were obtained about the effectiveness of non-resistance bicycle exercise, taking into account the results obtained from the study.

In this study, it was tried to determine the effectiveness of non-resistance cycling exercise in the treatment of spinal stenosis, which causes severe pain and significantly reduces quality of life and functionality. The aim of the study was to return patients with spinal stenosis to their normal lives as soon as possible.

The fact that there is no previous study of the subject is extremely important in that the results obtained from this study are the first in the literature. In the study of Yakut et al. (108), the Cronbach's alpha value of the Oswestry Low Back Pain Disability Index Scale was found to be 0.89.

2. THEORETICAL FRAMEWORK AND LITERATURE REVIEW

2.1. Lumbar Region Anatomy

The vertebral column is a complex multi-joint system that supports the head and trunk throughout posture and movements, protects the spinal cord, nerve roots and vertebral arteries in the cervical region, and is controlled by muscles (11). Columna vertebralis, also known as the vertebral column, is composed of 7 cervical, 12 thoracic, and 5 lumbar vertebrae, along with the sacrum and coccyx. The sacrum and coccyx (5 vertebrae in the sacrum and 4 vertebrae for the coccyx), formed by the fusion of the vertebrae, do not have the ability to move unlike other regions (12).

2.1.1. Lumbar Vertebra

The lumbar region consists of 5 vertebrae and with its thick structure, it is the strongest of the mobile vertebrae (12). Each lumbar vertebra mainly consists of two main parts, the vertebral body and the neural arch, and the vertebral body extends anteriorly and increases in size caudally. The neural arch, on the other hand, consists of structures formed by a pair of pedicles merging with double laminae located posterior to the vertebral body (13). Figure 2.1 shows the structure of the lumbar vertebra.

From L1 to L5, the vertebral body transforms from slightly concave posteriorly to slightly convex, and a gradual increase in diameter is observed in parallel with the body's load distribution (14). There is a vertebral foramen between the vertebral body and the neural arch, and by the union of all vertebrae, it forms the vertebral canal in which the medulla spinalis is located (12).

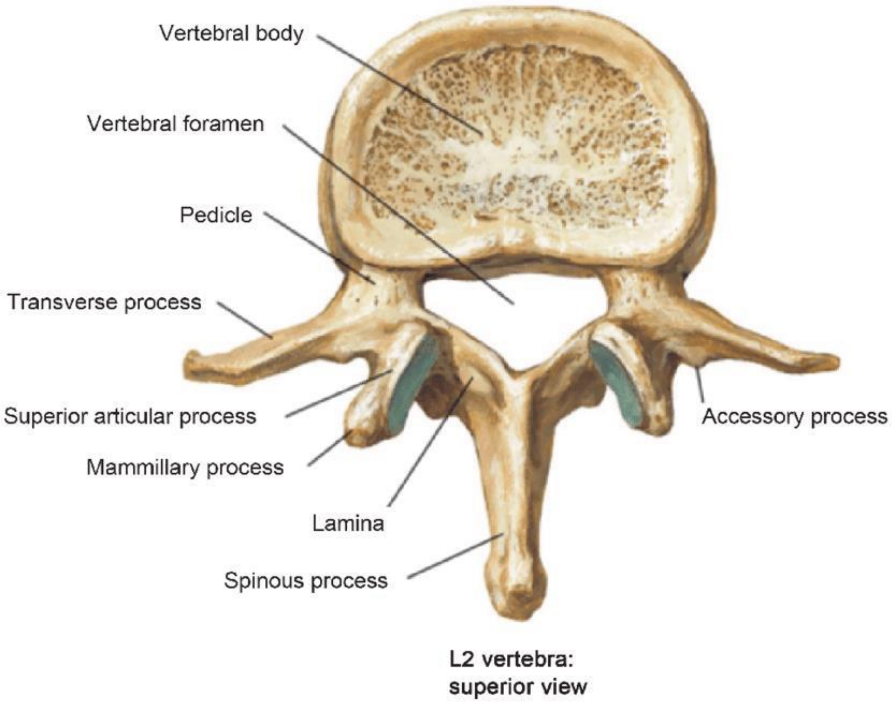

Figure 2. 1. The structure of the lumbar vertebra (15)

The pedicle starts from the lateral side of the vertebral body and curves backwards and joins with the transverse process. The part between the transverse and spinous process is known as the lamina. The right and left laminae join posteriorly to form the spinous process. The articular surfaces located superior and inferior to the vertebral pedicles unite when the vertebrae are loaded on top of each other to form the foramen intervertebrale. The spinal nerves and vessels are located in these foramina (16). While the anterior part, consisting of the vertebral body and discs, is responsible for shock absorption and load bearing, the posterior part, consisting of facet joints, is involved in the protection of neural structures (17).

2.1.2. Spinal Movement Segment

The spinal movement segment, also known as the functional spine unit, is the smallest physiological movement unit that revelations the biomechanical features of the columna vertebralis (18). The intervertebral disc between two successive mobile vertebrae is formed by the facet joints and ligaments. The spinal motion segment is shown in Figure 2.2.Columna vertebralis is specialized to provide physical stability, structural integrity and flexibility (12).

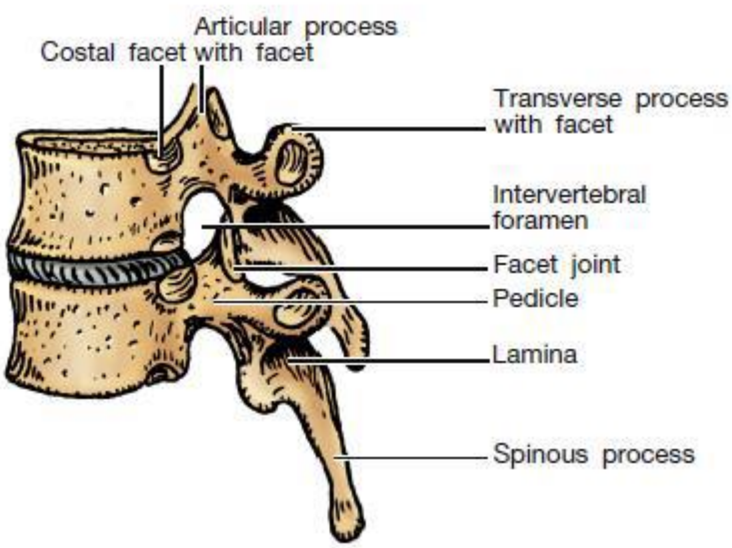

Figure 2. 2. Spinal motion segment (12).

2.1.2.1. Intervertebral Disc

Intervertebral discs, which have a non-vascular structure, are located between adjacent vertebral bodies. They allow flexion, extension and lateral flexion movements (13). There are 3 intervertebral discs in total, the first of which is located between the C2-C3 vertebral bodies and the last one is located at the lumbosacral junction. The discs are thinnest in the upper thoracic part of the colona vertebralis and thickest in the lumbar region (12). Each intervertebral disc consists of 3 parts in the form of the nucleus pulposus, annulus fibrosis and vertebral end plate. Figure 2.3 shows the structure of the intervertebral disc.

The nucleus pulposus forms the central part of the disc and is surrounded by the annulus fibrosus peripherally. The nucleus pulposus is a gel-like structure in the lumbar region and consists of water, proteoglycan and collagen. It contains 70-90% water in its content, but this ratio decreases with age. At the same time, 15-20% type-II collagen in its structure increases the resistance of the disc biomechanically under pressure. In the annulus fibrosus, on the other hand, there is more type-I collagen in the annulus and it appears more intense in the outer annulus.

In addition, the elastic fibers in its structure contain approximately 10% of the annulus fibrosus and are located circularly, obliquely and vertically within the lamellae of the annulus. Thus, it gives the disc its shape and undertakes the main task in shock absorption. They seem to be concentrated at the attachment sites of the vertebral endplate and the annulus. The vertebral endplate consists of two cartilage layers that surround the disc superiorly and inferiorly and have similar structural content with other disc structures (19).

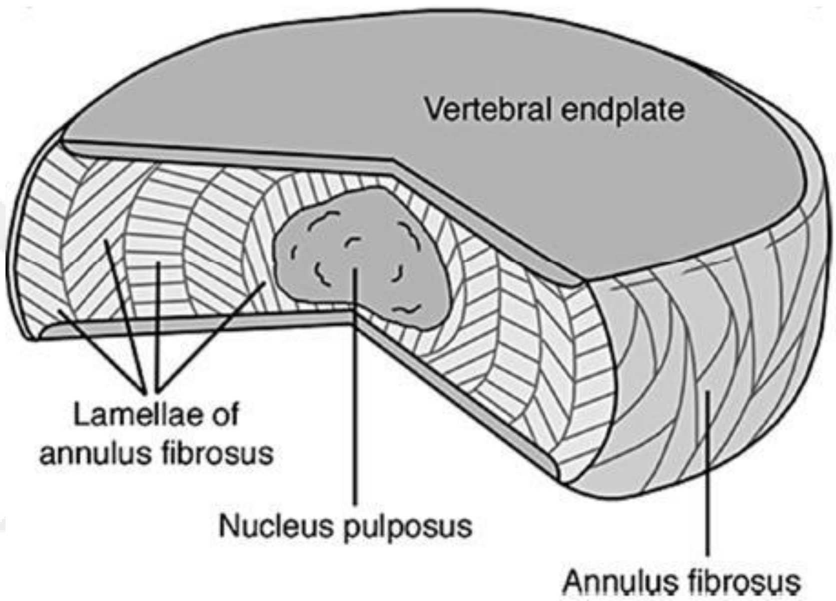

Figure 2. 3. The structure of the intervertebral disc (20).

The primary function of the disc is to transmit loads from one vertebral body to the other vertebral body by allowing movement between the vertebral bodies. Due to the flexible structure of the annulus fibrosus, it can withstand loads, and due to its gel structure, the nucleus puplosus is compressed to provide an effective spring mechanism to the disc (19).

The primary functions of the disc are to allow movement between the vertebral bodies and to transmit loads from one vertebral body to another. Thanks to the flexible structure of the annulus fibrosus, it can withstand loads and the nucleus pulposus can be compressed due to its gel structure, providing an effective spring mechanism to the disc (19).

2.1.2.2. Facet Joint

The facet joint, also known as the zygapophyseal joint, is a synovial type joint formed between the concave inferior articular surface of the upper vertebra and the convex superior articular surface of the lower vertebra in the lumbar region (19). Basically, it controls the direction and width of movement and plays a role in the sharing of loads in the column vertebralis (11).

The facet joint allows flexion and extension movements in the sagittal plane and thus plays an important role in the stabilization of the lumbar region. It also prevents excessive torsion of the intervertebral disc by limiting axial rotation (21). Facets, which also try to prevent the shearing movement between the two vertebrae that are articulated with each other, play a role in the prevention of spondiolisthesis (22).

2.1.2.3. Lumbar Region Ligaments

Spinal ligaments are uniaxial structures with high collagen content that connect the vertebrae along the columna vertebralis. In order not to damage the neurological structures surrounding the vertebrae, they enable the columna vertebralis to move within certain limits (23). Ligaments belonging to the lumbar region are given in Figure 2.4.

Anterior longitudinal ligament (ALL): It originates in the occiput anterior to the foramen magnum and attaches firmly to the inside of the sacrum by being firmly attached at the periosteum. While all parts of the ALL are attached to the midsection of the vertebral body, they are not tightly attached to the annulus of the intervertebral disc. It helps to limit the extension in the lumbar region and prevent the increase in lumbar lordosis (24).

Posterior longitudinal ligament (PLL): It is the ligament that attaches to the back of the vertebral body and the discs and extends from the occiput to the saddle. It is wider in the cervical part, but narrow in the vertebral body in the thoracic and lumbar regions, and wide on the discs. During flexion, the posterior longitudinal ligament works to stabilize the vertebral column (13). Compared to the anterior longitudinal ligament, the posterior longitudinal ligament has multiple nociceptors and acts as an alarm for some pathologies in the intervertebral disc (24).

Ligamentum flavum: It is located between the laminas of two adjacent vertebrae and fills the entire interlaminar space. It consists mainly of yellow elastic fibers extending in the vertical direction (13). The ligament, which is under tension even in upright posture, helps the vertebral column return from flexion to an upright posture (24). In the lumbar vertebra, the ligamentum flavum is quite thick, but its hypertrophy or thickening is a common cause of spinal stenosis (13).

Supraspinous ligament: It lies posteriorly on the spinous processes of two adjacent vertebrae. Together with the intertransverse and interspinous ligaments, it resists the flexion and shearing forces of the vertebral column (17,19).

Interspinous ligament: It lies between the spinous processes of two adjacent vertebrae and blends with the inner surface of the supraspinous ligament. The lumbar region has a relatively stronger structure compared to other regions (12).

Intertransverse ligament: The ligament that connects the transverse processes has a very thin and membranous structure in the lumbar vertebrae (24). Lumbar regional ligaments are shown in Figure 2.4.

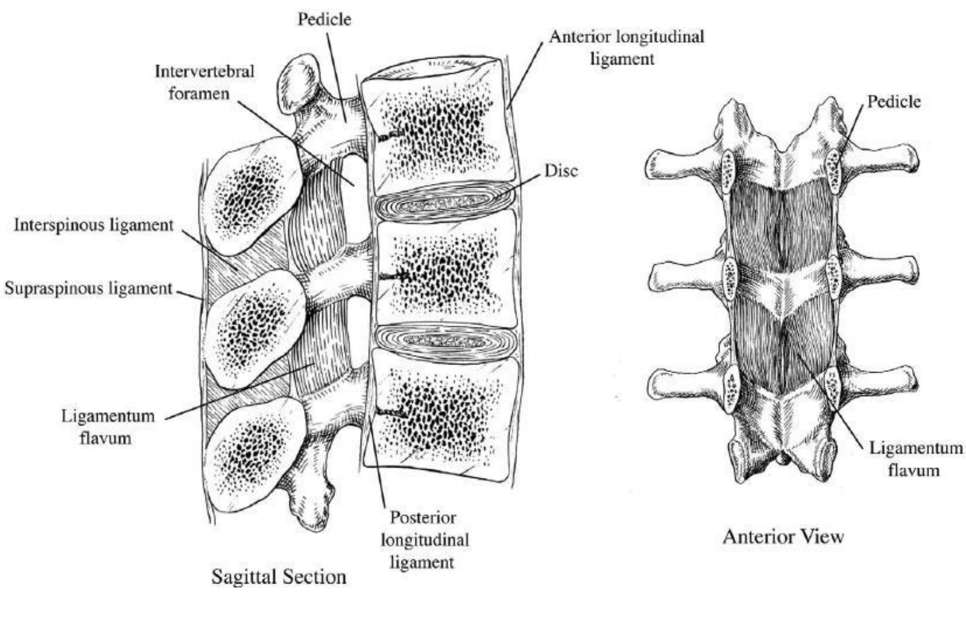

Figure 2. 4. Lumbar region ligaments (13).

2.1.3. Lumbar Region Muscles

The lumbar region contains several major muscle groups involved in stabilization and motor movements. These muscles; erector consists of spina, multifidus, transversus abdominis, rectus abdominis, internal oblique, external oblique, psoas major, quadratus lumborum and latissimus dorsi (25).

M. Erector spina: The muscle, which is divided into 3 parts as iliocostalis, longissimus and spinalis, is responsible for the extension and lateral flexion of the vertebral column. It also helps rotation in the cervical region.

Iliocostalis muscle: It extends from the posterior sacrum and ilium to the posterior ribs and transverse processes of the lumbar-cervical vertebrae.

Spinal Muscle: It is the muscle that extends from the lower thoracic and upper lumbar spine to the lower cervical vertebrae. The erector spina muscle, innervated by the dorsal branches of the spinal nerves, provides detailed stabilization and movement (26).

M. Multifidus: The fascicles of the muscle covering the laminae of the lumbar vertebrae, starting from the L1 spinous process, attach to the mammillary process of the L3-S1 vertebra (27). It undertakes the task of extension of the trunk bilaterally and rotation of the trunk to the opposite side unilaterally. It is stimulated by the dorsal branches of spinal nerves (26).

M. Quadratus Lumborum: It starts from the Crista iliaca and iliolumbar ligament and attaches to the lower anterior surface of the 12th rib and the transverse processes of the first 4 lumbar vertebrae. It stabilizes the 12th rib during breathing and assists in lateral flexion (28). The quadratus lumborum muscle is innervated from the ventral branches of the spinal nerves between T12-L3 (27).

