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Muscle Strength, Lumbar Curve, Fear of Movement and Functional Disability among Patients with Lumbar Disc Herniation: A Review

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Abstract

Introduction: Lumbar disc herniation (LDH) refers to the rupture of the fibrous annulus of the intervertebral discs. Lumbar curvature may lead to the occurrence of lumbar disc degeneration. Fear of movement may worsen their disc herniation and cause further pain and injury. LDH conditions impact the individuals' quality of life, to explore the relationship between lumbar curve, muscle strength, fear of movement and functional disability among patients with LDH. **Methods:** An electronic search was conducted on PubMed, Medline, Science Direct, Springerlink, Google Scholar and a hand search from reference lists was reviewed. Publications were included in human studies, patients 25 - 85 years of age, original studies and published in English language journals from January 2002 to December 2023. **Result:** In total, 64 articles were researched through the online search engines, and 9 papers were found through manual searches of reference lists. As a result, a total of 11 articles were included for the purpose of this review. The comprehensive analysis revealed the presence of eight cross-sectional studies, two retrospective studies and one experimental study. A minimum of 25 participants and a maximum of 360 participants were included. Ten studies included both genders, only one studies included healthy adults and patients with LDH but these studies didn't mention gender. Results showed that the factors influencing LDH can be categorized into non-modifiable factors, such as gender, age, height or others. Modifiable factors included increased BMI, DM, smoking, alcohol, employment status, lifestyle and health problems or psychology. **Conclusion**: Females with greater VASC may be at risk of LDH. The lumbar extensor muscles indicated a localized disc herniation or nerve root pathology in patients with LDH. The fear of movement may lead to psychological con-

sequences and reduce functional disability among patients with LDH.

Keywords

Lumbar Disc Herniation, Fear of Movement, Functional Disability, Vertical Angle of Spinal Curvature

1. Introduction

Lumbar disc herniation (LDH) is characterised by the rupture of the fibrous annulus of the intervertebral disc, leading to the extrusion of the nucleus pulposus. This extrusion causes compression of the spinal nerve root, resulting in the manifestation of radiculopathy [1], and potentially affecting the cauda equina [2]. The aetiology of LDH has been attributed to various factors operating at the genetic, mechanical, and behavioural levels [3]. The prevalence of symptomatic LDH is estimated to be less than five percent of the population [4] [5].

Additionally, it has found that the incidence of LDH is twice as high in men compared to women. According to [6] the annual incidence rate of LDH in adults ranges from 5 to 20 cases per 1000 individuals. According to [7] individuals aged 55 and above have a higher prevalence of disc herniation over a certain level. However, among individuals aged 25 to 55, the occurrence of herniated discs is predominantly concentrated at the lower lumbar spine, namely at the L4/5 and L5/S1 levels, accounting for over 95% of cases.

According to the study conducted by [8] it showed that the prevalence of LDH is greater in adults compared to children and adolescents. Genetic factors have been identified as the primary cause of the majority of instances with LDH. However, genetic predisposition that affects the composition and strength of their spinal discs, makes them more susceptible to herniation [9]. As people age, their intervertebral discs lose hydration and elasticity which can lead to disc degeneration. This degeneration process reduces the ability of the disc to absorb shock and increases the risk of tearing or rupturing with strain or stress [1]. Repetitive activities or occupations that place a significant amount of stress on the lower back can increase the risk of disc herniation. This includes heavy lifting, prolonged sitting or repetitive bending and twisting movements [8]. Being overweight or leading a sedentary lifestyle can contribute to the risk of lumbar disc herniation (LDH). Excess body weight puts additional pressure on the discs in the lumbar spine and inactivity can lead to muscle weakness and a lack of support for the spinal column [10].

The pathology of LDH involves a combination of mechanical and biochemical processes. The intervertebral discs are avascular structures that receive nutrition through diffusion and with age or injury, these discs may degenerate, losing water content and elasticity [11]. The flexibility and strength of the nucleus pulposus and connective tissue within the lumbar intervertebral discs tend to diminish over time as individuals age [3] [11]. Consequently, this degenerative process

may contribute to the occurrence of a herniated disc. According to [3] explore occupational characteristics, such as physical workload, arduous employment, shifts over eight hours, and stress, are believed to exert a substantial influence on LDH.

The basic function of skeletal muscle is to facilitate movement and generate force [12]. The erector spinae, psoas, and quadratus lumborum are among the key muscles responsible for core stabilisation [13]. Based on a study conducted by [14] it was found that gender accounted for 53% and 21% of the variance in lumbar muscular strength among older and younger individuals, respectively. Nevertheless, the study conducted by [14] did not observe a linear correlation between age and trunk muscle strength. According to [15], the spine plays a crucial role in maintaining the health and functionality of the spine. Decreased load transmission and higher mechanical stress on other supporting musculoskeletal structures may arise from inadequate lumbar extensor muscle endurance over time [16]. The eccentric contractions of the rectus abdominis muscle play a vital role in the preservation of spinal stability and the prevention of back discomfort. The study conducted by [17] observed a modest gain of 1% - 3% in abdominal strength, whereas extensor strength shown a more substantial increase ranging from 13% - 31%. Previous studies have demonstrated that the presence of abdominal muscle dysfunction, namely involving the internal oblique and rectus abdominis, has a substantial role in the development and persistence of chronic low back pain [18].

