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Original Article

Correlation analysis of spine-pelvis parameters and age with lumbar paravertebral muscle degeneration in middle age and older adults

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Abstract: Objective: To analyze the correlation between spine-pelvis parameters, age and lumbar paravertebral muscle degeneration in middle-aged and older adults. Method: This retrospective study involved 143 middle-aged and elderly patients with suspected lumbar paravertebral muscle degeneration treated at The Third Hospital of Hebei Medical University between January 2021 and June 2023. Based on confirmed diagnoses, patients were divided into a degenerative group (57 cases) and a non-degenerative group (86 cases). Clinical data were analyzed to explore the relationship between pelvic parameters, age, and lumbar paravertebral muscle degeneration. Univariate and multivariate logistic regression were used to identify risk factors, and Receiver Operating Characteristic (ROC) analysis was performed to evaluate the predictive value of these factors. Differences in areas under the curve (AUC) for clinical factors were assessed using the DeLong test. Result: No significant differences were found between the two groups in clinical data, except for age (P<0.05). Comparison of spine-pelvis parameters revealed that the pelvic tilt (PT) and pelvic incidence (PI) were significantly higher in the degenerative group than those in the non-degenerative group, while the sacral slope (SS) and lumbar lordosis (LL) were lower (all P<0.05). Additionally, the CSA ratios between the third and fourth lumbar vertebrae (L3/4) and between the fourth and fifth lumbar vertebrae (L4/5) were found to be significantly lower in the degenerative group as opposed to those in the non-degenerative group (all P<0.05). Kendall's analysis showed that age and spine-pelvis parameters (PT, PI) were positively correlated with lumbar paravertebral muscle degeneration (OR=0.733, 0.639, 0.695; P<0.0001). In contrast, spine-pelvic parameters (SS, LL) were negatively correlated with degeneration (OR=-0.695, -0.698; P<0.0001). Pearson's correlation analysis also revealed a positive correlation between age and spine-pelvic parameters (PT, PI) (r=0.826, 0.985, P<0.001), and a negative correlation between age and spine-pelvic parameters (SS, LL) (r=-0.861, -0.942, P<0.001). Additionally, spine-pelvic parameter PT was negatively correlated with CAS ratio of L3/4 disc levels (r=-0.412, P<0.000). Logistic multivariate regression analysis identified age (OR=0.616, *P*<0.0001), PT (OR=0.827, *P*<0.0001), SS (OR=1.095, *P*=0.004), LL (OR=1.148, *P*=0.019), PI (OR=0.853, *P*<0.0001), CAS ratio of L3/4 (OR=1.977, *P*=0.002) and CAS ratio of L4/5 (OR=1.739, P=0.009) levels as independent risk factors for lumbar paravertebral muscle degeneration (all *P*<0.05). ROC results showed that the AUCs for age, PT, SS, LL, PI, L3/4, and L4/5 in predicting lumbar paravertebral muscle degeneration in middle-aged and elderly people were 0.949, 0.828, 0.642, 0.779, 0.850, 0.683, 0.677, respectively (all *P*<0.05). Conclusion: Lumbar paravertebral muscle degeneration in middle-aged and elderly individuals is significantly associated with both age and spine-pelvic parameters. These findings suggest that degeneration is not only age-related but also influenced by spine-pelvic configuration, providing a clinical basis for preventing lumbar paravertebral muscle degeneration.

Keywords: Older adults, pelvic parameters, lumbar paravertebral muscle degeneration, spine, correlation analysis

Introduction

Lumbar tissue degeneration is a common condition in the elderly population, manifested as the pain in the adjacent lumbar tissue, movement disorders, and other symptoms. This condition is prone to complications such as lumbar disc herniation, severely affecting quality of life

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[1, 2]. Studies have shown that degenerative changes in the lumbar spine generally begin between the ages of 16 and 20 years, often accompanied by changes in spinal-pelvic parameters, and the process is generally irreversible [3]. Within the spine structure, the lumbar paravertebral muscles play a crucial role in maintaining spinal stability and providing protection. Clinically, lumbar paravertebral muscle degeneration is not only associated with lumbar spondylolisthesis and intervertebral disc disease, but also with other degenerative conditions of the lumbar spine [4]. Several studies have pointed out that spinal-pelvic parameters are correlated with lumbar muscle degeneration to some extent. Specifically, the pelvic tilt (PT) has been shown to significantly affect lumbar spondylolisthesis and negatively correlate with the cross-sectional area (CSA) of the paravertebral muscles at the L4/5 level in patients with degenerative spondylolisthesis and lumbar spinal stenosis. Lumbar lordosis (LL) also plays a role in influencing lumbar spondylolisthesis to some degree [5, 6].