M. Transversus abdominis: It is the deepest of the abdominal muscles. Starting from the inner surfaces of the last six ribs, the muscle wraps around the waist up to the linea alba. It protects the abdominal organs by compressing and helps expiration.

Innervation occurs with anterior branches of T7-T12 spinal nerves and L1 spinal nerve (26).

M. Rectus abdominis: It is divided into two by the vertical linea alba. It starts from the pubis crista and attaches to the 5th-7th ribs with the processus xiphodeus. It flexes the trunk when it works bilaterally, and lateral flexes the trunk when it works unilaterally (26).

M. oblicus external abdominis: It is a large, wide muscle on the lateral side of the abdominal wall (27). The external oblique muscle starts from the outer surfaces of the 5th-12th ribs and extends anteriorly and inferiorly to the ilium, inguinal ligament, and linea alba. It is involved in trunk flexion bilaterally, lateral flexion of the trunk unilaterally and rotation to the opposite side. It is innervated by the ventral branch of the last six thoracic nerves (26).

M. oblicus internal abdominis: The muscle starts from the lateral thoracolumbar fascia, crista iliaca and inguinal ligament, and ends with the inner surface of the last 3 ribs and the linea alba. It is involved in trunk flexion bilaterally, lateral flexion of the trunk unilaterally and rotation to the same side. Innervation is provided by anterior branches of T7-T12 spinal nerves and L1 spinal nerve (26).

M. Latissimus dorsi: It is called the gill muscle and can affect lumbar stability through the thoracolumbar fascia (24). It is a large muscle that runs in the back. The muscle extending to the sacrum through the posterior crista iliac, T7-L5 spinous process and thoracolumbar fascia attaches medially to the humeral bicipital groove. It takes part in shoulder adduction, extension and internal rotation movements. It is innervated by the thoracodorsal nerve (26).

M. Psoas major: The muscle connecting the trunk and lower extremities, starting from the transverse processes and discs of the T12-L5 vertebrae, and ending in the lesser trochanter of the femur. The psoas, quadratus lumborum and erector spina muscles together provide stabilization between the trunk and pelvis. They also perform anterior tilt of the pelvis in standing posture. Its innervation occurs with spinal branches between L1-L4 (26).

2.1.4. Lumbar Region Innervation

Spinal nerves consist of ventral and dorsal roots that leaving from spinal cord and entering the spinal cord. There are 11 pairs of spinal nerves such as 5 lumbar, 5 sacral and 1 coccygeal nerves in the lumbar region. The ganglia of most of the lumbar spinal nerves are located in the intervertebral foramen, where each spinal nerve divides into a small dorsal and a large ventral branch. Of these, the dorsal branch extends posteriorly to innervate the spinal ligaments, muscles, and dorsal skin, while the ventral branch is longer than the dorsal branch and extends infero-laterally in the lumbar region to form the lumbar and sacral plexuses. The lumbar plexus consists of the ventral branch of the L1, L2, L3 and L4 nerves.

The femoral nerve passes under the inguinal ligament to innervate the hip flexor and knee extensor muscles is the largest lumbar plexus branch. The sacral plexus, which consists of the vental branch of the L4, L5 and S1, S2 nerves, supplies the peripheral nerves in the pelvis to innervate the hip, perineum and lower extremities (13).

2.1.5. Lumbar Region Bleeding

Segmental arteries originating from the intercostal and lumbar arteries are the main source of blood supply to the lumbar region. Each segmental artery gives a spinal branch to the vertebrae, spinal cord, and cauda equina. The spinal cord branches enter the spinal cord through the intervertebral foramen and anastomoses of the lower and upper spinal arteries. A single anterior spinal artery, double posterior spinal artery, and radicular arteries are the main sources of nutrition to the spinal cord (13).

2.1.6. Lumbar Region Kinematics

The lumbar region characteristically has a physiological curvature called lordosis. Intervertebral joints constitute 1/3 of the lumbar vertebrae and are positioned high. This placement facilitates flexion and extension, but complicates lateral flexion. As a result of the researches, flexion in the lumbar region is 22-36° and the extension is 16-21°. Lateral flexion does not exceed 20-30°, and apart from the intervertebral joints, the quadratus lumborum muscle also limits the movement. Rotation as a result of anatomical placement is quite limited. As a result of cadaver studies, it shows the rotation of 7-14° for each direction (29).

A healthy adult in standing upright has 40-45° lordosis. Lumbar lordosis is more common in women and the biggest differences are seen after the age of 50. In sitting, lordosis decreases to 20-35°. Compared to normal stance, full flexion of the lumbar spine increases the intervertebral foramen diameter by 19% and the vertebral canal volume by 11%. Therefore, therapeutically, lumbar flexion is often used to temporarily relieve pressure on a lumbar nerve root caused by occluded foramen. However, this situation may growth the pressure on the anterior of the disc and cause the nucleus to be displaced posteriorly and the pressure on the nerve root may increase. Lumbar extension decreases the diameter of the intervertebral foramen by 11% and the vertebral canal volume by 15%. Therefore, hyperextension activity is limited in individuals with stenosis (30).

2.2. Spinal Stenosis

2.2.1. History

Spinal stenosis was first described in 1883. Verbiest made its first modern definition in 1954 (31). Verbiest reported that congenital stenosis of the spinal canal is the main factor in many patients. He stated that further narrowing of the spinal canal with secondary wasting changes caused the symptoms to occur. The term neurogenic claudication, which has a characteristic symptom, was first used by Dejerine in 1911 and in 1948 Van Gelderen defined neurogenic claudication as "low back pain caused by localized bony narrowing of the spinal canal and clinical symptoms and signs associated with stress in the legs" (32).

2.2.2. Definition and Classification

Spinal stenosis is classified according to the affected area, the affected area of the vertebral segment, and the specific pathological cause. The stenosis may involve a specific area or all regions. In addition to this classification, lumbar spinal stenosis is also classified as relative and absolute stenosis (33).

Table 2. 1. Classification of spinal stenosis

Anatomical		**Pathological**			
Anatomical Area	Anatomical Region	Congenital	Degenerative	Idiopathic	Metabolic
Servical	Central	Achondroplastic	Osteoarthritis		Paget's Disease
Thorasic	Lateral recess	Congenital forms of spondylolisthesis	Inflammatory arthritis		Fluorosis
Lumbar	Foraminal	Scoliosis	Diffuse idiopathic skeletal hyperostosis		
	Extraforaminal	Kyphosis	Scoliosis		
			Degenerative forms of spondylolisthesis		

Reference: Postacchini, F. (1996). Management of lumbar spinal stenosis. The Journal of Bone and Joint Surgery. British volume, 78(1), 154-164

2.2.3. Epidemiology

Spinal stenosis is usually seen in elderly individuals (34). Its exact prevalence is not known, but it increases with age due to degenerative pathogenesis and is rarely seen in individuals under 50 years of age (35).

Jensen et al. (35) stated in their study that the estimated prevalence of lumbar spinal stenosis in the general population is 11%. The prevalence of lumbar spinal stenosis is estimated to be approximately 47% in people over the age of 60 (34,36).

In addition, lumbar spinal stenosis is a communal reason for surgical interventions for the vertebral column in individuals over the age of 65 (4,37).

2.2.4. Pathoanatomy

Intervertebral discs constitute the basis of degenerative changes seen in spinal stenosis pathologies (38,39). With the decrease in the building block materials of the intervertebral disc and the arthritis of the facet joints, disc degeneration increases and constitutes the first step in the pathogenesis of spinal stenosis (40).

As the nucleus of the disc degenerates, its height decreases, and changes occur in the annulus structure. Since these changes reduce the ability of the anterior column of the vertebral column to absorb stress and increase the load on the posterior column, the increased stress on the facets leads to facet joint hypertrophy, osteophyte formation and ligation. Depending on the combination of these conditions, spinal canal narrowing and compression in the neural elements occur (37,41).

The central canal is a structure surrounded by the vertebral body anteriorly, intervertebral disc, posteriorly laminae, lateral pedicles and facet joints, and posterior and lateral ligamentum flavum (42). Central spinal stenosis at the level of the intervertebral disc, lig. flavum hypertrophy, disc protrusion, facet joint hypertrophy and degenerative spondylolisthesis causes (43).

According to Lee et al. (44), the lateral part of the spinal canal consists of inlet, middle and outlet parts (Figure 2.5). The cause of lateral spinal stenosis in the entry area known as lateral recess is especially superior joint facet hypertrophy and posterior disc herniations. The foraminal height between the pedicles varies between 17-23 mm, and the foraminal width formed in the antero-posterior direction varies between 8-10 mm. It has been reported that a foraminal height of less than 15 mm and a foraminal width of less than 4 mm causes stenosis, which leads to nerve root compression at a rate of 80%. The foraminal stenosis in this exit region is caused by subluxation, facet joint hypertrophy, and osteophytic protrusions superior to the disc (43).

Foraminal stenosis is more common in the lower lumbar segments. It occurs mostly at L5 (75%) level and this rate decreases as the upper levels are reached (45). Lumbar spinal pathoanotomy is given in Figure 2.5.

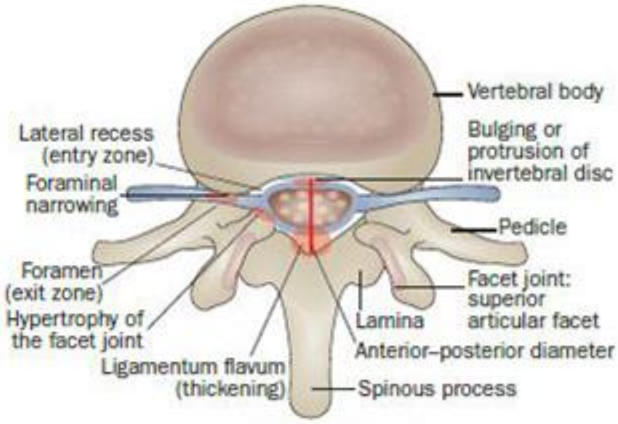

Figure 2. 5. Lumbar spinal pathoanatomy (32).

Extension of the vertebral column leads to posterior protrusion of the intervertebral disc and lig. It contributes to the overflow of the flavum and causes narrowing of the spinal canal (46). Willén et al. (47) informed a reduction in the cross-sectional area of the central canal during extension and axial compression. Depending on the degree of degeneration, central, lateral, and foraminal stenosis may develop alone or in combinations. Among the intervertebral discs, LSS occurs mostly at the L4-L5 level. Then L3-L4, L5-S1 and L1-L2 levels are accepted (32,48).

2.2.5. Pathophysiology

Spinal stenosis occurs as a result of spinal canal insufficiency as a outcome of changes in joint structure. It develops as a consequence of degenerative changes that occur between the intervertebral disc and two adjacent vertebral bodies and facet joints in this joint complex. When degeneration starts in one of these joints, it affects other joints as well. In addition, pathological changes that begin in three joints at one level begin to cause changes at the upper and lower levels.

In the lumbar spine, the first changes in the intervertebral disc begin in the second decade of life. According to the biomechanical characteristics of the lumbar spine, the changes start from the caudal side and progress towards the cranial spines. Although disc degeneration in the lumbar spine after the fifth decade is at different degrees in humans, this situation is mostly at L4-L5 and L5-S1 levels (49,50).

The most important structure that plays a fundamental role in spinal stenosis pathology is intervertebral discs. Biomechanically, it consists of three basic building blocks; water, collagen and proteoglycans. These 3 basic structures make up 90-95% of the normal disk volume. Water makes up a significant portion of the disc weight and causes mechanical forces to be dissipated. The water volume of the disc decreases with increasing age (51,52). As the nucleus pulposus becomes dehydrated, its ability to distribute the load forces on it is lost and ruptures occur in the annulus fibrosus.

Collagen, which is spread laminarly in the intervertebral disc, creates the tensile strength and flexibility of the disc. While there is type 2 collagen with higher water retention in the structure of the nucleus, type 1 and type 2 collagen are found in almost equal amounts in the annulus, while the type 1 collagen content increases with age (51,52).

Proteoglycans provide the hydrodynamic and electrostatic possessions of the disc. The ability of the disc to resist the compression force is due to the proteoglycans present in higher proportion in the nucleus than in the annulus. Depending on aging and degeneration, proteoglycan production decreases and its content changes in the annulus fibrosus and nucleus pulposus.

As a result of the degeneration event, fibrous tissue is formed depending on the process that causes the narrowing of the disc space over time. Due to the narrowing of the distance, it can be seen that the excess of the ligamentum flavum and the epidural fat suppress the spinal canal and spinal roots. Decreased intervertebral disc distance leads to stretching of ligaments and ligaments, resulting in increased mobilization. Thus, increased mobilization causes degeneration and ligament tears due to excessive mobilization of the ligaments in the bilateral facet joints. Thus, it leads to instability and spinal stenosis (53,54). Figure 2.6 shows the structure of lumbar spinal stenosis.

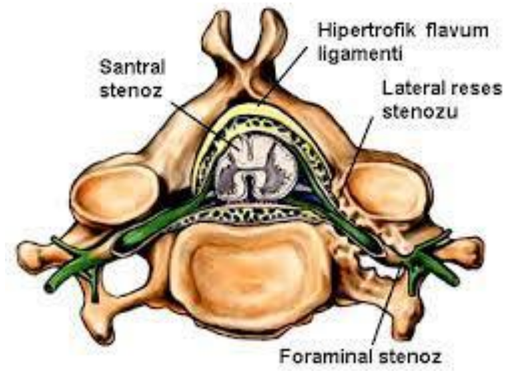

Figure 2. 6. Lumbar spinal stenosis (53).

Degeneration in spinal stenosis may begin with synovitis in the facet joints. As synovitis progresses over time, the articular cartilage becomes thinner. This causes facet joint subluxation. As the subluxation continues, subperiosteal osteophytes begin to develop in the advanced period (55). Over time, osteophytes in the facet may cause facet joint hypertrophy, and over time, the joint stabilizes with periarticular fibrosis.

In the lumbar spine, facet joints are located sagittally, if facet joint degeneration progresses slowly during disc degeneration, the patient develops retrolisthesis, but if facet degeneration progresses faster than disc degeneration, there is no anterolisthesis (56).

Spinal stenosis may be produced by facet hypertrophy, ligamentum flavum hypertrophy, intervertebral disc protusion and spondylolisthesis at this level (54,57).

In spinal stenosis, degenerations may occur in neural formations over time, thus neurological disorders may occur.

The lumbar canal consists of three anatomical zones;

Entry zone: It is the subarticular zone, also called lateral reset. This is where the nerve root enters the canal.

Middle zone: This zone, also named the central zone, is located under the pars interarticularis.

Exit zone: intervertebral foramen. The foraminal region where the spinal nerve exits is also called the extrapedicular area (58).

The normal height of the lateral recess in the lumbar spine is 5 mm or more. A lateral recess height of 3-4 mm suggests stenosis, while 2 mm or less indicates absolute stenosis (59).

In the lateral recess, there are that protect the nerve root consisting of epidural fat and vein against compression. Since the veins are without valves, blood flow is provided by postural movements. While the narrowed lateral recess loses its epidural fat, the venous structures are not resistant to compression. As a result, the nerve roots are subjected to compression.

Spinal stenosis most commonly happens at L3-L4 and L4-L5 levels. Spinal stenosis at the L5-S1 level is very rare. The main reason is that the channel is wider at this level.

The most important physiopathological hypothesis for the lumbar stenosis was first established by Porter and Ward (60) based on clinical observations and studies and with the concept of two-level stenosis. They noticed that the neuronal structures were compressed in at least two anatomical areas, usually multilevel or both in the central and foraminal regions. Then they created the "double collision" theory. In this theory, they suggested that the symptoms are due to pressure on the vascular structures in the cauda equina or pressure in the nerve root complex due to degenerative changes. Radiologic measurements in lumbar spinal stenosis are given in Table 2.2.