Despite extensive study conducted on low back pain (LBP) and its association with the multifidus (MF) and other muscles of the trunk, as highlighted by [19]. In the context of preserving the well-being of the lumbar spine, the musculature located in the lower extremities, specifically the hip and gluteal muscles, exert a substantial influence [20]. In their study, [21] discovered that the flexed Gluteus Maximus (GMax) plays a substantial part in the act of lifting heavy loads.

According to [22] improper lifting technique can lead to incorrect loading on the intervertebral discs, making them more vulnerable to herniation, and placing the spinal ligaments under increased stress. According to [16] the transmission of forces from the lower extremities to the lumbopelvic region is assisted by the strength and proper activation of the muscles in the lower limbs. According to a study conducted by [13] a potential factor contributing to chronic lower back pain (LBP) is a diminished level of muscle support.

The presence of a weak GMax muscle has been identified as a potential risk factor for the development of low back pain [10]. This is particularly significant during the initial 50% of trunk extension following complete flexion [23]. Additionally, [24] have provided evidence suggesting that GMax may serve as a protective mechanism against low back injuries. This is achieved through the activation of GMax when the erector spinae muscles get fatigued, hence compensating for their diminished functionality. The development or exacerbation of low back pain (LBP) may be attributed to heightened lateral trunk flexion and consequent compression of intervertebral discs, alongside altered movement patterns. This

phenomenon has been identified by [25]. It is plausible that insufficient strength in the gluteus medius muscle could be a contributing factor to this occurrence.

According to [14], there is an association between thoracolumbar curvature and a decline in the strength of the lumbar extensor muscles. In that study [26] have demonstrated that age and gender have influence on the formation of thoracolumbar curvature. The occurrence of disc degeneration in the lumbar region can be attributed to a change in lumbar lordosis. According to [27] alterations in the height of the intervertebral disc result in a corresponding adjustment in the angle between adjacent vertebrae. This adjustment subsequently leads to an uneven distribution of pressure along the spine, thereby elevating the susceptibility to both herniated disc conditions and low back pain.

The lumbosacral region plays a crucial role in facilitating movement and providing structural support for the body's load-bearing functions. The lumbosacral region can be influenced by various factors such as age, posture, degenerative changes, height, trauma or surgery, racial/ethnic background, and gender [28]. Previous research has put out the concept that deviations in the lumbosacral angle (LSA) or curvature may contribute to the occurrence of spinal degeneration [29] [30]. According to [29], the lumbosacral angle (LSA) is a consequence of the most significant alterations that occur in the lumbosacral column throughout the progression of bipedal locomotion and the adoption of an upright posture.

The basic function of skeletal muscle is to facilitate movement and generate force [12]. The capacity of a muscle to produce force is impacted by its structural composition and other physiological attributes. Weakness in the lumbar extensors has been linked to alterations in the bregma angle and muscle tone. Increased muscle strength is connected with alterations in the angles of the vertical angle of sacral curvature and thoracolumbar curvature.

The study conducted by [31] has demonstrated a correlation between the fear of relocation and restricted movement of the trunk. According to a recent systematic review and meta-analysis conducted by [32] individuals suffering from low back pain (LBP) who exhibit heightened levels of apprehension towards movement tend to exhibit a little reduction in spinal mobility. In that studies, [33] found that those experiencing a high level of apprehension about mobility exhibited increased rigidity in their trunk and reduced speed of sagittal plane flexion. Individuals who possess elevated fear avoidance attitudes and have low back pain may encounter difficulties in accurately executing a prescribed movement trajectory including trunk flexion and extension [31].

Extensive research has been conducted to investigate the aetiology of low back pain (LBP) [34]. Numerous research have examined the influence of various characteristics, such as gender, age, obesity, level of back muscle development, education, socioeconomic status, smoking, and stress, on the reduction of both the occurrence and duration of lower back pain [22] [35]. Therefore, the present study aimed to enhance the provision of therapy for patients with low back pain

(LBP) and lumbar disc herniation (LDH) by updating the information on trunk and hip muscular strength, spine curvature, and fear of movement.

2. Materials and Methods

2.1. Identification and Selection of Studies

A literature review was conducted utilising electronic databases including PubMed, Medline, Science Direct, Springerlink, and Google Scholar. Furthermore, a comprehensive manual search was conducted to verify the inclusion of all relevant references. The search terms included muscle strength, lumbar curvature, fear of movement and functional disability among patients with lumbar disc herniation. In the review studies selection criteria were as follows: Inclusion and Exclusion criteria.

The inclusion criteria were as follows: 1) Patients with lumbar disc herniation (L4 - L5 or L5 - S1) as assessed by MRI and clinical symptoms corresponding to position of the impaired nerve root; 2) Patients assessed as positive in the SLR test; 3) Patients with sciatica in either leg; Patients with no improvement from conservative treatment

The exclusion criteria were as follows: 1) Patients who have two or more lumbar disc herniations as assessed by MRI; 2) Patients in whom a rupture into the posterior longitudinal ligament is identified by MRI; 3) Patients who have received spinal injection, epidural injection, nerve block within 3 weeks prior to the time of informed consent; 4) Patients who have undergone lumbar operation, or lumbar percutaneous nucleotomy or lumbar intradiscal therapies.

All criteria consisted of articles that involved investigations with human participants aged between 25 and 85 years. These papers were required to be unique research studies and published in English-language journals between January 2002 and December 2023.

2.2. Study Selection

The selection of research was conducted using a screening method that comprised assessing the title, abstracts, and full text. The inclusion criteria comprised studies that investigated either acute or chronic lumbar disc herniation (LDH), examined the risk factors associated with LDH or related conditions, explored the direct causes of LDH or related conditions, and analysed the prevalence of LDH or related conditions based on demographic and anthropometric characteristics. The exclusion criteria encompassed studies that involved narrative reviews and secondary data, including systematic reviews with or without meta-analysis.