However, previous studies have reported limited findings on the correlation between spinal-pelvic parameters, age, and degenerative lumbar muscle diseases. Through a retrospective analysis of 143 middle-aged and elderly patients, this study integrated imaging measurements with statistical modeling to systematically identify independent risk factors for lumbar paravertebral muscle degeneration and examine the interplay between spine-pelvic parameters and lumbar muscle degeneration.

Key data and methodology

General information

A retrospective review was conducted on 143 middle-aged and elderly patients with suspected lumbar paravertebral degeneration, who were enrolled between January 2021 and June 2023 based on the exclusion criteria. The patients were divided into two groups: the degenerative group (57 cases) and the non-degenerative group (86 cases), based on confirmed diagnoses. This study received approval from the Ethics Committee of the Third Hospital of Hebei Medical University (Approval No. KSD2022-035-1).

Inclusion criteria: (1) Confirmation of lumbar disc degenerative diseases through physical examination, imaging, and other diagnostic methods; (2) Age between 40 and 70 years; (3) Complete clinical and MRI data, without information loss; (4) No prior treatment with acupuncture, medications, or other interventions targeting the paravertebral muscles.

Exclusion criteria: (1) Presence of benign or malignant tumors; (2) History of lumbar surgery within the past six months; (3) Presence of arthritis, ankylosing spondylitis, or other related conditions; (4) Congenital lumbar vertebral deformities; (5) Neuromuscular system diseases.

Method

Data collection: General data, including sex, age, body mass index (BMI), clinical symptoms, comorbidities, and spinal-pelvic parameters [sacral slope (SS), pelvic tilt (PT), lumbar lordosis (LL)], as well as the cross-sectional area (CSA) of paravertebral muscles at different lumbar segments, were collected for all patients.

Clinical examination: (1) Spine-pelvis parameters: patients were instructed to remove any metal items, such as earrings and necklaces. X-ray images were taken from the C1 vertebra to the femoral head. The hospital's Picture Archiving and Communication System (PACS) was then used to determine the spine-pelvis parameters, including LL, PT, pelvic incidence (PI), and SS. (2) Degree of degeneration of lumbar paravertebral muscles: Patients were positioned supine for an MRI examination. The cross-sectional area (CSA) of the lumbar paravertebral muscles was measured at the intervertebral disc levels between the 3rd and 4th lumbar vertebrae (L3/4), and the 4th and 5th lumbar vertebrae (L4/5). Additionally, the CSA of the inferior endplates of the L3, L4, and L5 vertebrae was marked on the MRI images using PACS. The ratio of the CSA of the paravertebral muscles to the vertebral body CSA was calculated using dedicated software.

Statistical methods

Data processing was performed using SPSS 24.0. Categorical data (n, %) were compared using the Chi-square (X^2) test. For normally distributed continuous data, results were present-

Table 1. Clinical data of the two groups

Index		Degeneration group (n=57)	Non-degeneration group (n=86)	X^2/t	P
Sex	Male	30 (52.63)	47 (54.65)	0.056	0.812
	Female	27 (47.37)	39 (45.35)		
Age ($\bar{x}$±sd)		64.68±2.16	55.71±1.46	29.647	<0.0001
BMI ($\bar{x}$±sd, kg/m^2)		20.16±1.03	20.14±1.02	0.114	0.909
Symptom	Lumbago	11 (19.30)	16 (18.60)	0.901	0.825
	Decreased lower extremity muscle strength	12 (21.05)	17 (19.77)		
	Lower limb numbness	10 (17.53)	11 (12.79)		
	No Symptom	24 (42.11)	42 (48.84)		
Complication	Hypertension	12 (21.05)	18 (20.93)	0.654	0.721
	Diabetes	10 (17.54)	11 (12.79)		
	No complications	35 (61.40)	57 (66.28)		

Note: BMI: body mass index.