Table 2. 2. Radiological measurements in the lumbar spinal stenosis

Central spinal stenosis anteroposterior diameter	Stenosis 10-12 mm	Absolute Stenosis < 10 mm
Lateral Recess Stenosis	Height ≤ 2 mm	Depth ≤ 3 mm
Foraminal Stenosis	Diameter 2-3 mm	

Reference: Porter, R. W., & Ward, D. (1992). Cauda equina dysfunction. The significance of two-level pathology. *Spine*, *17*(1), 9-15

2.2.6. Symptoms

Intermittent neurogenic claudication (INC) is characteristically seen in lumbar spinal stenosis. At the same time, symptoms for example low back pain, radicular pain and/or numbness in the legs and neuropathic pain are also observed (61). Patients also frequently report complaints such as loss of balance, sensory loss (numbness, tingling) and weakness in the lower extremity muscles (39).

These symptoms may occur due to neurovascular mechanisms such as decrement of arterial flow in the cauda equina, increased epidural pressure, venous occlusion, nerve root infiltration, direct pressure to the central canal or lateral recess (61).

Commonly, LSS has an insidious onset. Symptoms may appear months later. Neurogenic claudication develops, in which complaints of tingling, numbness, weakness in the lower extremities, and pain radiating from the vertebral column to the hips and legs when walking or standing for a long time are described (48,62).

The increase or emergence of symptoms depending on the posture is called INK (63). Intermittent neurogenic claudication; It is the most common clinical manifestation of LSS, causing leg pain, low back pain, and weakness affecting ambulation ability (64).

Symptoms depend on posture, appear with standing and trunk extension, worsen when walking, and improve with sitting and trunk flexion (39). Neurogenic claudication should be considered in the presence of paresthesias with lower back pain that occurs in extension of the trunk, descending a slope. Patients with neurogenic claudication can better tolerate functions with increased trunk flexion, such as walking uphill and using a shopping cart (65). Thus, in order to reduce pain, patients have reduced lumbar lordosis and a forward-leaning posture (66).

In addition to neurogenic claudication, radicular symptoms may also occur in LSS (67). Neurogenic claudication and axial back pain are mainly associated with central stenosis, and pain in central stenosis is typically bilateral (62). In contrast, patients with only foraminal or lateral recess stenosis commonly report symptoms similar to unilateral radiculopathy (68). These symptoms, which mostly occur as rest and night pain, are found in younger patients (67).

2.2.7. Vascular Claudication

Cladication, which is defined as pain associated with walking and caused by peripheral vascular diseases, is called intermittent vascular claudication (IVC) (69) this symptom associated with peripheral arterial diseases, usually caused by atherosclerosis in the arteries supplying the lower extremity (70). Intermittent vascular claudication occurs as a result of muscle ischemia resulting from occlusion of arterial flow during exercise (71).

The narrowing of the arterial vessels causes a decrease in the level of blood flow necessary to meet the metabolic demands of the lower extremity musculature (72). In addition, the prevalence of atherosclerotic plaque formation in diabetes and its more distal occurrence cause atypical IVC in individuals (73).

In addition to an arterial etiology, IVC may be due to venous deficiency, in which case pain may occur when standing and sitting with the legs in a fixed position (74).

Compression occurring in the iliac veins in the lower extremity, and impaired blood flow back cause pain, fatigue, and IVC, which is called venous claudication, in the lower part of the leg (75).

Contrary to arterial claudication, pain in venous claudication is relieved by resting the legs for 15-20 minutes (76). Intermittent vascular claudication is characterized by cramping and pain, particularly of the calf muscles (34).

Symptoms are not posture dependent and improve with rest (62). It has also been stated that individuals with IVC have lower functional capacity and reduced muscle strength (77). At the same time, it has a negative effect on various aspects of quality of life and work performance of individuals (71).

Peripheral arterial diseases (PAH): It has similar risk factors as coronary artery insufficiency, including family history, hypertension, diabetes, smoking, hyperlipidemia (78).

In addition, the prevalence of claudication is a common problem that increases by 0.6-10% with age (79). In this context, it is stated that 30% of individuals have claudication symptoms within the PAH disease prognosis. As a result, it is shown that a significant percentage is not identified, resulting in inadequate intervention (80).

Since both LSS and arterial insufficiency are often related with degenerative conditions, their prevalence increases with aging (81). Thus, arterial insufficiency and spinal stenosis can coexist. This may cause both claudication to be seen in the patient at the same time (69,81,82).

Most elderly individuals with vascular claudication do not apply to clinics, thinking that the symptoms occur with age. Therefore, peripheral vascular disease evaluation is required in LSS, which increases with age (83).

Park and Lee (84) stated that in individuals diagnosed with LSS, the presence of arterial disease and therefore the presence of IVC should be considered simultaneously. In order to carry out a successful treatment, the claudication causing disability must be diagnosed correctly. Because an untreated circulatory disorder causes an increase in LSS symptoms (84,85).

While symptoms are triggered by standing, relief by sitting, symptoms above the knees are specific to INC, relief of symptoms with standing and symptoms below the knees suggest the possibility of INC (85). Table 2.2 shows the differences between vascular claudication and neurogenic claudication (34,86).

Vascular evaluation is the most important component in the examination of patients who present with vascular claudication symptoms (80). The ankle-brachial index (ABI) test is used as a standard for questioning the presence of peripheral vascular disease. Under physiological conditions, the ABI in the supine position is close to 0.9-1.4. ABI values fall below 0.9 in patients with arterial disease. A value below 0.4 is associated with critical limb ischemia (87).

In venous claudication, the other component of vascular claudication, there is a pulse, but it can be prevented by swelling in the legs. Varices, pigmentation and venous ulcers may be evidence of venous insufficiency causing venous claudication. However, according to the ABI, it is stated that approximately half of the patients who are stated to have vascular problems do not have claudication symptoms (88). Therefore, the presence of pathology should be detected with advanced imaging. Table 2.3 shows the comparison of vascular and neurogenic claudication symptoms.

Table 2. 3. Comparison of vascular and neurogenic claudication symptoms

	Vascular	Neurological
Pain location	Leg	Back, hips, thighs
Pain Type	Cramp, dull, tight/Distal to proximal	Radicular, sharp, numb, tingling/Proximal to distal
Aggravating factors	Activity, walking	Walking/standing upright, trunk extension
Mitigating factors	Resting	Trunk flexion
The onset of relaxation	Immediately	In minutes
Walking Distance	Stable	Unstable
bike test	Positive (painful)	Negative
Uphill walking	Painful	Painless
Atrophy	Rare	Sometimes
Skin	Hair loss, shiny	-
Pulse	Unavailable	Available

Reference: Murabito, J. M. Evans, J. C. Nieto, K. Larson, M. G. Levy, D. & Wilson, P. W. (2002). Prevalence and clinical correlates of peripheral arterial disease in the Framingham Offspring Study. *American heart journal*, *143*(6), 961-965.

Venous occlusion can be confirmed by venography, duplex ultrasound, or magnetic resonance venography (89). Doppler ultrasonography (DUS), magnetic resonance angiography, and computed tomography angiography are the non-invasive imaging methods used to determine the arterial lesion location (80,90).

Doppler ultrasonography has a high level of evidence as an easy and inexpensive method to determine the location of arterial disease in the lower extremity, to monitor the flow dynamics of peripheral vessels in the lower extremities (80).

In the treatment of vascular claudication, it is aimed, firstly, to reduce the risk of cardiovascular problems through secondary prevention, and secondly, to improve the symptoms of claudication (71). In addition to drug therapy, secondary risk factors include smoking cessation, weight management, appropriate diet, exercise and walking programs (80). Exercise, oral drug use and percutaneous transluminal angioplasty methods are used for the symptomatic treatment of vascular claudication (71,80).

2.2.8. Diagnosis

Lumbar spinal stenosis clinical syndrome is usually diagnosed through the combined analysis and interpretation of radiographic findings of lumbar stenosis, such as patient history, physical examination, computed tomography (CT) and magnetic resonance imaging (MRI) methods (32,39,62).

2.2.8.1. Physical Evaluation

The clinical finding of LSS and the exclusion of other possible analyses are important in terms of determining the characteristics of the symptoms, patient history, movement evaluation, balance tests, walking tests, sensory-motor tests, treadmill test, palpation of peripheral pulses and ABI. Differential diagnosis is required to exclude spinal tumors, peripheral and diabetic neuropathies, iliac artery involvement, and local musculoskeletal abnormalities (91).

Contrary to the situation in lumbar spinal stenosis, hyposensitivity in peripheral neuropathies is usually bilateral and distal stocking style. Iliosacral joint discomfort presents with symptoms similar to LSS while walking, but is differentiated by joint tenderness (32).

Back pain may be more pronounced when stenosis is associated with spondylolisthesis than with neurogenic claudication. On the other hand, it should not be forgotten that changes such as osteoporosis and arthritis may also cause back pain (48).

It is also important to distinguish between neurogenic and vascular claudication, which causes pain in the lower extremity. While the first is corrected with trunk flexion and sitting, the second; improves with resting of the affected extremity (62). In neurogenic claudication, ABI is palpable and a negative result is obtained with the bicycle test (86).

In addition, the treadmill test (10-12% grade) in which the patient walks until claudication pain occurs (maximum 5 minutes) can also be used to distinguish claudications. Stair climbing and walking exercises can be used instead of the treadmill, and a decision can be made based on the decrease in ABI (92).

As the severity of claudication increases, deficiencies occur in both balance and physical skills (93). In addition, the presence of claudication causes loss of postural control and leads to falls as a result of impaired balance (77).

2.2.8.2. Imaging Methods

There are many imaging modalities used to evaluate lumbar spinal stenosis. Current LSS guidelines for the diagnosis of LSS state that LSS-related symptoms provide the most important diagnostic information for patients (39).

Direct Graph

Radiography is usually the first diagnostic method used in the examination of spinal stenosis. Anterior, posterior, lateral, flexion and extension motion radiographs are routinely examined. Static pathologies such as scoliosis and spondylolisthesis can be detected. Neural foramen stenosis, spinal canal stenosis, ligament ossification, vertebral ankylosis, disc space erosion and any abnormal appearance of bone structure should be detected with direct radiographs (41). These radiographs are limited to anatomical details and are insufficient for the evaluation of soft tissue and spinal cord (94).

Computed Tomography

Scanning with computed tomography is used when more detailed evaluation of the bone structure is required. Myelographic CT is used for more detailed evaluation of neural structures (94). At the same time, it gives important information about spinal compression, but its disadvantages are that it contains an invasive method and radiation (41). Therefore, this method is used when MRI is contraindicated (94).

Magnetic Resonance Imaging (MRI)

MRI, that allows to examine the shape, size and anatomical shapes between spinal and neural components, is one of the recommended methods for confirming the diagnosis of LSS (94). This imaging method, which is non-invasive, does not contain radiation, and can provide information on sagittal, coronal and axial planes, is widely used in the diagnosis of LSS (41).

Stenosis is mostly encountered as central canal, foraminal and lateral recess stenosis. Here, surgical planning is made by evaluating facet joint changes, the condition of the intervertebral disc and ligamentous structures with MRI. It is extremely helpful in determining the level of surgical decompression (38).

As a result of MRI scans in the lumbar region, the necessary radiological criteria for LSS are as follows;

- Central canal stenosis: Antero-posterior diameter of the spinal canal ≤ 12 mm.
- Lateral recess stenosis: lateral recess height ≤ 3 mm or lateral recess depth ≤ 5 mm
- Foraminal stenosis: Foraminal diameter ≤ 5 mm (95).

Electromyography (EMG) and Nerve Conduction Tests

Electromyography (EMG) and nerve conduction tests are not useful tools for the diagnosis of LSS. They are sometimes used to investigate differential diagnoses for example peripheral neuropathy and underlying problems such as superimposed radiculopathy (94).

Electromyography is not routinely used, but when clinical chart and imaging results do not correlate, it is useful in differentiating it from diseases with similar symptoms, with vascular claudication, hip osteoarthritis, and spinal cord lesions (94). Nerve conduction tests may also be useful in differentiating neuropathy and radiculopathy (41).

It has been reported that the EMG method called paraspinal mapping shows significant differences between LSS, mechanical back pain and asymptomatic volunteers and is useful in the finding of LSS (39). It has been reported that paraspinal mapping with a high specificity confirms the diagnosis of degenerative LSS in patients with mild to moderate symptoms and LSS imaging findings (94).

2.2.9. Treatment

The natural course of the disease varies (96). Therefore, the natural history of the disease is important in determining the most appropriate therapeutic method (48). Conservative treatment is the first choice for patients with mild to moderate symptoms (97). In general, conservative treatment should be preferred, except for patients with bladder or bowel dysfunction and severe motor deficits (98).

2.2.9.1. Conservative Treatment

Conservative treatment is a heterogeneous program that includes modalities such as spinal orthosis, physiotherapy, exercise, analgesic and anti-inflammatory drugs, and education (99).

Pharmacological Treatment

Analgesics, nonsteroidal anti-inflammatory drugs (NSAIDs), muscle relaxants and opioids are widely used in patients with LSS (67). Analgesic prescription should begin with acetaminophen, NSAIDs should be used if symptoms do not respond. Opioid analgesia is used for more severe cases (100). Lurie and Tomkins-Lane (39) stated in their study that prostaglandin E1 can increase symptoms by increasing blood flow to the cauda equina and nerve roots due to its vasodilation and antiplatelet aggregation effects. Gabapentin and pregabalin are used in neuropathic pain (101).

Physical therapy and rehabilitation

Physiotherapy practices are an accepted treatment for LSS. Among these treatment methods, the following are often used:

- Aerobic, strengthening and flexibility exercises

• Exercises in lumbar flexion (cycling)

• Body weight reinforced treadmill walking

• Manual therapy (spine mobilization and manipulation)

• Lumbar semi-rigid orthosis – Corsets

• Pain relieving treatments (hot, cold, electrical stimulation, massage, ultrasound)

• Balance training (39).

Flexion-based stabilization exercises are generally recommended for patients (41). Flexion-based exercises (for example, stationary bike and incline treadmill) increase the cross-sectional area of the lumbar spinal canal to advance microcirculation of the spinal cord. Therefore, these exercises are improved tolerated by patients, helping to improve weight loss and cardiovascular fitness (102).

Aquatic exercises reduce the axial load on the vertebral column and strengthen the hip and abdominal muscles (103). Neural mobilizations, mobilizations in the posteroanterior direction, and distraction in flexion are manual therapy methods used in the treatment of LSS (91).

There is no definite opinion in the literature about the duration and frequency of these exercises. Low-level evidence suggests that rehabilitation practices can improve pain and function (62). Evidence for acupuncture used as an alternative method is limited and its effectiveness is uncertain (39).

Patient Education

Long-term activity and avoidance of standing, lumbopelvic flexion and rotational stretching techniques are recommended as beneficial activities for pain control (104). Diet, exercise and smoking cessation are also recommended for patients to maintain a healthy life (102).

Epidural Injection

Epidural steroid injections are a safer and less invasive method compared to surgical intervention. It is recommended for short-term alleviation of neurogenic claudication and radiculopathy symptoms (62). The pain reduction achieved with injections facilitates the patient's tolerance to a rehabilitation program. The lumbar epidural space is accessed with interlaminar, caudal and transforaminal techniques. It is recommended to be applied with fluoroscopy. It is stated that the transforaminal approach can better target the main pathology area and therefore is more effective (105).

2.2.9.2. Surgical Treatment

Various surgical methods are used for the dealing of patients with lumbar spinal stenosis who cannot be controlled/treated at the desired level using other treatment methods and have permanent symptoms (67).

The main purpose of decompression surgical interventions in lumbar spinal stenosis is to open neural structures, release symptoms and improve functions. Decompression approaches include bilateral laminotomy, traditional laminectomy, bilateral decompression via unilateral laminotomy, etc. (39).

Smaller incisions made by minimally invasive columnar vertebral surgery lead to faster reduction of general back pain and rapid recovery in the postoperative period (102). Insertion of interspinous processing devices is one of the minimally invasive surgical options for LSS. Interspinous processing devices are devices that goal to indirectly open neural elements by increasing the space between head-to-head spinous processes that stimulate flexion. This provides relief of symptoms in LSS patients (62).

3. MATERIAL AND METHOD

3.1. Aim of the Research

There are surgical and non-surgical options in the treatment of spinal stenosis. Among the non-surgical treatment options, especially lifestyle changes, exercises and physiotherapy are extremely important. In this study the effects of a 10-minute cycling program on pain, quality of life and functionality of patients with spinal stenosis were investigated.