Following the removal of redundant studies, an assessment was conducted on the titles, abstracts, and full texts to ascertain their adherence to the predetermined criteria for inclusion and exclusion. The screening process was carried out following the search protocol as described in the PRISMA flow diagram (**Figure 1**).

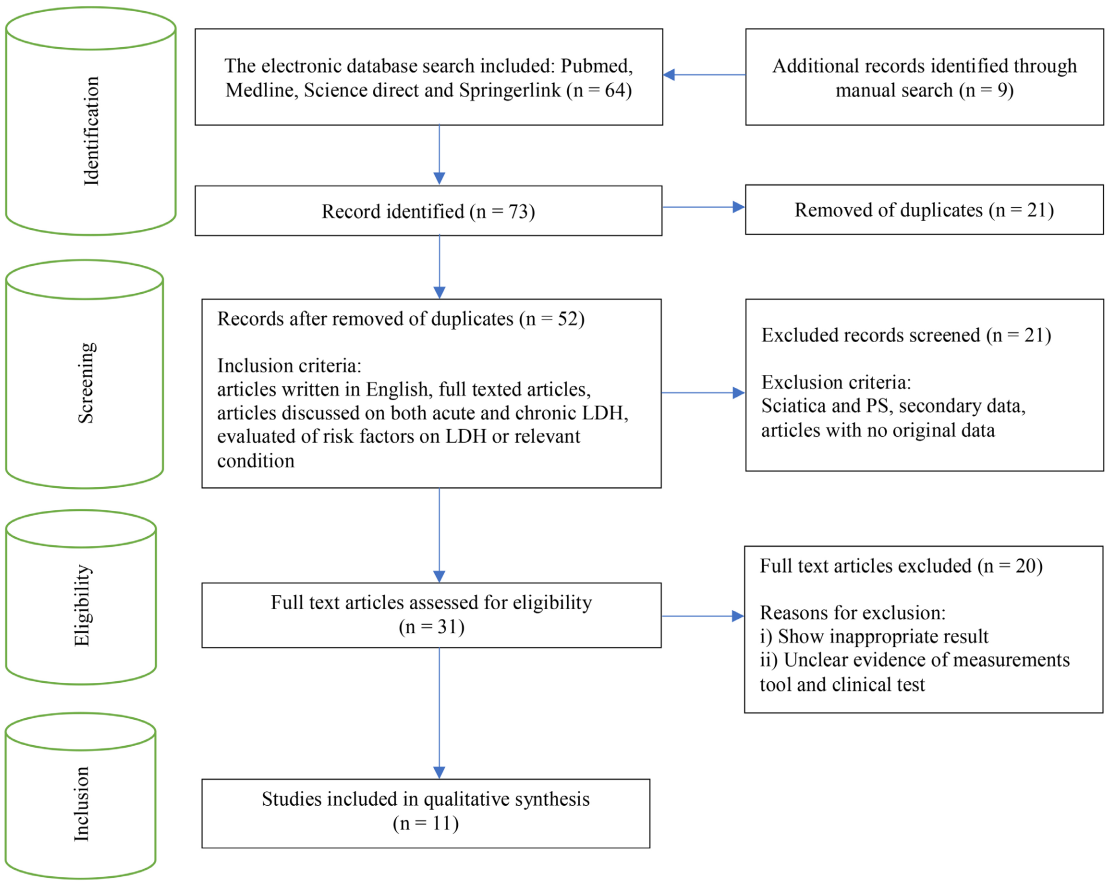

Figure 1. Study selections flow chart.

2.3. Data Extraction

Data were extracted based on author name & year, country, name of research article, study design, traits of the population, outcome measurements and finding.

SL No.	Author name & Year	Country	Name of the research article	Study design	Traits of the population	Outcome measurements	Finding
1	Ghasemi *et al.* (2016)	Iran	The relation between sacral angle and vertical angle of sacral curvature and lumbar disc degeneration	A cross sectional (case-control)	Total of 463 (male 228 and female 235)	MRI report	Did not find any significant correlation between vertical angle of sacral curvature and LDH in lumbosacral MRI. Also, SA is not an independent risk factor for LDH in men and women.
2	Kanat *et al.* (2012)	Türkiye	Introducing a New Risk Factor for Lumbar Disc Herniation in Females: Vertical Angle of the Sacral Curvature	A cross sectional study	Total of 128 (male 34 and female 94)	X-ray and MRI report	The vertical angle of sagittal sacral curvature may be another risk factor in females with lumbar disc herniations.