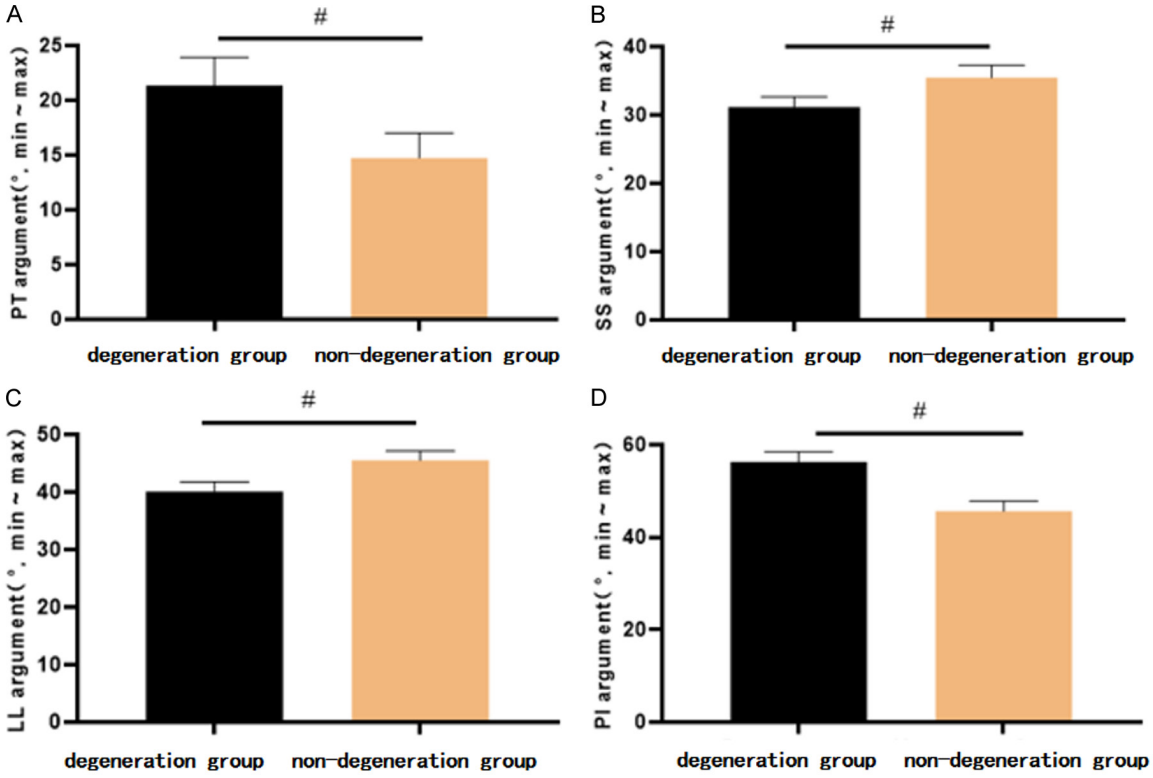

Figure 1. Comparison of spinal-pelvic parameters between the two groups. A: PT (Pelvic Tilt); B: SS (Sacral Slope); C: LL (Lumbar Lordosis); D: PI (Pelvic Incidence). #P<0.05.

ed as mean ± standard deviation (mean ± SD). A t-test was used to compare data between two groups. Kendall's tau-b was applied to analyze the relationship between age, spine-pelvis parameters, and lumbar paravertebral muscle degeneration. Pearson correlation was used to investigate the relationships between pelvic parameters, age, and lumbar paravertebral muscle degeneration.