3.2. Type of Research

This research is an experimental research. In the study, by comparing the scores obtained from the scales to be applied before and after the 10-minute cycling exercise without resistance, the effect of the 10-minute cycling exercise without resistance on pain, quality of life and functionality in individuals with canal narrowing was determined. Before the study, the participants were informed about the study with an informed consent form.

3.3. Participants

The volunteers consisted of patients who applied to the Physiotherapy Polyclinic of Tuzla Private Gisbir Hospital between 20 December 2021 and 20 April 2022 with the complaint of low back pain. After examining the MRI images, the doctor diagnosed spinal stenosis and was referred to the physical therapy and rehabilitation unit for the session. Patients who met the inclusion criteria voluntarily participated in our study after informing. Over 65 years of age, with chronic disease, with hip, knee and ankle problems, and pregnant people were eliminated. Patients who could cycle a bicycle were selected among the patients. Since the registration dates of the volunteers differed, it took longer for the first patient to start treatment than for the last patient to complete the treatment.

The volunteers are mostly under the age of 60, unlike the literature. The reason for this is that the elderly population effected by the pandemic and the study was carried out during the periods when the effects of the pandemic began to decrease. The elderly population was reluctant to go to physical therapy during the pandemic period. As a result, the study was conducted with a younger population.

The volunteers were treated for a total of 15 sessions (average 1 hour per session) for 3 weeks, 5 days a week. In addition to classical physical therapy modalities, 10 minutes of non-resistance cycling exercise was applied.

3.4. Clinical Examination

Postures of the participants were evaluated and MRI images were examined. Evaluation and treatment was done by a single physiotherapist

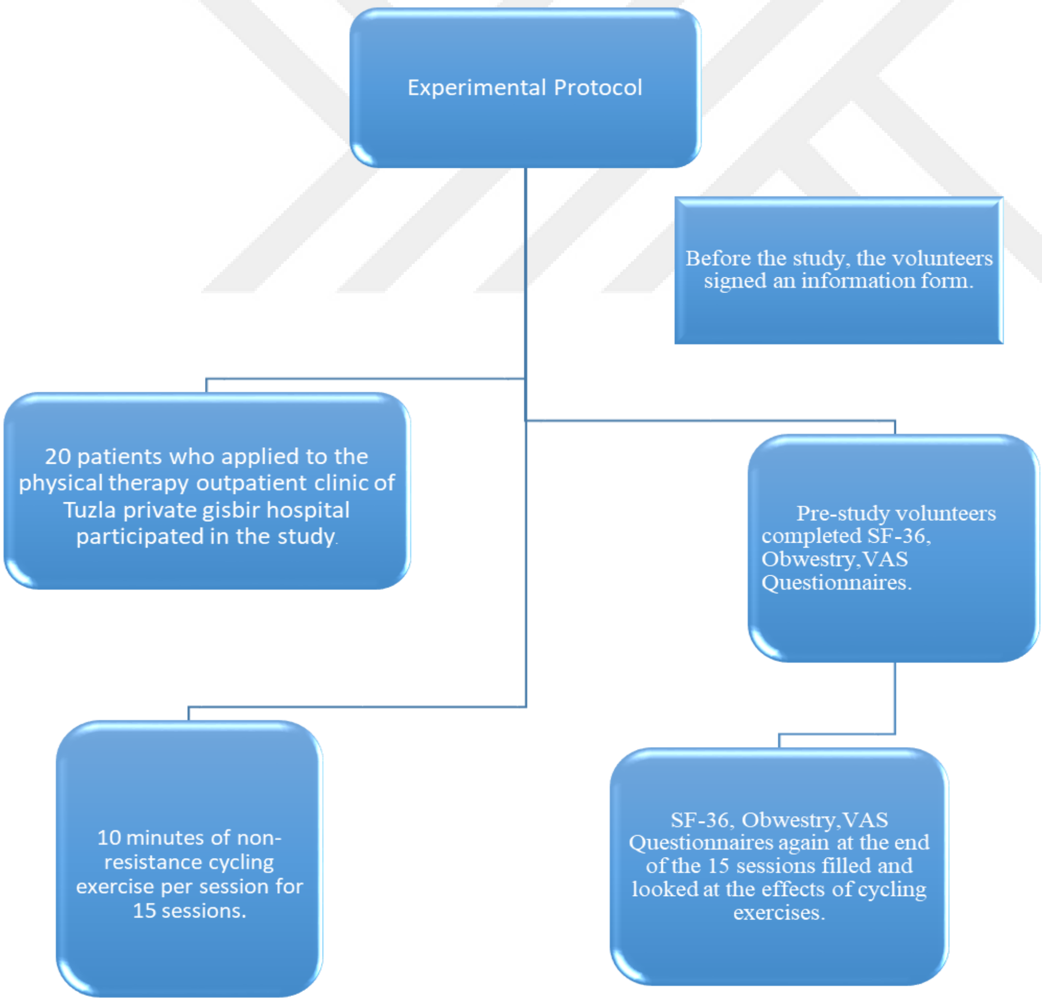

Figure 3. 1. Flow chart of the experimental protocol

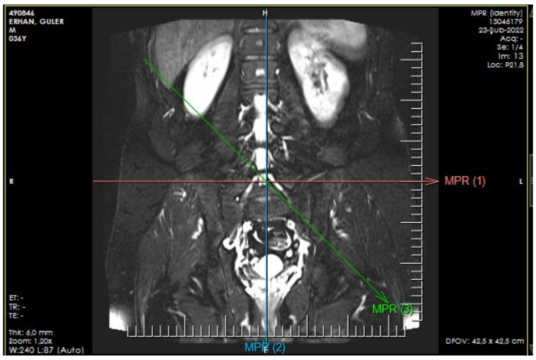

Figure 3. 4. 1. MRI vertabrae distance **Figure 3. 4. 2. MRI vertebrae distance on the side**

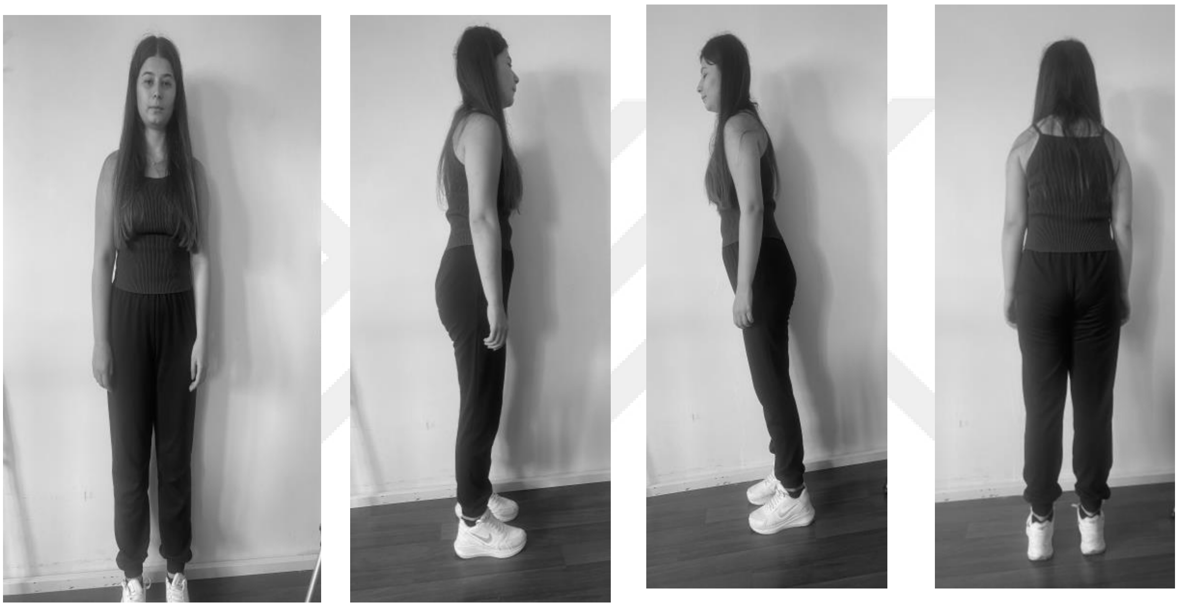

Figure 3. 4. 3. Posture analaysis from the front, on the side and behind

Figure 3. 4. 4. Cycling Exercise

3.5. Data Collection Tools

Individual Information Form: It consists of questions to determine the characteristics of patients such as gender, age, marital status, educational status, height, and weight (Annex-2). Volunteers were asked to fill out SF-36 Short Form, Oswestry Scale and Visual Analog Scale.

SF-36 Short Form: The SF-36 short form was used to evaluate the quality of life. The SF-36 consists of eight sub-dimensions (general health perception, physical function, physical role difficulty, emotional role difficulty, social functioning, pain, energy-vitality, mental health), each of which has a total of 2-10 questions, and a health score that is not included in the scoring. consists of a question. Each question is scored on only one scale. Scoring is made between 0-100 for each scale. The lowest score represents the worst health condition. (Fairbank JC, Couper J, Davies JB, O'Brien JP. (1980). "The Oswestry low back pain disability questionnaire." Physiotherapy,66, 271-273).

Oswestry Scale: It was developed by Fairbank et al. (106) in 1980 to assess functional disability. It was revised by Fritz and Irrang (107) in 2001 and transformed into its current form. Its Turkish validity and reliability were evaluated by Yakut et al. in 2004. This scale measures activities of daily living from 10 different aspects (intensity of pain, personal care, lifting weights, walking, sitting, standing, sleeping, degree of change in pain, social life, travel). The minimum score obtained from the scale is 0, and the maximum score is 50. (Yakut, E., Düger, T., Öksüz, Ç., Yörükan, S., Üreten, K., Turan, D., and Güler, Ç. (2004). Validation of the Turkish version of the Oswestry Disability Index for patients with low back pain. Spine, 29(5), 581-585).

Visual Analog Scale: The VAS, which measures pain severity in one dimension, is a valid and reliable scale. It is used to transform some values that cannot be measured numerically into numeric. The VAS is used as a horizontal line with two ends labeled. The words "No pain" on the left end and "The most unbearable pain" on the right end. The patient marks his current state on this line. (Fritz JM, Irrgang JJ. (2001). A comparison of a modified Oswestry Low Back Pain Disability Questionnaire and the Quebec Back Pain Disability Scale. Physical Therapy, 81, 776-788).

3.6. Statistical Analysis

The results obtained from the study were analyzed using the SPSS 21.0 package program. Mean, standard deviation and percentage values were given as descriptive statistics. Whether the data fit the normal distribution was tested with the Kolmogorov-Smirnov test and it was determined that the data did not fit the normal distribution. Spearman's correlation analysis was used to determine whether there was a relationship between numerical variables, Mann Whitney U test was used to determine whether there was a difference according to gender, and Wilcoxon analysis was used to compare values before and after exercise. Obtained results were evaluated at 95% ($p<0.05$) significance level.

4. RESULTS

4.1. Demographic Properties

Target age group was over 60 years old, participants were min 20 max 42 years old and the mean age was 31.60±9.38 years (Table 4.1).

Table 4. 1. Mean age of the participants

	N	Minimum	Maximum	Mean	Std. Deviation
Age	20	19,00 years	48,00 years	31,60 years	9,38

Of the spinal stenosis patients included in the study, 11 (55%) were male and 9 (45%) were female (Table 4.2)

Table 4. 2. Circulation of the participants by gender

		n	%
Gender	Female	9	45,0
	Male	11	55,0
	Total	20	100,0

4.2. Findings Regarding Quality of Life

4.2.1. Quality of Life Before The Cycling Exercise Program

Table 4. 3. Comparison of quality of life levels of patients with spinal stenosis giving to gender before cycling exercise program

	Gender	N	Mean	Std. Deviation	U	p
Physical Function	Female	9	59,44	9,82	30.000	.116
	Male	11	52,72	10,09		
Physical Role Difficulty	Female	9	2,77	8,33	45.000	.582

	Male	11	11,36	25,89		
Emotional Role Difficulty	Female	9	59,25	22,22	49.000	.965
	Male	11	57,57	26,20		
Enery-Vitality	Female	9	56,11	11,66	47.000	.841
	Male	11	54,09	8,60		
Mental Health	Female	9	53,77	11,68	44.500	.696
	Male	11	52,00	9,63		
Social Functioning	Female	9	61,11	14,58	47.500	.864
	Male	11	62,50	14,79		
Pain	Female	9	15,83	16,72	48.000	.904
	Male	11	13,18	13,92		
General Health Perception	Female	9	48,33	23,18	40.000	.459
	Male	11	40,10	15,17		
QUALITY OF LIFE	Female	9	47,76	7,25	38.500	.392
	Male	11	44,85	4,11		

The Mann Whitne U test performed to determine whether the quality of life of patients with spinal stenosis differs according to their gender before the bicycle exercise program. Although female patients with spinal stenosis achieved higher scores in all sub-dimensions of quality of life, the difference in quality of life according to gender was not significant (p>0.05) (Table 4. 3).

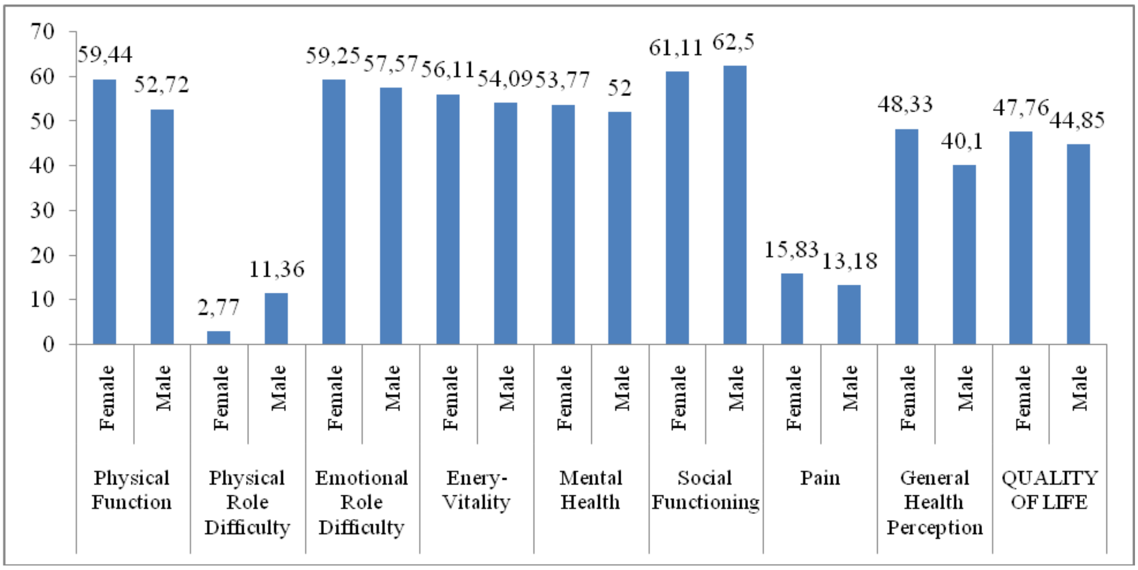

Figure 4. 1. Quality of life levels of patients with spinal stenosis according to gender before cycling exercise program

Table 4. 4. Mean Scores Obtained from the SF-36 Scale Before Cycling Exercise Program

	N	Minimum	Maximum	Mean	Std. Deviation
Physical Function	20	40,00	75,00	55,75	10,29
Physical Role Difficulty	20	,00	75,00	7,50	20,03
Emotional Role Difficulty	20	,00	100,00	58,33	23,87
Energy-Vitality	20	45,00	75,00	55,00	9,86
Mental Health	20	36,00	68,00	52,80	10,34
Social Functioning	20	37,50	100,00	61,87	14,32
Pain	20	,00	45,00	14,37	14,88
General Health Perception	20	25,00	85,00	43,81	19,10
QUALITY OF LIFE	20	40,69	59,17	46,16	5,76

The SF-36 quality of life scale was applied to the patients with spinal stenosis volunteers in the study before the cycling exercise program. When the scores obtained by the volunteers from the quality of life scale before the bicycle exercise program were examined. It was seen that the highest score was obtained from the social functionality with 63.63±18.07. And the lowest score was obtained from the physical role difficulty sub-dimensions with 13.63±25.89. Before the application, the total quality of life was found to be low (Table 4. 4; Figure 4. 2).