Continued

3	Gao *et al.* (2021)	China	Analysis of Sagittal profile and radiographic parameters in symptomatic thoracolumbar disc herniation patients	A experimental study	Total of 70	Anteroposterior and lateral X-rays and MRI	Two distinctive sagittal profiles in Thoraco-Lumbar Disc Herniation (TLDH) patients, and a regional kyphotic deformity with a balanced spine was validated in both subtypes (type I: Normal population, type II: Disc herniated population).
4	Rajnics *et al.* (2012)	France	The importance of spinopelvic parameters in patients with lumbar disc lesions	A cross sectional study	Total of 50 (male 28 and female 22)	X-ray report	The anterior shift of the line of gravity may cause spinopelvic instability and contraction of the posterior spinal muscles in trying to balance this disturbed spatial relationship may produce back pain.
5	Chen *et al.* (2021)	China	Morphology of the lumbar multifidus muscle and in lumbar disc herniation at different durations and at different ages	A cross sectional study	Total of 327 (male 178 and female 149)	1) The extent and activity level were evaluated by VAS and JOA 2) CT images (Lumbar multifidus) were obtained by a soft tissue window	Two distinctive sagittal profiles in TLDH patients, and a regional kyphotic deformity with a balanced spine was validated in both subtypes (type I: Normal population, type II: LDH).
6	Kuai *et al.* (2012)	China	The effect of Lumbar disc herniation on musculoskeletal loadings in the spinal region during level walking and stair climbing	A cross sectional study	Total of 33 (male 33)	EMG (electromyography)	LDH patients exhibited different kinetic alternations during level walking and stair climbing and extra burdens to the trunk system and further increased the risk for development of LDH
7	Choi *et al.* (2022)	China	Psoas muscle measurement as a predictor of recurrent lumbar disc herniation	A retrospective study	Total of 49 (male 22 and female 27)	T2 axial preoperative magnetic resonance images at L2 - L3, L3 - L4, and L4 - L5 disc levels to represent muscle mass	In middle-aged and elderly patients with LDH, relatively younger age, segmental instability, and greater psoas muscle mass may be risk factors for recurrence.

Continued

8	Van *et al.* (2012)	Netherlands	Fear of movement in pre-operative patients with a lumbar stenosis and or herniated disc: Factor structure of the Tampa scale of kinesiophobia	A cross sectional study	Total of 128 (male 63 and female 65)	TSK 17	Half of the patients suffered from kinesiophobia 10 - 34 months after surgery for LDH. These patients were more disabled, pain, catastrophizing thoughts, symptoms of depression and poorer health-related QL than patients without kinesiophobia.
9	Svensson *et al.* (2022)	Sweden	High degree of kinesiophobia after lumbar disc herniation surgery	A retrospective study	Total of 84 (male 84)	TSK, ODI, EQ-5D, VAS, ZDS, SES	In middle-aged and elderly patients with LDH, relatively younger age, segmental instability, and greater psoas muscle mass may be risk factors for recurrence.
10	Yilmaz *et al.* (2018)	Türkiye	The effect of Functional disability and quality of life on decision to have surgery in patients with lumbar disc herniation	A cross sectional study	Total of 239 (male 101 and female 138)	SBAQ, VAS, ODI, RMDQ, SF-36	Patients with LDH who have been referred for surgery experience high functional disability and pain and a poor QoL, and that these factors have an impact on their decision to have surgery process.
11	Alshammari *et al.* (2022)	Saudi Arabia	Correlation between pain, disability and levels of disc herniation in Michigan state university Grade-3 disc prolapsed patients using MRI	A cross section study	Total of 57 (male 30 and female 27)	VAS, RMDQ-Arabic version	Level of the LDH shows weak correlation both intensity of pain and functional disability; thus, the clinical symptoms of the patients with MRI to decide therapeutic intervention

Note: SA (Sacral angle), MRI (Magnetic resonance imaging), VAS (Visual analogue scale), JOA (Japanese Orthopaedic Association Scores), TSK (Tampa scale of kinesiobhobia), ODI (Oswestry disability index), EQ-5D (European quality of life in 5 dimentions), ZDS (Zung self-rating depression scale), SES (Self efficacy scale), SBAQ (Surgical belief and attitudes questionnaire), RMDQ (Roland morris disability questionnaire), SF-36 (Short form-36).

2.4. Assessment of Study Quality

The evaluation of methodological quality was performed using the quality assessment technique for observational cohort and cross-sectional studies. The tool consists of a collection of 14 questionnaires that address various aspects of the investigation. These aspects include study objectives, patient eligibility criteria, power analysis, timing considerations between exposure and outcome, speci-

fication of exposure and outcome measurements, and identification of potential sources of bias. The studies were evaluated based on their quality, which was categorised as good, fair, or poor (Table 1).

3. Results

In total, 64 articles were researched through the online search engines, and 9 papers found through manual searches of reference lists. As a result, a total of 11 articles were included for the purpose of this review. The comprehensive analysis revealed the presence of eight cross-sectional studies, two retrospective studies and one experimental study. A minimum of 25 participants and a maximum of 360 participants were included. Ten studies included both genders, only one studies included healthy adults and patients with LDH but these

Table 1. Quality assessment and risk of bias (ROB) summary.

Authors	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	ROB	Quality rating
Ghasemi *et al.* (2016)	yes	yes	yes	yes	no	yes	yes	yes	yes	no	yes	no	yes	no	low	good
Kanat *et al.* (2012)	yes	yes	yes	yes	no	yes	yes	yes	no	no	yes	yes	yes	yes	low	good
Gao *et al.* (2021)	yes	yes	yes	yes	no	yes	yes	yes	yes	no	yes	yes	yes	yes	moderate	fair
Rajnics *et al.* (2002)	yes	yes	no	yes	no	yes	yes	yes	no	yes	no	yes	no	yes	low	good
Chen *et al.* (2017)	yes	yes	yes	yes	no	yes	yes	yes	no	no	yes	no	yes	no	high	poor
Kuai *et al.* (2017)	yes	yes	yes	yes	no	yes	yes	yes	no	no	no	yes	yes	no	low	good
Choi *et al.* (2022)	yes	yes	yes	yes	no	yes	yes	no	yes	yes	no	no	yes	no	low	good
Van *et al.* (2010)	yes	yes	yes	no	no	no	yes	yes	no	yes	no	no	yes	yes	moderate	fair
Svensson *et al.* (2011)	yes	yes	no	yes	no	yes	yes	yes	no	no	yes	yes	yes	yes	low	good
Yilmaz *et al.* (2018)	yes	yes	yes	yes	no	no	yes	yes	no	yes	no	no	yes	no	high	poor
Alshammari *et al.* (2022)	yes	yes	yes	yes	no	yes	yes	no	no	no	yes	no	yes	yes	moderate	fair