Univariate and multivariate logistic regression models were applied to identify the risk factors for lumbar paravertebral muscle degeneration in the included subjects. Receiver Operating

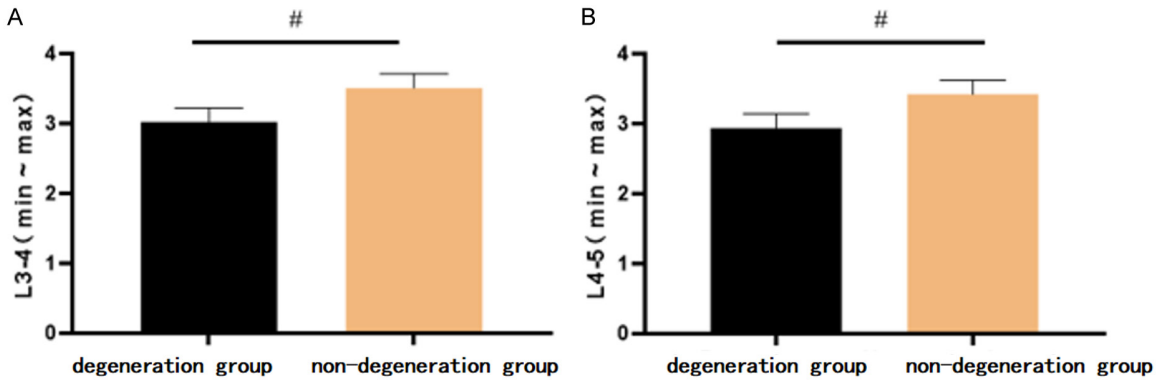

Figure 2. Comparison of CSA ratio (paravertebral muscle-to-vertebral body) between the two groups in different lumbar segments. A: L3/4; B: L4/5. Note: L3/4: the disc between the 3rd and 4th lumbar vertebrae; L4/5: the disc between the 4th and 5th lumbar vertebrae. #P<0.05.

Table 2. Correlation analysis of the occurrence of lumbar paravertebral muscle degeneration with age and spine-pelvis parameters

Index	Kendall correlation	P	N	Standard error	95% CI	
					Lower limit	Upper limit
Age	0.733**	<0.001	143	0.011	0.704	0.750
PT	0.639**	<0.001	143	0.032	0.573	0.694
SS	-0.695**	<0.001	143	0.013	-0.711	-0.662
LL	-0.698**	<0.001	143	0.013	-0.714	-0.666
PI	0.695**	<0.001	143	0.013	0.662	0.712

Note: PT, Pelvic Tilt; PI, Pelvic Incidence; SS, Sacral Slope; LL, Lumbar Lordosis. **The correlation is significant when the confidence (double test) is 0.01.

Characteristic (ROC) analysis was conducted to assess the predictive performance of these identified factors for lumbar paravertebral muscle degeneration. A statistically significant level was set at P<0.05.

Results

Comparison of clinical data between the two groups

A significant difference in age was observed between the two groups (P<0.05), while no significant differences were found in other data (P>0.05), as shown in **Table 1**.

Comparison of spinal and pelvic parameters between the two groups

As shown in **Figure 1**, the spinal-pelvic parameters (PT and PI) were significantly higher in the degenerative group compared to the non-degenerative group; while SS and LL were significantly lower in the degenerative group (all P<0.05).

Comparison of CSA ratio (paravertebral muscle-to-vertebral body) between the two groups in different lumbar segments

The ratios at the L3/4 and L4/5 were significantly lower in the degenerative group than those in the non-degenerative group (all P<0.05), as shown in **Figure 2**.

Correlation analysis of lumbar paravertebral muscle degeneration with age and spine-pelvis parameters

Kendall's tau correlation analysis revealed that age and spine-pelvis parameters (PT, PI) were positively correlated with the occurrence of lumbar paravertebral muscle degeneration (OR=0.733, 0.639, 0.695; P<0.001). In contrast, the spine-pelvic parameters (SS, LL) showed a negative correlation with lumbar paravertebral muscle degeneration (OR=