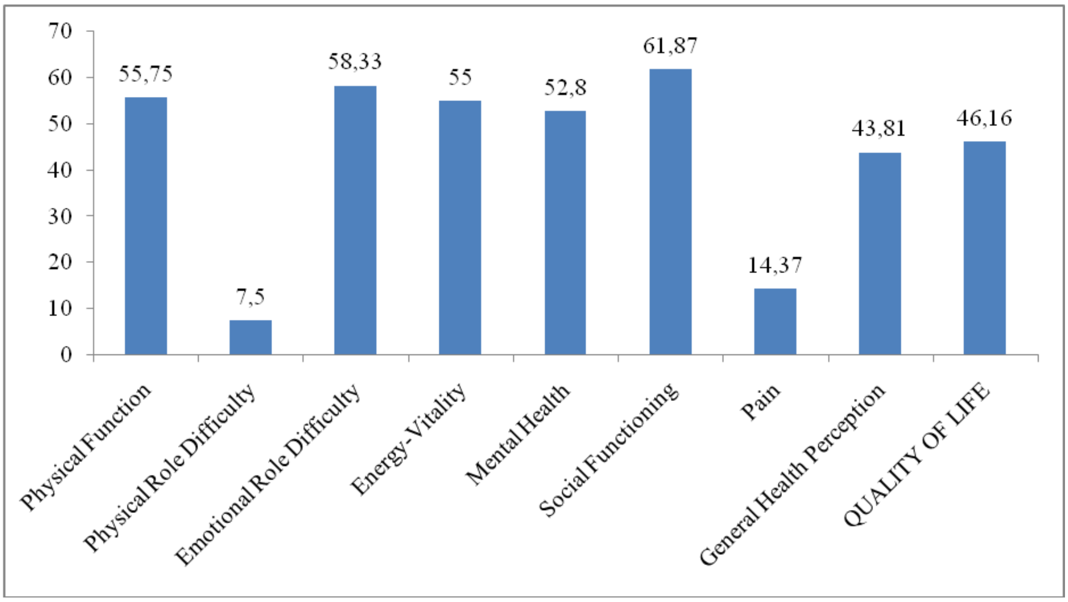

Figure 4. 2. Mean Scores Obtained from the SF-36 Scale before cycling exercise program

Table 4. 5. The relationship between the age of patients with spinal stenosis and quality of life before bicycle exercise program

			Physical Funciton	Physical Role Difficultu	Emotional Role Difficulty	Energy-Vitality	Mental Health	Social Funcitoning	Pain	General Health Perception	QUALITY OF LIFE
Spearman's rho	Age	r	,022	,369	**,-475***	,297	**,473***	,208	**,454***	**,727****	**,627****
		p	,926	,110	**,034**	,204	**,035**	,380	**,045**	**,000**	**,003**
		N	20	20	20	20	20	20	20	20	20

As a result of Spearman's correlation analysis, a negative and moderate (r = -.475; p<0.05) relationship was found between age and emotional role difficulty before the non-resistance bicycle exercise. A positive and moderate relationship (r = .473; p<0.05) was found between age and mental health. There was a positive and moderate relationship between age and pain (r = .454; p<0.05), and a positive and high-severity relationship between general health perception (r = .727; p<0.001). A positive and high degree of correlation (r = .627; p<0.05) was found between age and total quality of life (Table 4.5).

4.2.2. Quality of Life Related Findings After Cycling Exercise Program

Table 4. 8. Comparison of quality of life levels of patients with spinal stenosis according to gender after cycling exercise program

	Gender	N	Mean	Std. Deviation	U	p
Physical Function	Female	9	71,11	16,35	23.500	***.043****
	Male	11	56,81	16,01		

Physical Role Difficulty	Female	9	27,77	38,41	40.500	.421
	Male	11	15,90	30,15		
Emotional Role Difficulty	Female	9	48,14	33,79	47.000	.837
	Male	11	48,48	27,33		
Enery-Vitality	Female	9	56,11	7,81	39.500	.423
	Male	11	53,63	7,10		
Mental Health	Female	9	49,77	14,98	43.000	.604
	Male	11	45,09	10,89		
Social Functioning	Female	9	79,16	8,83	43.000	.518
	Male	11	76,13	6,74		
Pain	Female	9	42,77	22,44	36.000	.292
	Male	11	33,86	16,06		
General Health Perception	Female	9	51,66	15,20	48.000	.906
	Male	11	50,00	8,94		
QUALITY OF LIFE	Female	9	55,49	13,40	31.000	.149
	Male	11	48,06	7,74		

As a result of the Mann Whitne U test performed to determine whether the quality of life of patients with spinal stenosis differs according to their gender after the non-resistance bicycle exercise program, it was determined that the physical function levels of females were significantly higher than males. ($p<0.05$) (Tablo 4.8).

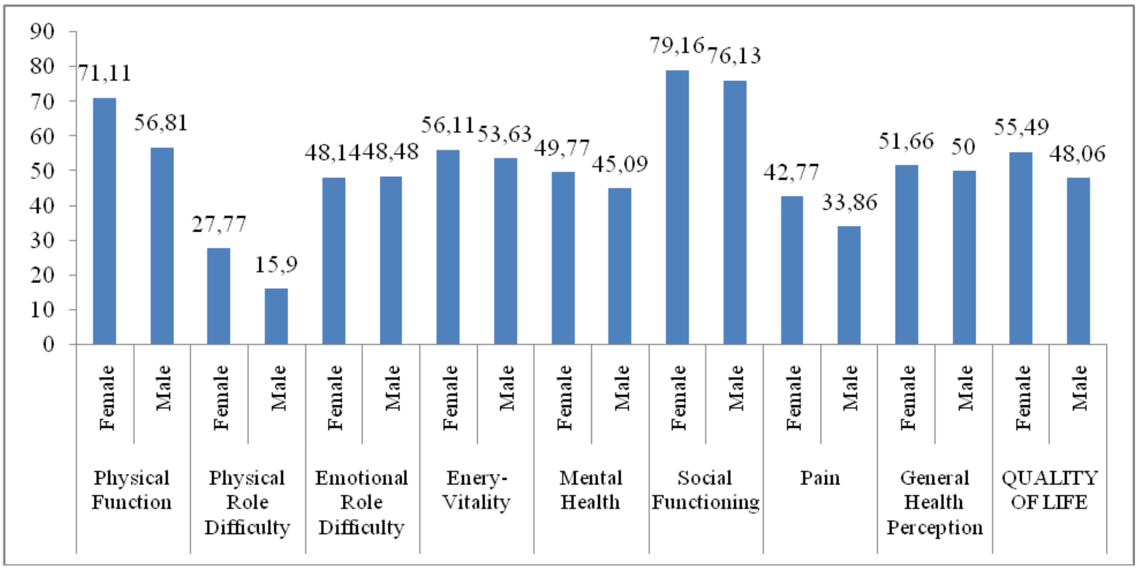

Figure 4. 4. Quality of life levels of patients with spinal stenosis according to gender after cycling exercise program

Table 4. 6. Mean Scores Obtained from the SF-36 Scale After Cycling Exercise Program

	N	Minimum	Maximum	Mean	Std. Deviation
Physical Function	20	35,00	90,00	63,25	17,34
Physical Role Difficulty	20	,00	100,00	21,25	33,71
Emotional Role Difficulty	20	,00	100,00	48,33	29,56
Energy-Vitality	20	40,00	70,00	54,75	7,34
Mental Health	20	36,00	72,00	47,20	12,75
Social Functioning	20	62,50	100,00	77,50	7,69
Pain	20	22,50	77,50	37,87	19,19
General Health Perception	20	35,00	80,00	50,75	11,84
QUALITY OF LIFE	20	43,06	77,50	56,52	12,33

When the quality of life values of patients with spinal stenosis were examined after cycling exercise program. It was seen that the highest mean score was obtained from social function, the lowest mean score was obtained from the physical role difficulty sub-dimensions, and the total quality of life level was above the average (Table 4. 3; Figure 4. 3).

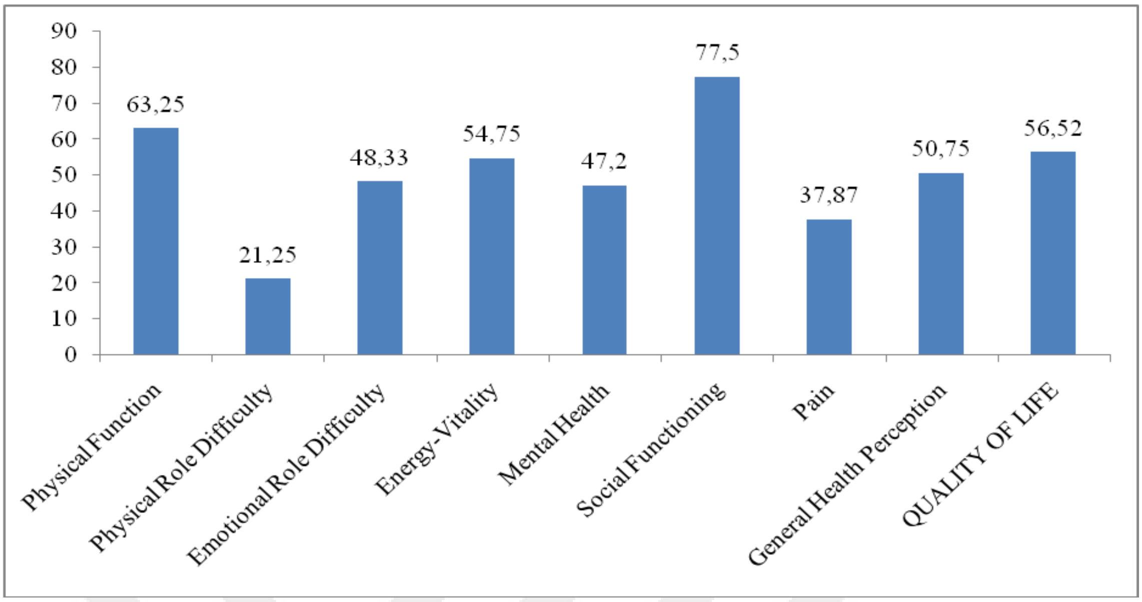

Figure 4. 3. Mean Scores Obtained from the SF-36 Scale after cycling exercise program

Table 4. 7. The relationship between the quality of life of patients with spinal stenosis and age after bicycle exercise program

			Physical Funciton	Physical Role Difficultu	Emotional Role Difficulty	Energy-Vitality	Mental Health	Social Funcitoning	Pain	General Health Perception	QULITY OF LIFE
Spearman's rho	Age	r	,071	**,552***	,306	-,047	**,510***	-,045	,218	,434	,236
		p	,766	**,012**	,190	,844	**,022**	,851	,356	,056	,317
		N	20	20	20	20	20	20	20	20	20

As a result of Spearman's correlation analysis, a positive, moderate ($r = .510$; $p<0.05$) correlation was found between the age of patients with spinal stenosis and mental health, one of the sub-dimensions of quality of life, cycling exercise program (Table 4.7).

4.3. Findings Related to Functionality

4.3.1. Functionality Related Findings Before Cycling Exercise Program

Table 4. 11. Comparison of functionality levels of patients with spinal stenosis by gender before the cycling exercise program

	Gender	N	Mean	Std. Deviation	U	p
Oswestry Low Back Pain Scale	Female	9	29,55	8,87	44.000	.669
	Male	11	31,63	8,38		

As a result of the Mann Whitne U test performed to determine whether the functionality levels of the patients with spinal stenosis before the cycling exercise program differ according to their gender. It was determined that the functionality level of the male patients with spinal stenosis before the cycling exercise program was higher than that of the female groups. The difference was not significant (p>0.05) (Table 4.11).

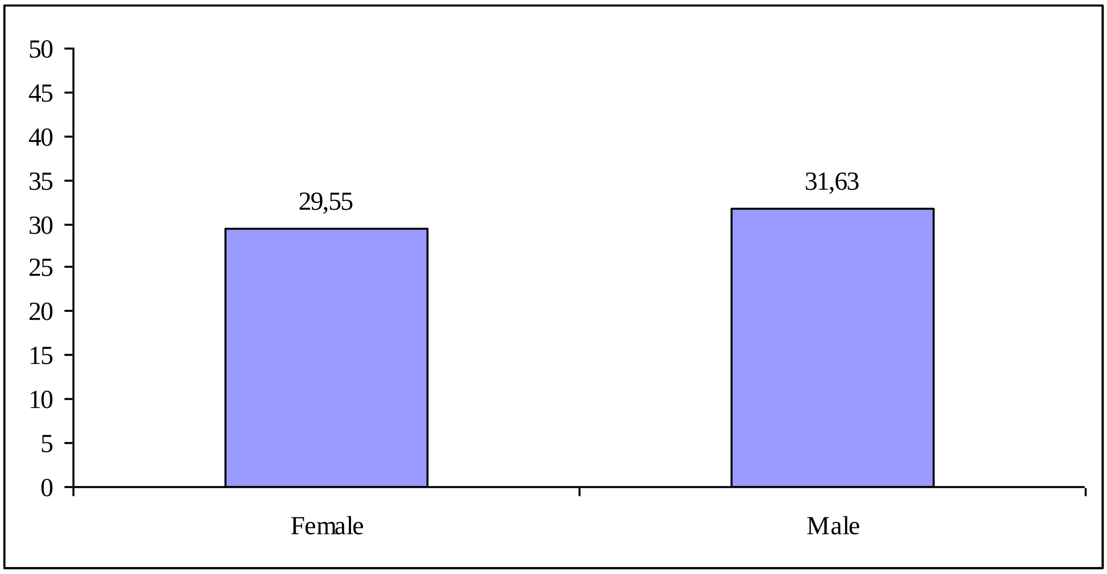

Figure 4. 5. Functionality levels of patients with spinal stenosis by gender before the cycling exercise program

Table 4. 9. Functionality level of patients with spinal stenosis before cycling exercise program

	N	Minimum	Maximum	Mean	Std. Deviation
Oswestry Scale	20	14,00	46,00	30,70	8,44

The mean scores obtained from the Oswestry scale, which is used to determine the functionality levels of patients with spinal stenosis before the cycling exercise program. Values are shown in Table 4.9. As can be seen from the table, the mean functionality level of the participants was 30.70±8.44%. This means that the functionality patients with spinal stenosis before cycling exercise slightly restricts their daily life (Table 4. 9).

Table 4. 10. The relationship between the level of functionality and age of patients with spinal stenosis before the cycling exercise program

			Oswestry Scale
Spearman's rho	Age	r	,162
		p	,496
		N	20

As a result of Spearman's correlation analysis performed to determine whether the functionality levels of patients with spinal stenosis before cycling exercise program were related to age, no significant correlation was found ($p>0.05$) (Table 4.10).

4.3.2. Findings Related to Functionality Level After Cycling Exercise Program

Table 4. 14. Comparison of functionality levels of patients with spinal stenosis by gender after cycling exercise program

	Gender	N	Mean	Std. Deviation	U	p
Oswestry Scale	Female	9	18,00	11,83	25.000	.057
	Male	11	26,72	14,09		

As a result of the Mann Whitney U test, which was performed to determine whether there was a difference in functionality levels after cycling exercise program according to the gender of patients with spinal stenosis. It was determined that although male patients had higher functionality levels, the difference between the groups was not significant (p>0.05) (Table). 4.14; Figure 4.6).