Note: NIH quality assessment tool for observational cohort and cross-sectional studies. Q1: research question, Q2: study population, Q3: participation rate, Q4: inclusion criteria, Q5: sample size, Q6: exposure prior to outcome, Q7: sufficient timeframe, Q8: different level of exposure, Q9: exposure measure, Q10: multiple exposure measurement, Q11: outcome measure, Q12: blinding of outcome assessor, Q13: loss of follow, Q14: potential confounding.

studies didn't mention gender. Results showed that the factors influencing LDH can be categorized into non-modifiable factors (Table 2), such as gender, age, height or others. Modifiable factors included increased BMI, DM, smoking, alcohol, employment status, lifestyle and health problems or psychology (Table 3).

3.1. Factors Influence Risk of LDH

Findings on the influence of gender in risk of LDH were inconsistent. Five studies showed that being male had greater risk [36]-[42]. Only two studies agreed employed men with strenous physical workload had higher incidence of LDH than women [40] [41]. In the older age people were getting change to LDH rather than younger people [38] [39] [41] [42] [43] and all were non modified factors to influence LDH and based on gender and age. With regards to modifiable factors, a high incidence of LDH among higher BMI and overweight/obese subjects were reported in five studies and higher BMI having change to LDH [36] [37] [39] [42] [44]. Only one studies [44] found that diabetes can hinder the body's ability to heal and repair tissues. In the case of a LDH, the intervertebral disc may have difficulty healing properly, leading to prolonged symptoms and a higher risk of recurrence. Two studies reported that [39] [44] smoking has been associated with an increased risk of developing LDH. Only one studies [39] mentioned that regular exercise a positive impact on LDH. In psychosocial and psychological aspects [42] found that poor mental health may perceive pain as more intense or have a lower pain threshold and psychological stress were determined as risk for LDH.

Table 2. Nonmodifiable factors associated with LDH.

Authors (year)/ROB	Non-modifiable		
	Gender	Age	Height/others
Ghasemi *et al.* (2016)/low	Male/Female	yes	-
Kanat *et al.* (2012)/low	Male/Female	yes	-
Gao *et al.* (2021)/moderate	Male/Female	yes	-
Rajnics *et al.* (2002)/low	Male/Female	yes	-
Chen *et al.* (2006)/high	Male/Female	yes	-
Kuai *et al.* (2017)/low	-	yes	-
Choi *et al.* (2022)/low	Male/Female	yes	-
Van *et al.* (2010)/moderate	Male/Female	yes	-
Svensson *et al.* (2011)/low	Male	yes	-
Yilmaz *et al.* (2018)/high	Male/Female	yes	-
Alshammari *et al.* (2022)/moderate	Male/Female	yes	-

Table 3. Modifiable factors associated with LDH.

Authors (year)/ROB	The factors associated with LDH					
	BMI P value Mean (SD)	DM P value	Employment status Mean (SD)	Education P value	Lifestyle P value	Health problems/psychology P value
Ghasemi *et al.* (2016)/low	-	-	-	-	-	-
Kanat *et al.* (2012)/low	-	-	-	-	-	-
Gao *et al.* (2021)/moderate	P > 0.38	P > (0.46)	-	-	Smoking (P > 0.30)	-
Rajnics *et al.* (2002)/low	25.43 (SD 2.4)	-	-	-	-	-
Chen *et al.* (2006)/high	20.86 (SD 1.9)	-	-	-	-	-
Kuai *et al.* (2017)/low	-	-	-	-	-	-
Choi *et al.* (2022)/low	P >0.38	-	-	-	Smoking (P > 0.08), Regular exercise (P > 0.62)	-
Van *et al.* (2010)/moderate	-	-	72 (SD 0.6)	-	-	Back pain (P < 0.03), leg pain (P < 0.02)
Svensson *et al.* (2011)/low	-	-	P > 0.07	-	-	Back pain (P < 0.001), leg pain (P < 0.01)
Yilmaz *et al.* (2018)/high	28.12 (SD 4.7)	-	-	P < 0.01	-	Mental health (OR 0.98)
Alshammari *et al.* (2022)/moderate	-	-	-	-	-	-

3.2. Spinal Curvature and Muscle Strength, Fear of Movement and Functional Disability among Patients with LDH

Spine curvature related three cross sectional studies [10] [30] and one retrospective study indicated that vertical angle of sacral curvature (VASC) was directly influence to development of LDH and impacted on the surrounding lower back muscles in the lumbar spine.

One study showed that developing thoracic hyperkyphosis may lead to weaken the lumbar extensor muscles and associated problem with LDH patients [36]. Also, the lumbar lordosis at L1 - L5 associated with weakness of the abdominal flexor muscles and gluteal muscles

Three studies [37] [38] [39] found that lumbar multifidus muscle has a significant impact on LDH. One studies explored that lumbar extensor muscle lumbar multifidus, erector spine, external oblique, internal oblique, and semisphinalis potentially contributing to increased stress on the intervertebral disc subsequently LDH [38].

Two cross sectional studies [40] [41] demonstrated that the fear of movement directly associated with LDH. Another two cross sectional studies [42] [43] found that functional disability among patients with LDH who have been chosen surgery or MRI to decide therapeutic intervention to improve their quality of life (**Table 4**).

Table 4. Spinal curvature and muscle strength, fear of movement and functional disability among patients with LDH.

Authors (year)/ROB	Spinal curvature, muscle strength, fear of movement and functional disability among patients with LDH			
	Spinal curvature	Muscle strength	Fear of movement	Functional disability
Ghasemi *et al.* (2016)/low	yes	no	no	no
Kanat *et al.* (2012)/low	yes	no	no	no
Gao *et al.* (2021)/moderate	yes	no	no	no
Rajnics *et al.* (2002)/low	yes	no	no	no
Chen *et al.* (2006)/high	no	yes	no	no
Kuai *et al.* (2017)/low	no	yes	no	no
Choi *et al.* (2022)/low	no	yes	no	no
Van *et al.* (2010)/moderate	no	no	yes	no
Svensson *et al.* (2011)/low	no	no	yes	no
Yilmaz *et al.* (2018)/high	no	no	no	yes
Alshammari *et al.* (2022)/moderate	no	no	no	yes

4. Discussion

4.1. Factors Influence Risk of LDH

In the showed that females with LDH have a statistically significantly bigger vertical angle of sacral curvature (VASC) compared to females without LDH. This suggests that the presence of LDH may have an influence on the sacral curvature in female patients [36]. The larger VASC in females with LDH could potentially be attributed to the structural changes caused by the herniated disc or the compensatory mechanisms of the body in response to the condition [10]. Numerous studies have explored the association between genders. While some early studies suggested a higher prevalence in males, more recent research indicates a more equitable distribution between genders [45]. Another research studies found that gender differences in lumbar lordosis with women generally having a greater degree of compared to men. This difference in lumbar curvature may be attributed to anatomical and biomechanical variations between the sexes [46]. In the relationship between lumbar lordosis and LDH suggest that excessive lumbar lordosis may increase the risk of LDH due to altered biomechanical forces on the intervertebral discs. However, other research has proposed that a moderate degree of lumbar lordosis may be protective against LDH by distributing loads more evenly [47]. While some studies have suggested that gender may play a role, other factors such as genetics, lifestyle and occupation also influence risk of LDH [8]. Hormonal differences, biomechanical factors and genetic predisposition may contribute to any gender specific variation [48]. Some studies have

suggested that estrogen, which is more abundant in females, may have a protective effect on intervertebral discs due to its influence on collagen metabolism and tissue repair. However, hormonal variations throughout a women's life such as during pregnancy or menopause, can also affect the risk of LDH [8]. Biomechanical factors such as posture, lifting techniques and physical activity can contribute to LDH in both males and females. Male and females may have different patterns of physical activity and occupational exposures that can affect their risk. For instance, certain occupations that involve heavy lifting or repetitive bending may increase the risk of both genders [48].

Studies have shown that hereditary component to disc degeneration and herniation, which may affect both males and females. Specific genes related to collagen and matrix metabolism may play a role in the development of LDH [49]. LDH often occurs as a result of degenerative disc disease, a condition where the intervertebral discs in the spine deteriorate over time [43]. Herniations at L5 - S1 occur at a lower mean age than those at L4 - L5, and the latter at a lower age than those at L3 - L4 [39]. Possibly, histologic characteristics of the lower discs change in such a way that with aging the proteoglycans and water contents diminish and the collagen content increases [41]. High disc involvement with diffuse lesions in the lower lumbar spine was observed more commonly older age group [42]. However, aging is a significant risk factor for LDH due to degenerative changes in the intervertebral discs [50]. Reduced water content, loss of disc height and decreased disc elasticity are more pronounced with advancing age. These changes contribute to increased vulnerability to herniation [51]. While less common, LDH can occur in younger individuals, even in their twenties. Trauma or genetic predisposition may play a role in younger age group. A study by [9] explored genetic factors associated with early onset LDH. LDH can also affect older adults, although it becomes less common as people age. Spinal degeneration, rather than acute herniation tends to be the primary concern in the elderly. A study by [3] investigated age related changes in lumbar discs and found that disc degeneration increased with age. LDH may also have gender differences in terms of age distribution. Some studies that men may experience it at a slightly younger age than woman [14].

Research studies have indicated that there is a positive association between higher BMI and overweight/obese and an increased risk of LDH [52]. As BMI increases, so does the risk of herniated discs. Overweight and obese individuals are more susceptible to LDH compared to those with a healthy BMI [8]. Excess body weight can an increased load on the spinal column [39] also affect the biomechanics of the spine, altering the distribution of forces and increasing the likelihood of LDH [44]. Additionally, higher BMI and overweight/obese often accompanies a sedentary lifestyle and poor posture [36] both of which can contribute to the development of LDH [42]. High BMI, often indicative of obesity, has been linked to an increased risk of LDH.

Excess weight can lead to increased mechanical stress on the spine, potentially

contributing to the development of LDH. Research has also shown that higher BMI may worsen the symptoms of LDH. A study by [53] found that individuals with higher BMI often experienced more severe pain and functional limitations compared to those with lower BMI when diagnosed with LDH. Additionally, obesity is associated with chronic low grade inflammation, which might play a role in the degeneration of intervertebral discs [54].