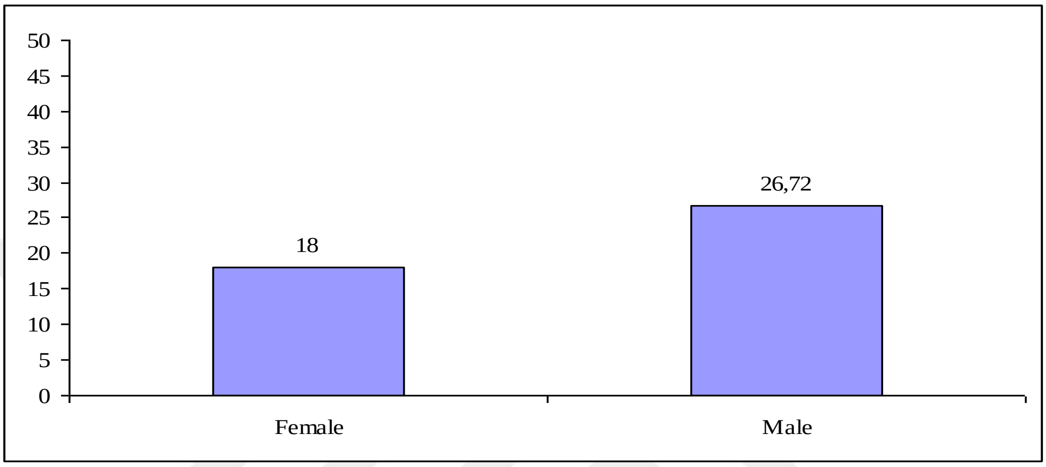

Figure 4. 6. Functionality levels of patients with spinal stenosis by gender after cycling exercise program

Table 4. 12. Functionality Related Findings After Cycling Exercise Program

	N	Minimum	Maximum	Mean	Std. Deviation
Oswestry Low Back Pain Scale	20	8,00	48,00	22,80	13,53

The mean scores obtained from the Oswestry functionality scale, which is used to determine the functionality levels of patients with spinal stenosis after the non-resistance cycling exercise program. Means are shown in Table 4.12. As can be understood from the table, the mean functionality level of the participants was 22.80±13.53%. This means that the functionality of patients with spinal stenosis after cycling exercise slightly restricts their daily life.

Table 4. 13. The relationship between the level of functionality and age of patients with spinal stenosis after the cycling exercise program

			Oswestry Scale
Spearman's rho	Age	r	-,129
		p	,587
		N	20

As a result of Spearman's correlation examination performed to determine whether the functionality levels of patients with spinal stenosis after cycling exercise program were related to age, no significant correlation was found (p>0.05) (Table 4.13).

4.4. Findings Related to Visual Analogue Scale

4.4.1. Visual Analogue Scale Related Findings Before Cycling Exercise Program

Table 4.17. Comparison VAS scores of patients with spinal stenosis by gender before resistance cycling exercise program

	Gender	N	Mean	Std. Deviation	U	p
VAS	Female	9	7,88	0,78	47.500	.866
	Male	11	7,81	0,60		

As a result of the Mann Whitne U test performed to determine whether the low back pain levels of the patients with spinal stenosis before the cycling exercise program differ according to their gender. It was determined that the low back pain level of the male patients with spinal stenosis before the cycling exercise program was higher than that of the female groups. The difference was not important (p>0.05) (Table 4.17).

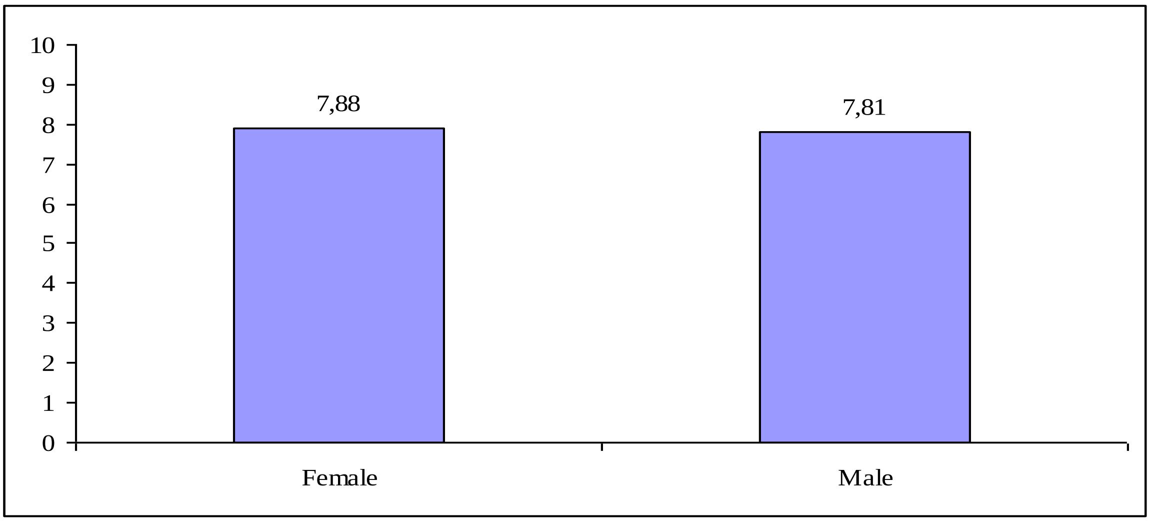

Figure 4. 7. VAS scores of patients with spinal stenosis by gender before cycling exercise program

Table 4. 15. VAS scores of patients with spinal stenosis before cycling exercise program

	N	Minimum	Maximum	Mean	Std. Deviation
VAS	20	7,00	9,00	7,85	0,67

The mean scores obtained from the VAS of patients with spinal stenosis before the cycling exercise program, are shown in Table 4.15. As can be seen from the table, the mean VAS score of the participants was 7,85. ±0.67. This means that pain level of the patients before the cycling exercise program is high (Table 4. 15).

Table 4. 16. The relationship between VAS and age of patients with spinal stenosis before the cycling exercise program

			VAS
Spearman's rho	Age	r	,013
		p	,955
		N	20

As a result of Spearman's correlation analysis performed to determine whether the VAS scores of patients with spinal stenosis before cycling exercise program were related to age, no significant correlation was found (p>0.05) (Table 4.16).

4.4.2. Findings Related to Low Back Pain Level Visual Analogue Scale After Cycling Exercise Program

Table 4. 20. Comparison of VAS scores of patients with spinal stenosis by gender after cycling exercise program

	Gender	N	Mean	Std. Deviation	U	p
VAS	Female	9	5,55	0,72	37.500	.326
	Male	11	5,90	0,83		

As a result of the Mann Whitney U test, which was performed to determine whether there was a variance in the VAS scores of patients with spinal stenosis after cycling exercise program according to their gender. Although the VAS scores of the male patients were higher, the difference between the groups was not found to be significant (p>0.05) (Table 4.20; Figure 4.8).

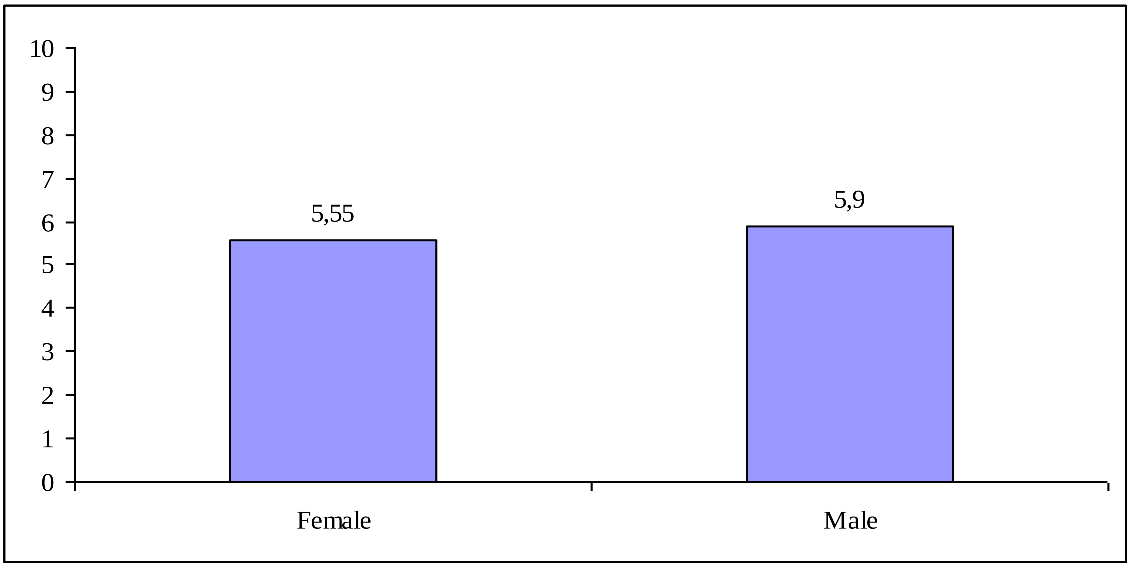

Figure 4. 8. VAS scores of patients with spinal stenosis by gender after cycling exercise program

Table 4. 18. VAS scores of patients with spinal stenosis after cycling exercise program

	N	Minimum	Maximum	Mean	Std. Deviation
VAS	20	5,00	7,00	5,75	0,78

The mean scores obtained from the VAS scores of patients with spinal stenosis after the cycling exercise program, are shown in Table 4.18. As can be understood from the table. The mean VAS scores of the participants was 5.75±0.78. This means that the pain levels of patients with spinal stenosis after cycling exercise program is moderate.

Table 4. 19. The relationship between the level of low back pain and age of patients with spinal stenosis after the cycling exercise program

			VAS
Spearman's rho	Age	r	,104
		p	,664
		N	20

As a result of Spearman's correlation analysis performed to determine whether the VAS scores of patients with spinal stenosis after cycling exercise program were related to age, no significant correlation was found ($p>0.05$) (Table 4.19).

4.5. Comparison of Quality of Life Levels Before and After Cycling Exercise Program

Table 4. 21. Comparison of quality of life before and after cycling exercise program

	N	Mean	Std. Deviation	Z	p
Physical Funciton (Before Exercise)	20	55,75	10,29	-2.377	***.017****
Physical Funciton (After Exercise)	20	63,25	17,34		
Physical Role Difficulty (Before Exercise)	20	7,50	20,03	-2.264	***.024****
Physical Role Difficulty (After Exercise)	20	21,25	33,71		
Emotional Role Difficulty (Before Exercise)	20	58,33	23,87	-1.500	.134
Emotional Role Difficulty (After Exercise)	20	48,33	29,56		
Energy-Vitality (Before Exercise)	20	55,00	9,86	-.079	.937

Energy-Vitality (After Exercise)	20	54,75	7,34		
Mental Health (Before Exercise)	20	52,80	10,34	-2.821	***.005****
Mental Health (After Exercise)	20	47,20	12,75		
Social Functioning (Before Exercise)	20	61,87	14,32	-3.577	***.000****
Social Functioning (After Exercise)	20	77,50	7,69		
Pain (Before Exercise)	20	14,37	14,88	-3.662	***.000****
Pain (After Exercise)	20	37,87	19,19		
General Health Perception (Before Exercise)	20	43,81	19,10	-1.996	***.046****
General Health Perception (After Exercise)	20	50,75	11,84		
QUALITY OF LIFE (Before Exercise)	20	46,16	5,76	-3.003	***.003****
QUALITY OF LIFE (After Exercise)	20	51,40	11,03		

As a result of Wilcoxon analysis performed to determine whether there was a difference in quality of life parameters before and after cycling exercise program in patients with spinal stenosis. It was seen that physical function, physical role difficulty, social function, pain and general health perception level after cycling exercise program were significantly higher ($p<0.05$). However, it was observed that the total quality of life of the participants after 10 minutes of non-resistance cycling exercise increased significantly compared to before the cycling exercise program ($p<0.05$) (Table 4.21; Figure 4.9).

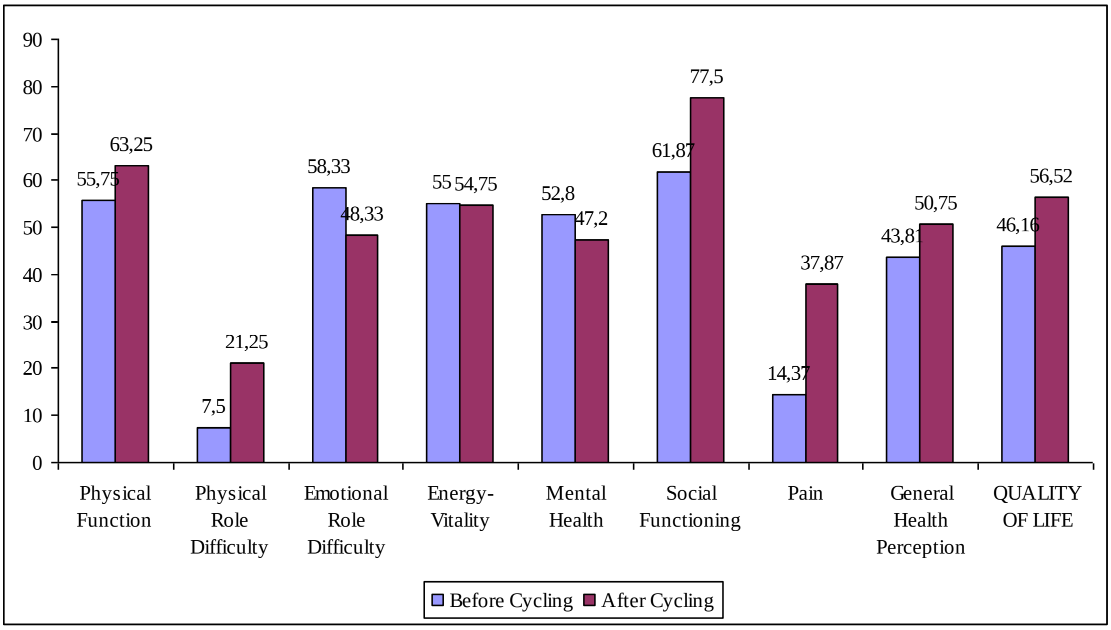

Figure 4. 9. Quality of Life before and after Cycling Exercise Program

4.6. Comparison of Functionality Levels Before and After Cycling Exercise Program

Table 4.22. Comparison of low back pain before and after exercise program

	N	Mean	Std. Deviation	Z	p
Oswestry Before Exercise)	20	30,70	8,44	-1.964	***.050***
Oswestry (After Exercise)	20	22,80	13,53		

As a result of Wilcoxon analysis to determine whether there is a alteration between the levels of functionality before and after cycling exercise program in patients with spinal stenosis. It was observed that there was a decrease in the level of functionality after cycling exercise program (p = 0.05) (Table 4.22; Figure 4.10).

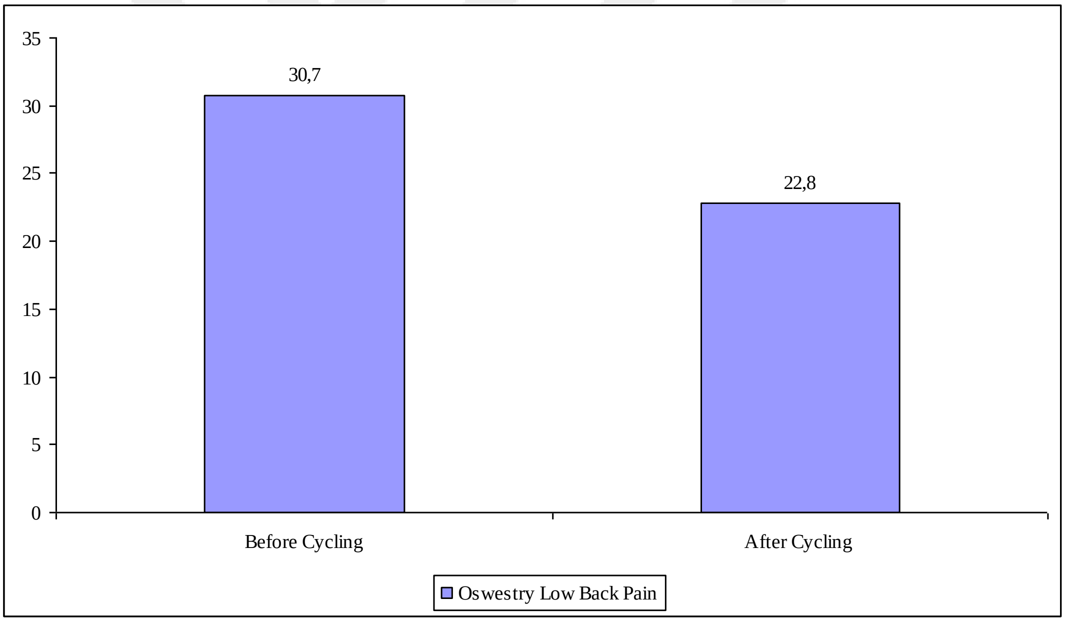

Figure 4. 10. Functionality before and after Cycling Exercise Program

4.7. Comparison of Visual Analogue Scale Scores Before and After Cycling Exercise Program

Table 4. 23. Comparison of VAS scores before and after cycling exercise program

	N	Mean	Std. Deviation	Z	p
VAS (Before Exercise)	20	7,85	0,67	-3.882	***.000***
VAS (After Exercise)	20	5,75	0.78		

As a result of the Wilcoxon test performed to determine whether the change in VAS scores before and after cycling exercise program was significant, it was observed that the VAS score after cycling exercise program was meaningfully lower ($p<0.001$) (Table 4.23; Figure 4.11). In other words, cycling exercise program provided a significant decrease in the pain level of patients with spinal stenosis.