On the other hand, diabetes mellitus (DM) has also been associated with an increased risk of LDH. Diabetes can affects the blood supply to various tissue, including the intervertebral discs, potentially contributing to their degeneration and vulnerability to herniation [55]. Some research suggests that diabetes may increase the risk of developing LDH. The mechanisms behind this association are not entirely clear, but several factors could contribute, such as changes in the structure and composition of spinal discs, impaired nutrient supply to the intervertebral discs, and altered inflammatory responses [44]. Lifestyle factors such as physical activity and diet, plays a important role in the spine health [36] [39] [42] [44]. Smoking has been associated with accelerated degeneration of the spinal discs, including the lumbar discs [56]. In that study, the association between smoking and LDH involved a potential correlation where smoking is linked to an increased risk of developing this condition. Smoking might contribute to the weakening of spinal discs, potentially due to reduced blood flow, inflammation and healing process [50]. It can lead to decreased disc height, compromised disc nutrition, and reduced disc hydration, making the discs more susceptible to LDH [44]. Studies with a low, moderate and high risk of bias would provide more reliable evidence regarding the effects of regular exercise and employment status on LDH.

The association between employment status and LDH depends on factors like physical demands of the job, ergonomics, sedentary behaviour, psychosocial stress, , age, and lifestyle choices. Both physically demanding jobs and sedentary occupations can contribute to the risk. Proper ergonomics, stress management, and a healthy lifestyle can play a role in preventing LDH [9] [40] [41]. Research studies investigated that the relationship between different occupations and the risk of developing LDH. It found that certain physically demanding jobs, such as heavy lifting or prolonged sitting were associated with a higher risk of LDH [57]. A study done by [58] explored both occupational and personal risk factors for LDH. It examined the role of manual labor and sedentary work in the development of LDH.

Another study investigated the influence of physical activity and employment status on the risk of LDH. It looked at how sedentary jobs and lack of physical activity might contribute to the development of LDH [22]. The role of psychological factors in the workplace such as job stress and job satisfaction, is in relation to the risk of developing LDH [59]-[64].

Postural education often includes guidance on ergonomics and lifting techniques which can minimize stress on the lumbar spine and contribute to disc

herniation prevention [8] [42]. Good posture helps distribute the forces evenly across the spine, reducing the compressive load on the lumbar discs. This can mitigate the risk of disc degeneration and herniation [65] [66]. Posture education can address risk factors such as prolonged sitting or poor ergonomics, which are associated with an increased risk of developing LDH [10]. Incorporating postural education into daily routines, especially in workplaces reduces the incidence of LDH [59].

Regular exercise and activities can potentially contribute to LDH and plays a positive role in preventing and managing the condition. Exercises maintain fitness level and prioritize activities that strengthen the core muscles and support spinal health [39] [60]. Incorporating exercises that improve flexibility and mobility can reduce the risk of LDH. Activities like yoga and pilates can be benefited. But exercise can stimulate the release of endorphins which act as natural pain killers. This can help manage the discomfort associated with LDH [59]. Regular exercise when done correctly and under guidance, can reduce the risk of recurrent LDH [61]. It helps maintain spinal flexibility and prevents further injury. Hence, the type and intensity of exercise should used to the acute or chronic LDH condition and needs [47].

The association between back pain and leg pain with LDH occurs due to compression or irritation of nearby nerves, including sciatic nerve. The specific symptoms experienced by an individual will depend on factors such as the location and grade of the herniation and the nerves affected [40] [41] [61] [62]. Leg pain resulting from LDH can significantly impact a patient's daily life and mobility. Prompt diagnosis and appropriate treatment are essential to alleviate pain, prevent complications and improve the patients overall quality of life [64]. Research studies explored that the epidemiology and risk factors associated with lumbar disc degeneration which is closely related to LDH and can contribute to back pain [67] [68] [69] and various conservative treatment approaches for LDH, including their effectiveness in relieving back pain and associated symptoms [23].

Positive finding could suggest that exercise has beneficial effects in terms of pain reduction, functional improvement or prevention of further LDH. Employers can aware to prevention of LDH and provide ongoing education, support and resources to maintain healthy lifestyle while on the job [39] [40] [41] [42]. In that association between LDH and leg or back pain can cause nerve irritation and muscles spasm and to finding proper diagnosis and treatment to address the symptoms and underlying causes of LDH related pain [40] [41]. Mental health conditions such as stress and anxiety can lead to muscle tension. Prolonged muscle tension in the back to contribute to poor posture and strain on the spinal structures, potentially increasing the risk of LDH [42].

However caution should be exercised when interpreting the results and provide insights into the potential influence of regular exercise and employment status on LDH. Hence, highly questionable should not be used as a basis for making decisions about treatment or recommendations for LDH patients.

4.2. Spinal Curvature, Muscle Strength, Fear of Movement and Functional Disability among Patients with LDH

The VASC can have an influence on the development of LDH. A larger sacral slope or an increased angle is associated with an increased load and stress on the intervertebral discs in the lumbar spine [30]. This increased load can lead to excessive pressure on the discs, making them more susceptible to degeneration, bulging or herniation [10]. Furthermore, a larger sacral slope may affect the distribution of forces and load-bearing capacity of the lumbar spine [30]. It can alter the alignment and biomechanics of the lumbar vertebrae, potentially leading to abnormal stress concentrations on specific discs. These altered mechanical forces can contribute to the degenerative changes and weakening of the disc structures, making to herniation [10].

With thoracic hyperkyphosis, there is an increased forward bending of the upper back, which may lead to an imbalance in the distribution of forces along the spine [26]. This imbalance can result in increased pressure on the lower back. Stress on the lumbar spine can weaken the lumbar extensor muscles, which are responsible for extending and stabilizing the lower back [57]. Weakened lumbar extensor muscles can contribute to a lack of support for the lumbar discs, increasing the risk of LDH [64]. Excessive lumbar lordosis can lead to an anterior pelvic tilt, where the pelvis tilts forward, causing the lower back to arch excessively [69].