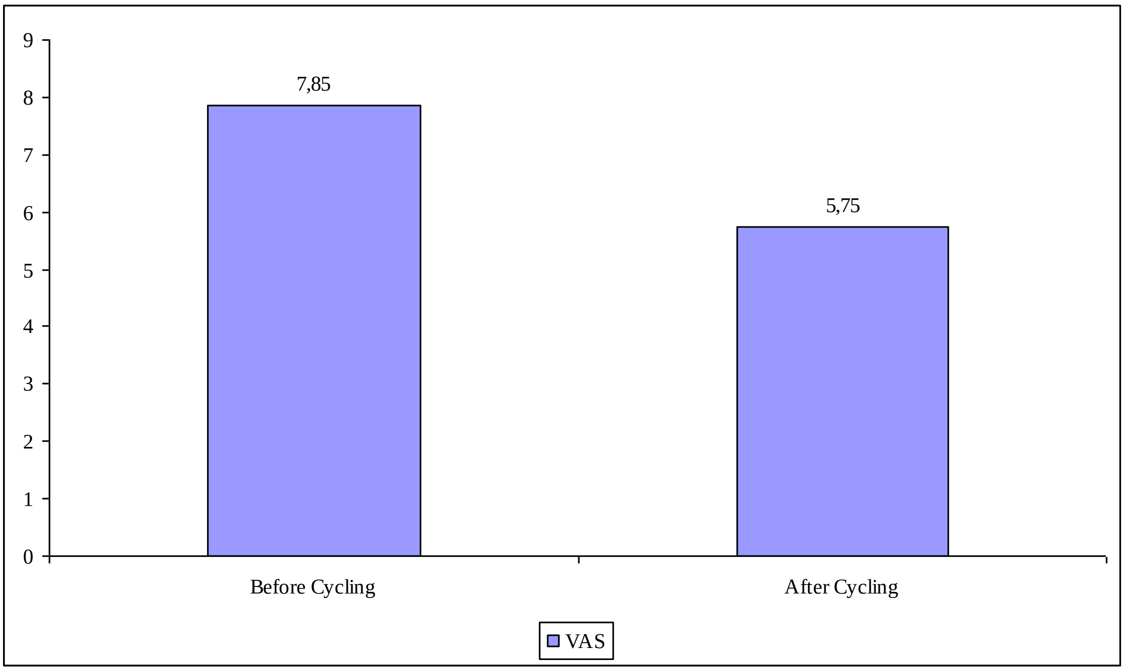

Figure 4. 11. VAS scores before and after Cycling Exercise Program

5. DISCUSSION AND CONCLUSIONS

Treatment options in LSS include conservative methods such as movement modification, non-steroidal anti-inflammatory drugs, epidural or facet injections, physical therapy methods, and exercise therapy, as well as surgical applications involving compression of the dural sac and nerve roots (109,110).

It is very important to be informed about the disease. Activities of daily living should be arranged, and strengthening exercises should be given to the back and abdominal muscles. Flexion exercises should be done, but not excessively. Since the stenosis of the canal will increase with the extension of the waist, extension exercises and the extension posture during daily activities should be escaped, and one should not lie face down (103,111).

There are surgical and non-surgical options in the treatment of spinal stenosis. Among the non-surgical treatment options, especially lifestyle changes, exercises and physiotherapy are extremely important. In the study performed by Gören et al. (7) on spinal stenosis patients, it was reported that the leg pain and disability level of the patients decreased with exercise therapy. In alternative study conducted by Fang (8) on 50 patients with spinal stenosis, it was found that patients who suffered lumbar extension exercise had a decrease in pain levels. Although studies have been conducted on the result of exercise therapy in spinal stenosis patients, no study has been found on the effect of non-resistance cycling exercise on functionality, pain level and quality of life in spinal stenosis patients. In this context, in this study, it was aimed to conclude the effect of resistance 10-minute cycling exercise on pain, quality of life and functionality in patients by spinal stenosis.

As can be understood from the explanations above, spinal stenosis is a health problem that causes pain in individuals and negatively affects functionality and quality of life. Although studies have been conducted on its treatment, it has been observed that studies on the effectiveness of non-surgical methods are limited.

There is no study in the literature to determine the effect of 10-minute non-resistance cycling exercise on quality of life, functionality and pain in patients with spinal stenosis. Therefore, the results obtained from the study are important in terms of being the first. However, there are studies evaluating quality of life, functionality and VAS in patients with chronic low back pain (112), knee osteoarthritis (113), hemodialysis (118), Parkinson's (123), stroke (124).

In this study, the effect of 10-minute non-resistance cycling exercise on quality of life and pain in patients with spinal stenosis was investigated. Twenty patients with spinal stenosis were included in the study. Before and after the study, the patients' quality of life and low back pain levels were determined by means of scales. This study is important in that it is the first and the results obtained from the study are as follows.

5.1. Evaluation of the Quality of Life of the Patients

In this study no significant correlation was found between the quality of life of patients with spinal stenosis and their age before and after the 10-minute non-resistance bicycle exercise. In the study showed by Meeus et al. (112), it was reported that the application of bicycle exercise did not cause a significant change in the pain threshold in patients with chronic neck pain. In the same study, no significant association was found between age and pain threshold. Similarly, in the study carried out by Berktaş (113) on), on 60 patients with knee osteoarthritis who applied to İnönü University Turgut Private Medical Center Physical Medicine and Rehabilitation outpatient clinic, it was aimed to determine the effect of exercise program on pain, functional capacity and quality of life in the treatment of knee osteoarthritis. The patients were randomly divided into 4 equal groups. These are Group 1 (hot-pack+TENS, US), Group II (Hot-pack+TENS+Pulse KDD), Group III (Hot-pack+TENS+US+Bike Exercise) and Group IV (Hot-pack+TENS+) Pulse KDD + Cycling Exercise). Similarly, in the study carried out by Berktaş (115) on patients with osteoarthritis, no relationship was found between age and quality of life in the group that underwent cycling exercise.

Even though female patients with spinal stenosis achieved higher scores in all sub-dimensions of quality of life before and after the non-resistance cycling exercise program, the difference in quality of life according to gender was not significant. In the study conducted by Marshall et al. (114), the efficiency of pilates exercises and cycling exercise in chronic non-specific neck pain was investigated. As a result of the study, no important difference was found in terms of pain level after the application to gender.

There was not association between the age and functionality before and after the non-resistance cycling exercise program. Although no important relationship was found between age and functionality before and after the practice in our study, it was reported that functionality decreased significantly as age increased, regardless of the type of exercise applied (115,116).

There was no major difference in functionality levels of male and female patients with spinal stenosis before and after the non-resistance bicycle exercise program. Similar with our results in a study conducted by Mekhail et al (117) functionality does not differ in terms of gender.

In our study, it was observed that physical function, physical role difficulty, social function, pain and general health perception, which are the sub-dimensions of quality of life, were meaningfully higher after cycling than before cycling exercise. In addition, it was observed that the total quality of life of the participants after 10 minutes of non-resistance cycling exercise increased meaningfully compared to before the cycling exercise. In a study conducted by Young et al (118) on hemodialysis patients it has been determined that the quality of life of the patients were upper after cycling exercise. In the study conducted by Noreau and Shephard (119) on patients with spinal cord injury, it was reported that there was a significant improvement in quality of life and physical function, which is one of the sub-dimensions of quality of life, after cycling exercise. In the study conducted by Hung et al. (120) on women with coronary artery disease, a significant improvement in general health perception was reported after cycling exercise.

5.2. Evaluation of the Functionality

There was a increase in the level of functionality after cycling exercise (p = 0.05). Smilar to our study, in the study conducted by da Rosa et al. (121) on stroke patients, it was reported that functionality increased after cycling exercise. In the review study showed by Latimer-Cheung et al. (122), it was reported that cycling exercises increased the level of functionality, similar to the results obtained from our study, in the study performed on multiple sclerosis patients. In a controlled single-blinded study conducted by Ferraz et al. (123) on Parkinson's patients, walking capacity was evaluated before and after cycling exercise. As a result of the study, it was reported that there was a significant improvement in walking capacity after cycling exercise. In the study showed by Pellicer et al. (124), the effect of the multiple exercise model, including cycling exercise, on the walking capacity and functionality of patients after stroke was examined. As a result of the study, it was reported that multiple exercise modalities provided important improvement in the walking capacity and functionality of the patients.

5.3. Evaluation of the VAS

In our study VAS score after cycling exercise was significantly lower. Paralellel with our results, in the study conducted by Neely et al. (125), it was informed that there was a major decrease in VAS scores after cycling exercise. Similarly, in the study conducted by Jondeau et al (126), it was reported that cycling exercise on condition that a significant decrease in VAS score in patients with congestive heart failure.

Limitations of the Research

The lack of a control group among the participants in the study is the limitation of the study.

Evaluation of pain as only local pain is the limitation of the study.

Recommendation

In the study, only local pain in the lower back was asked to the participants. Subparameters of pain can also be asked. Body chart analysis can be done.

The work was done with the experimental group; a control group can be added to this study.

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APPENDIX. A

T.C.
YEDİTEPE ÜNİVERSİTESİ REKTÖRLÜĞÜ
Girişimsel Olmayan Klinik Araştırmalar Etik Kurulu

Sayı : E.83321821-805.02.03-41
Konu : Etik Kurul Karar Yazısı

Sayın Prof. Dr. Feryal Subaşı

Yeditepe Üniversitesi Girişimsel Olmayan Klinik Araştırmalar Etik Kuruluna etik onay için başvuru yapılmış olan araştırma önerisinin başlığı, araştırmacılar, başvuru numarası, sunulan belgeler ve toplantı bilgileri aşağıda yer almaktadır. İlgili araştırma önerisi, etik kurulumuz üyeleri tarafından değerlendirilmiş olup, etik ve bilimsel açıdan **UYGUN** olduğuna karar verilmiştir.

Araştırma Başlığı:	**Kanal daralması olan hastalarda dirençsiz 10dk bisiklet çevirme egzersizinin ağrı,fonksiyonellik ve yaşam kalitesi üzerine etkisi**
Araştırmacılar:	**Fzt. Sariye Nur Karaca**
Başvuru Numarası:	**202204Y0240**

TOPLANTI BİLGİLERİ			
Toplantı Tarihi:	13.05.2022	**Toplantı Yeri:**	Çevirim içi (Google Meet)

SUNULAN BELGELER
Islak imzalı başvuru dosyası, CD veya USB belleğe kaydedilmiş başvuru dosyası ve elektronik başvuru
Araştırma başlığı ve araştırmacıların isimleri
Başvuru dilekçesi
Başvuru formu
Araştırmanın;
• Niteliği
• Önemi ve özgün değeri
• Amaç ve hedefleri
• Yöntemi
• Yönetimi
• Yaygın etkisi
• Araştırma bütçesi (Mevcutsa)
• Süresi ve uygunluğu (Zaman cetveli)
• Kaynakları
Bilgilendirilmiş Gönüllü Olur Formu (yapılan araştırmaya özel olarak hazırlanmış)

Bu belge, güvenli elektronik imza ile imzalanmıştır.
Belge Doğrulama Adresi : http://belgedogrulama.yeditepe.edu.tr/bg.aspx?id=2DEB24FF-7F7C-428B-B4D8-56C8E038B72B

Yeditepe Üniversitesi 26 Ağustos Yerleşimi, İnönü Mahallesi Kayışdağı Caddesi 34755
Ataşehir / İSTANBUL
Telefon No: (0216) 578 00 00 Faks No : (0216) 578 02 99
İnternet Adresi www.yeditepe.edu.tr
Kep Adresi : yeditepeuniversitesi@hs03.kep.tr

Bilgi İçin: Sinem ARI
Unvan: Uzman Yardımcısı
Telefon No:

Taahhütname-1 Araştırmanın yapılacağı kurumdan izin alma sorumluluğunun araştırmacılara ait olduğuna dair taahhüt
Taahhütname-2 Dünya Tıp Birliği Helsinki Bildirgesinin son versiyonunun ve Sağlık Bakanlığı'nın ilgili tüm kılavuzlarının okunmasına dair taahhüt
Taahhütname-3 Daha önce yapılmış etik kurul başvuruları mevcut olup olmadığına dair taahhüt
Taahhütname-4 Araştırma sırasında araştırma bütçesinde yer almayan ve gönüllünün kendisine veya Sosyal Güvenlik Kurumuna ek yük getirecek hiçbir işlem uygulanmayacağına dair taahhüt
Taahhütname-5 COVID-19 hastalarında tedavi yaklaşımları ve bilimsel araştırmalar genelgesi okunmasına dair taahhüt
Taahhütname-6 Millî Eğitim Bakanlığı Araştırma Uygulama İzinleri konulu yazının okunmasına dair taahhüt
Araştırmacıların her birisine ait özgeçmiş formu
Ek belgeler (Varsa kullanılan ölçek)

Prof. Dr. Didem ÖZDEMİR ÖZENEN
Başkan

Doç. Dr. Gökhan ERTAŞ
Başkan Yardımcısı

Doç. Dr. Elif SUNGURTEKİN EKÇİ
Raportör

Prof. Dr. Feryal SUBAŞI
Üye

Doç. Dr. Mehmet Engin CELEP
Üye

Doç. Dr. Binnur OKAN BAKIR
Üye

Dr. Öğr. Üyesi Elif Çiğdem KELEŞ
Üye

Dr. Öğr. Üyesi Emine Nur ÖZDAMAR
Üye

Dr. Öğr. Üyesi Sevim ŞEN
Üye

Yeditepe Üniversitesi 26 Ağustos Yerleşimi, İnönü Mahallesi Kayışdağı Caddesi 34755
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Telefon No: (0216) 578 00 00 Faks No : (0216) 578 02 99
İnternet Adresi www.yeditepe.edu.tr
Kep Adresi : yeditepeuniversitesi@hs03.kep.tr

Bilgi İçin: Sinem ARI
Unvan: Uzman Yardımcısı
Telefon No:

APPENDIX. B

SF-36 (Short Form 36)

Adınız Soyadınız: _________________________________ Hasta # ___________

Aşağıdaki sorular sizin kendi sağlığınız hakkındaki görüşünüzü, kendinizi nasıl hissettiğinizi ve günlük aktivitelerinizi ne kadar yerine getirebildiğinizi öğrenmek amacındadır. Her hangi bir sorunun yanıtı hakkında emin değilseniz bile size en uygun yanıtı verin. Ayrıca 10 uncu sorudan sonraki boşluğa yorumlarınızı yazabilirsiniz.

1-Genel sağlık durumunuz hakkında aşağıdaki tanımlardan hangisi doğrudur? Lütfen tek bir yanıt veriniz.

Mükemmel

Çok iyi

İyi

Orta (fena değil)

Kötü

2-Bir yıl öncesi ile karşılaştırdığınızda genel sağlık durumunuzu nasıl değerlendirirsiniz?

Bir yıl öncesinden çok daha iyi

Bir yıl öncesinden biraz iyi

Hemen hemen aynı

Bir yıl öncesinden biraz daha kötü

Bir yıl öncesinden çok daha kötü

SAĞLIK VE GÜNLÜK AKTİVİTELER

3-Aşağıdaki sorular bir gün içinde yapabileceğiniz işlerle (aktivitelerle) ilgilidir.

Sağlığınız bu aktiviteleri kısıtlıyor mu? Eğer kısıtlıyorsa, ne kadar?

	Evet, çok kısıtlı	Evet, biraz kısıtlı	Hayır, hiç kısıtlı değil
a)Zorlu aktiviteler; örneğin koşma, ağır eşyaları kaldırma, zor sporlara katılma vb			
b)Orta derecede aktiviteler; örneğin bir masayı kaldırma, elektrikli süpürgeyi itme, hafif sporlara katılma vb			
c)Ağır kaldırma ve yük taşıma			
d)Çok sayıda merdiven basamağını çıkma			
e)Tek bir merdiven basamağını çıkma			
f)Öne eğime, çömelme veya diz çökme			
g)İki kilometreden çok yürüme			
h)Bir kilometre yürüme			
i)100 metre yürüme			

j)Kendi başına banyo yapma ve giyinme

4-Son 4 hafta içinde çalışma sırasında veya günlük aktiviteleriniz sırasında aşağıdaki problemlerden herhangi birini yaşadınız mı?