This posture can be associated with weakness in the abdominal flexor muscles (e.g., rectus abdominis) and gluteal muscles. As a result, the lumbar spine may be subjected to increased stress and potential instability [36].

Lumbar lordosis maintains the stability and biomechanics of the lumbar spine. An abnormal increase (hyperlordosis) or decrease (hypolordosis) in lumbar lordosis can potentially lead to altered spinal mechanics which may contribute to the development of various spinal conditions including LDH [67]. Poor posture which can be associated with abnormal lumbar lordosis, may increase the risk of developing LDH [47]. Excessive lumbar lordosis can result from habits such as excessive sitting, which can place added stress on the lumbar discs [65].

Changes in lumbar lordosis can affect the distribution of load on the lumbar discs. This altered load distribution may increase the risk of LDH in certain individuals, particularly when combined with factors such as lifting, repetitive bending or traumatic injury [61]. In the relationship between lumbar lordosis and LDH can vary from person to person. Not everyone with an abnormal lordotic curve will develop LDH and other others such as genetics, lifestyle and overall spinal health also play significant roles [58].

While scoliosis primarily involves the lateral curvature of the spine, it can also affect the stability and alignment of the lumbar spine. Individuals with scoliosis may have an increased risk of developing lumbar disc problems, including herniation [59]. The altered spinal alignment in scoliosis can lead to uneven pres-

sure on the discs, potentially contributing to disc degeneration and LDH. Scoliosis treatment depends on factors such as the severity of the curvature, the age of the individual and the presence of associated symptoms [69].

Research suggests that the lumbar multifidus muscle plays a significant role in maintaining spinal stability and preventing excessive stress on the intervertebral discs. This muscle acts as a local stabilizer, providing segmental control and support to individual vertebrae during movements [39]. A well-functioning multifidus muscle helps distribute the load and forces evenly across the lumbar spine, reducing the pressure on the intervertebral discs [37].

However, in cases of lumbar multifidus dysfunction or weakness, there might be an imbalance in spinal loading. When the multifidus muscle fails to provide adequate support and stabilization, it can result in increased stress on the intervertebral discs. This may contribute to the development or exacerbation of LDH [38].

Individuals with LDH may develop fear and avoidance of certain activities or movements that they associate with pain [41]. People with LDH may experience limitations in daily activities, reduced social participation, and a decreased ability to perform work-related tasks [40]. Over time, it can contribute to the development of anxiety and depression [42]. Anxiety and depression are commonly associated with chronic pain conditions, including LDH.

The fear of movement may lead to a cycle of avoidance, isolation, and negative thoughts, which can exacerbate emotional distress [66]. Engaging in regular exercise can help strengthen the muscles surrounding the lumbar spine, including the core muscles, which provide stability and support [69] [70] [71]. Stronger muscles can help alleviate stress on the discs and reduce the risk of LDH [39]. Patients with LDH had poor quality of life and functional disability measured by SF-36 subscales and SBAQ [58].

In the current study, the ODI and SBAQ scores of the patients who decided to have surgery or had surgery because other treatment methods did not reduce their symptoms and/or they believed that their health was going to deteriorate [52]. The severity of functional disability and pain in these patients reduced their QoL, making it difficult to perform not only daily but also professional and social activities [40].

A weak correlation between the pain intensity and disability, which was in contrast to the previous research reported correlation of disability not only with pain intensity but also with other factors such as depression, fatigue, psychosocial factor, financial status and unemployment [43]. Disc protrusion and bulges were found to be highest in the 5th and 6th decade, but in present study it was in the 4th decade, this may be due to the limitation of the subjects' age [42]. A low, moderate and high risk of bias studies indicated that higher BMI can increase stress on the spine, potentially raising the risk of herniation.

5. Conclusion

The lumbar curvature can influence treatment decisions for LDH. The greater

VASC anteriorly shifted the gravity line with increased VASC in females and may be a risk factor for LDH. Factors like the VASC, location of the herniation and the patients overall spinal alignment can impact the choice of conservative treatments or surgical interventions. The lumbar extensor muscles may be selectively indicative of localized disc herniation or nerve root pathology in patients with LDH. However, mainly focusing on exercises to strengthen the muscles around the lumbar spine provides better support and stability. Fear of movement can lead to psychological consequences and reduce functional disability among patients with LDH. Overall, addressing the modified and non modified factors alongside the physical aspects of the LDH, exercises can help to regain the patient's confidence, improve functional capacity and enhance their overall quality of life. The findings of the study can offer valuable insights that can be translated into more effective and holistic treatment approaches for patients with LDH and that potentially improve rehabilitation outcomes, reduce the burden of disability and enhance the quality of life.

6. Recommendations

1) Strengthening the core muscles, including the abdominals, back and gluteal muscles, can help support the lumbar spine.

2) Educating patients on proper posture to minimize stress on the lumbar spine.

3) Making changes to the work and home environment to support natural spinal alignment.

4) To address kinesiophobia (fear of movement due to pain), cognitive behavioural therapy (CBT) may help patients overcome fear-avoidance beliefs.

5) Weight management, smoking cessation, and other health improvements can alleviate symptoms and prevent further injury.

6) In cases where conservative treatments have failed, and the disc herniation is causing severe symptoms or neurological deficits, surgical options such as a microdiscectomy may be recommended.

7) Regular follow-up to monitor progress and adjust treatment plans as necessary.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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