Her bir soruya evet veya hayır yanıtı verin.

	Evet	Hayır
a)Çalışma yaşamınızda veya diğer aktivitelerinizde geçirdiğiniz zamanı kısalttınız mı?		
b)Arzu ettiğinizden daha az şey mi yaptınız?		
c)Çalışma veya diğer yaptığınız işlerin çeşidinde kısıtlama yaptınız mı?		
d)Çalışma yaşamınızda veya diğer aktivitelerinizi yapmakta güçlük çektiniz mi? (aşırı efor gösterdiniz mi?)		

5-Son 4 hafta içinde çalışma sırasında veya günlük aktiviteleriniz sırasında duygusal sorunlar nedeniyle (depresyon veya sıkıntı gibi nedenlerle) aşağıdaki problemlerden herhangi birini yaşadınız mı?

Her bir soruya evet veya hayır yanıtı verin.

	Evet	Hayır
a)Çalışma yaşamınızda veya diğer aktivitelerinizde geçirdiğiniz zamanı kısalttınız mı?		
b)Arzu ettiğinizden daha az şey mi yaptınız?		
c)Çalışma veya diğer aktivitelerinizi her zamanki gibi dikkatlice yapabildiniz mi?		

6-Son 4 hafta içinde fizik sağlığınız veya duygusal sorunlarınız sizin ailenizle, arkadaşlarınızla, komşularınızla olan sosyal ilişkilerinizi ne ölçüde etkiledi?

Lütfen tek bir yanıt veriniz.

Hiç etkilemedi

Çok az

Orta derecede

Epeyce

Çok fazla

7-Son 4 hafta içinde ne kadar ağrınız oldu?

Lütfen tek bir yanıt veriniz.

Hiç olmadı

Çok az

Az

Orta derecede

Çok

Pek çok

8-Son 4 hafta içinde ağrınız sizin normal çalışmanızı ne kadar etkiledi (hem ev dışında, hem de ev işi olarak)?

Lütfen tek bir yanıt veriniz.

Hiç etkilemedi

Biraz etkiledi

Orta derecede etkiledi

Epey etkiledi

Çok etkiledi

GENEL SAĞLIK

9-Aşağıdaki cümlelerin sizin için ne kadar doğru veya yanlış olduğunu belirtiniz.

Her bir soruya tek bir yanıt veriniz.

	Kesinlikle doğru	Çoğunluk la doğru	Emin değilim	Çoğunluk la yanlış	Kesinlikle yanlış
a)Ben diğer insanlara göre daha kolay hastalanıyorum					
b)Tanıdığım kişiler kadar sağlıklıyım					
c)Sağlığımın kötüleşmekte olduğunu sanıyorum					
d)Sağlığım mükemmel					

DUYGULARINIZ

10-Aşağıdaki sorular duygularınızı ve son bir ay içinde nasıl olduğunuzu anlamak için düzenlenmiştir. Her bir soru için lütfen size en uygun tek bir yanıtı işaretleyin.

	Sürekli	Çoğu Zaman	Epey zaman	Bazen	Ara sıra
a)Kendinizi yaşam dolu olarak mı hissediyorsunuz?					
b)Çok sinirli biri mi oldunuz?					
c)Kendinizi lağım çukuruna düşmüş gibi hissettiğiniz ve hiçbir şeyin moralinizi düzeltemeyeceğini düşündüğünüz oldu mu?					
d)Kendinizi sakin ve barışçı hissettiniz mi?					
e)Çok enerjik oldunuz mu?					
f)Kendinizi kalbi kırık ve üzgün hissettiniz mi?					
g)Kendinizi yıpranmış hissettiniz mi?					
h)Mutlu bir insan oldunuz mu?					
i)Yorgunluk hissettiniz mi?					
j)Sağlığınız sosyal aktivitelerinizi sınırladı mı? (arkadaşları veya yakın akrabaları ziyaret etmek gibi)					

APPENDIX. C

OSWESTRY SKALASI

Hazırlayan: Dr.Atilla Akbay

Aşağıdaki sorular, bel ağrınızın günlük aktivitelerinizi ne kadar etkilediğini anlamak için planlanmıştır. Size en uygun yanıtı işaretleyiniz. Lütfen ***her soruya tek bir yanıt veriniz!***

1-**Ağrınızın şiddeti** nasıl?

1)Gelip geçici ve çok hafif bir ağrı
2)Sürekli, fakat hafif bir ağrı
3)Gelip geçici ve orta şiddette bir ağrı
4)Sürekli ve orta şiddette bir ağrı
5)Gelip geçici ve şiddetli bir ağrı
6)Şiddetli ve çok değişmeyen bir ağrı

2-**Kişisel bakım**

1)Ağrıdan kaçınmak için günlük yaşamımda (yıkanma, giyinme şekli vb) değişiklik yapmadım
2)Biraz ağrı yapsa da yıkanma ve giyinme şeklinde değişiklik yapmadım.
3)Yıkanma ve giyinmem ağrımı arttırıyor, fakat bunları değiştirmeden idare ediyorum
4)Yıkanma ve giyinmem ağrımı arttırıyor, bu yüzden bunları yapma şeklimde değişiklik yaptım.
5)Ağrı nedeniyle yıkanma ve giyinmede bir miktar yardım alıyorum.
6)Ağrı nedeniyle yıkanma ve giyinmeyi yardımsız yapamıyorum.

3-**Yük Kaldırma**

1)Ağır yükleri ağrım olmadan kaldırabiliyorum.
2)Ağır yükleri kaldırırken bir miktar ağrım oluyor.
3)Ağrı yüzünden ağır yükleri kaldıramıyorum.
4)Ağrı, ağır yükleri kaldırmamı önlüyor, fakat uygun pozisyon varsa (örn. masa üzerinden) bunu başarabilirim.
5)Sadece çok hafif yükleri kaldırabiliyorum
6)Hiç yük kaldıramıyorum

4-**Yürüme**

1)Yürürken ağrım yok
2)Yürümeyle biraz ağrım var, fakat mesafeyle artmıyor
3)Ağrımda belirgin artma olmaksızın 2 km den fazla yürüyemiyorum
4)Ağrımda belirgin artma olmaksızın 500 m den fazla yürüyemiyorum
5)Ağrımda belirgin artma olmaksızın yürüyemiyorum
6)Hiç yürüyemiyorum

5-**Oturma**

1)Herhangi bir sandalyede istediğim kadar uzun oturabilirim
2)Sadece uygun bir sandalyede istediğim kadar uzun oturabilirim
3)Ağrım bir saatten uzun oturmamı önlüyor

4)Ağrım yarım saatten uzun oturmamı önlüyor
5)Ağrım 10 dakikadan fazla oturmamı önlüyor
6)Ağrımı arttırdığı için oturmaktan kaçınıyorum

6-**Ayakta durma**

1)Ağrı olmaksızın istediğim kadar uzun ayakta durabilirim
2)Ayakta durmakla biraz ağrım oluyor, fakat bu zamanla artmıyor.
3)Bir saatten uzun ayakta kaldığımda ağrım şiddetleniyor.
4)Yarım saatten uzun ayakta kaldığımda ağrım şiddetleniyor. 5)On dakikadan uzun ayakta kaldığımda ağrım şiddetleniyor.
6)Ağrımı arttırdığı için ayakta durmaktan kaçınıyorum

7-**Uyuma**

1)Yatakta ağrım yok
2)Yatakta ağrım var, fakat iyi uyuyorum
3)Ağrı nedeniyle normal uykumun 3/4 ünü uyuyorum
4)Ağrı nedeniyle normal uykumun yarısını uyuyorum
5)Ağrı nedeniyle normal uykumun 1/4 ünü uyuyorum
6)Ağrı nedeniyle hiç uyuyamıyorum

8-**Sosyal yaşam**

1)Sosyal yaşamım normal ve ağrı yaratmıyor.
2)Sosyal yaşamım normal, fakat ağrımı arttırıyor.
3)Ağrı, dansetmek, futbol oynamak gibi daha fazla enerji gerektiren ilgilerimi kısıtlamak dışında sosyal yaşamımda belirgin etki yaratmıyor.
4)Ağrı, sosyal yaşamımı kısıtlıyor, bu nedenle çok sık dışarıya çıkamıyorum.
5)Ağrı, aile içi yaşamımı da kısıtlıyor.
6)Ağrı nedeniyle hemen hemen tüm sosyal yaşamım kısıtlandı.

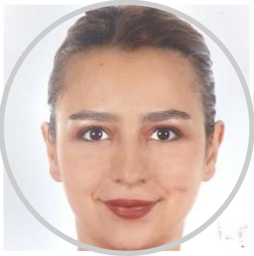
9-**Seyahat**

1)Seyahatte ağrım olmuyor.
2)Seyahatte biraz ağrım oluyor, fakat artmıyor.
3)Seyahatte ağrım artıyor, fakat bu ağrı seyahat şeklimi değiştirmedi.
4)Seyahatte olan şiddetli ağrılarım nedeniyle başka seyahat şekilleri arıyorum.
5)Ancak yatarak seyahat edebiliyorum.
6)Ağrı nedeniyle seyahat edemiyorum.

10-**Ağrının değişme derecesi**

1)Ağrım hızla iyileşiyor.
2)Ağrım artıp azalıyor, fakat genelde iyiye gidiyor.
3)Ağrım iyileşiyor, fakat düzelme yavaş.
4)Ağrım ne kötüleşiyor, ne de iyileşiyor.
5)Ağrım yavaş yavaş kötüleşiyor.
6)Ağrım hızla kötüleşiyor.

APPENDIX. D CV



Sariye Nur Karaca

Evliya Celebi Neighborhood Coastal Road Boulevard No:1 Tuzla GİSBİR Hospital/ İstanbul, istanbul, Turkey

Email address **Phone number:**

Nationality: Turkish

WORK EXPERIENCE

[01/08/2021 – Current] **Physiotherapist**

Tuzla Private Gisbir Hospital

Main activities and responsibilities:
Fracture rehabilitation
Extremity injuries, ruptures as a result of work accident
Hand Rehabilitation
Sports injuries and return to sports exercise program
Gait analysis and posture analysis
Neurologic rehabilitation and improving quality of life
Responsible physiotherapist and team leadership

[01/07/2019 – 01/07/2021] **Physiotherapist**

Okan University Hospital

Main activities and responsibilities:
Treatment of orthopedic injuries
Pilates (reformer,mat)
Amputee rehabilitation
Neurological rehabilitation
Pediatric rehabilitation (Cerebral Palsy,muscle disorders)

[01/10/2017 – 01/05/2019] **Physiotherapist**

Tuzla Private Gisbir Hospital

Pediatric rehabilitation,gait analysing,posture analysing Treatment with play

EDUCATION AND TRAINING

[26/09/2017 – 28/10/2017] **Intern Physiotherapist**

6.25 Physical Therapy and Rehabilitation Centers

Main subject / occupational skills covered:
Organizing and following exercises programs of athletes
Learning some sport specific exercises
Learning how to disagn rehabilitation programs for the Athletes
Cybeks isokinetic test and exercise device use

[17/04/2017 – 12/05/2017] **Intern Physiotherapist**

Lifemed Tıp Center

Address: istanbul, Turkey
Main subject / occupational skills covered:
Completing the evaluations of the people who come to the clinic
Using electrotherapy devices
Create an exercise prescription
To carry out the evaluations of the athletes who come to the clinic

[06/02/2017 – 10/02/2017] **Intern Physiotherapist**

RİBEM Risky Baby Counseling Center

Main subject / occupational skills covered:
Attending sessions with a supervisor
Observing in the field of pediatric rehabilitation
Bobath therapy practice evaluation

[05/12/2016 – 30/12/2016] **Intern Physiotherapist**

Yeditepe University – Bagdat Street Polyclinic – Physical Therapy Service, Sport Physiotherapy Un

Main subject / occupational skills covered:
Organizing and following exercises programs of athletes
Learning when and how to uptade exercise and therapeutic programs of atheletes
Learning how to conduct recovery programs to athletes
Learning which parameters are important for sports branches

[31/10/2016 – 02/12/2016] **Intern Physiotherapist**

Erenköy Physiotherapy and Rehabilitation Hospital

Main subject / occupational skills covered:
Treatment approach to inpatient neurological patients
Creating a neurological patient exercise program
Gait and balance training
Applying stretching to patients with spasticity

[26/09/2016 – 28/10/2016] **Intern Physiotherapist**

Baltalimani Bone Diseases Hospital

Main subject / occupational skills covered:
Organizing and following exercises programs of athletes
Learning when and how to uptade exercise and therapeutic programs of atheletes
Learning how to disagn rehabilitation programs for the Athletes Learning some sport specific exercises

[06/06/2016 – 01/07/2016] **Intern Physiotherapist**

CARE Academy

Main subject / occupational skills covered:
Attending sessions with a supervisor
Observing in the field of pediatric rehabilitation
Sensory integration and vestibular system monitoring

[01/06/2015 – 26/06/2015] **Intern Physiotherapist**

Fatih Sultan Mehmet Training and Research Hospital

Main subject / occupational skills covered:
Completing the evaluations of the people who come to the clinic
To organize the exercise and therapeutic programs of the people who come to the clinic To carry out the evaluations of the athletes who come to the clinic

[01/02/2018 – 10/09/2022] **Master of Science (MSc)**

Yeditepe University Health Science Institute-Sports Physiotherapy and Rehabilitation Department

Address: İnönü Mah. Kayisdagi Cad. 326A 26 August Settlement 34755 Ataşehir İstanbul, istanbul, Turkey

Thesis: The Effect Of 10-Minute Flexion-Inducing Cycling Without Fixed Resistance On

Pain Quality Of Life And Functionality In Patients With Spinal Canal Stenosis **Main subject / occupational skills covered:**

◦ Physiotherapy rehabilitation protocols (Specified sports and general)
◦ Canal narrowing anatomy physiology
◦ Effects of cycling on patients with canal narrowing ◦
Literature search

[03/09/2012 – 20/08/2017] **Bachelor of Science (BSc)**

Yeditepe University- Department of Physiotherapy and Rehabilitation - Faculty of Health Sciences

Address: İnönü Mah. Kayisdagi Cad. 326A 26 August Settlement 34755 Ataşehir -

İstanbul, istanbul, Turkey

Main subject / occupational skills covered:

- Manuel therapy
- Exercise Physiology
- Posture Analysis
- Women's Health Physiotherapy
- Modified Clinical Exercises
- Sports Physiotherapy
- Functional Anatom

[29/04/2018 – 30/04/2018] **Modified Pilates Matwork Level 1**

APPI (The Australian Physiotherapy and Pilates Instute - Özlem Üstünkaya) https://appihealthgroup.c

Address: The Chapel, Wellington Road, London, United Kingdom NW105LJ

[13/01/2018 – 14/01/2018] **Musculoskeletal Skills for The Pregnancy, Post Natal, Women's&Pelvic**

Health Physiotherapist

Greene Physiotherapy Seminars (Gerard Greene) https:// www.greeneseminars.physio/

Address: Barefoot Birmingham 7 High Street Harborne Birmingham B17 9NT

[29/08/2020 – 30/08/2020] **The Functional Movement Training (FMT) Basic Kinesiology Taping Certification**

Dr Steven Capobianco Gulsah Basandac RockTape Instructer https:// www.rocktape.com/consumer

Address: 2001 TW Alexander Drive Durham, NC 27709 USA

LANGUAGE SKILLS

Mother

tongue:

Turkish

Other

languag:

English

LISTENING C1 **READING** C2 **WRITING** B2

SPOKEN PRODUCTION C1 **SPOKEN INTERACTION** B2

DIGITAL SKILLS

My Digital Skills

Microsoft Office Word Power Point Excel

Social Media

Computer

Microsof excel | Microsoft Microsoft Office | Micosoft powerpoint

Cominication

Linked In | Zoom | Skype | Good listener/Good communicator

Characteristics

Team work orientated | Communication skills (listening skills; verbal skills; written skills) | Have positive attitude | Analytical skills and abillity to solve problems | Spo