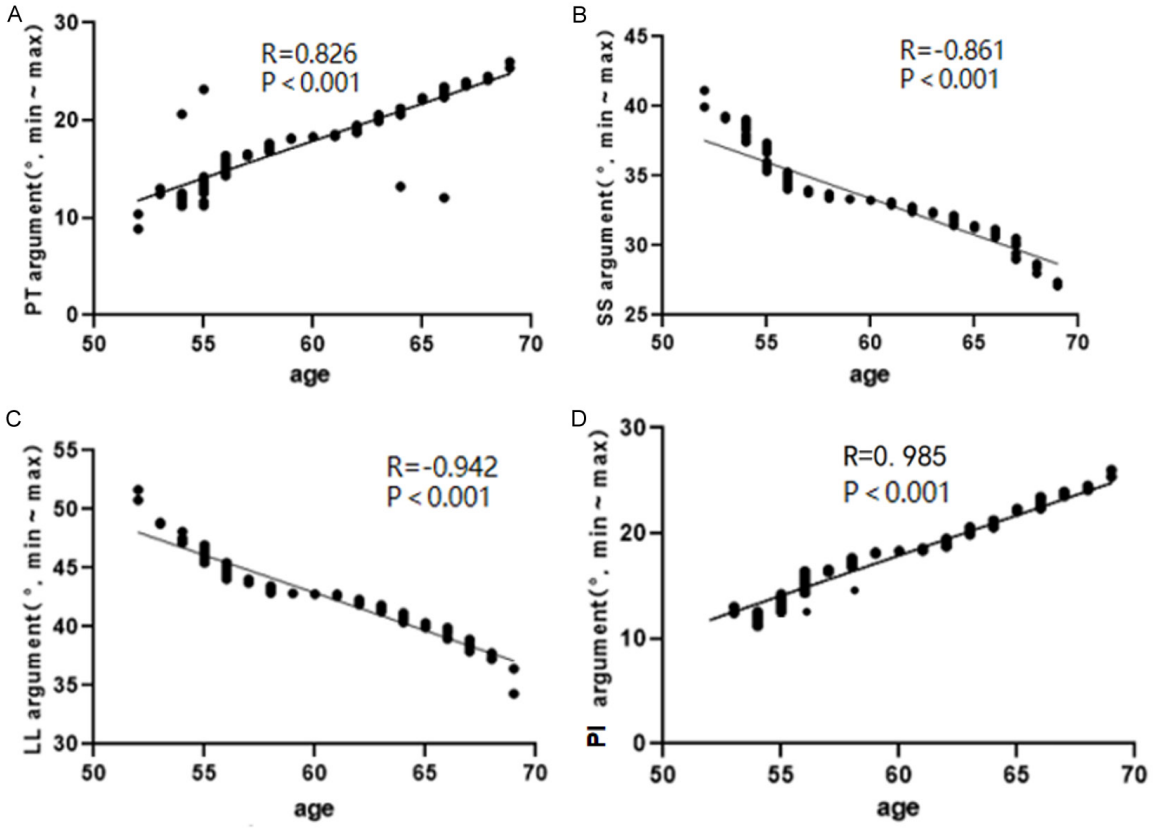

Figure 3. Correlation analysis between age and spinal-pelvic parameters. A: Correlation between age and PT; B: Correlation between age and SS; C: Correlation between age and LL; D: Correlation between age and PI. Note: PT: Pelvic Tilt; SS: Sacral Slope; LL: Lumbar Lordosis; PI: Pelvic Incidence.

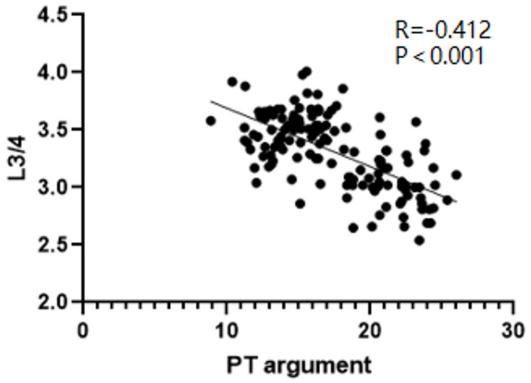

Figure 4. Correlation analysis between PT and the CAS ratio of L3/4. Note: PT: Pelvic Tilt; CAS: cross-sectional area; L3/4: the disc between the 3rd and 4th lumbar vertebrae.

-0.695, -0.698; P<0.001). See **Table 2** for details.

Pearson linear correlation analysis revealed a positive correlation between age and spine-pelvic parameters (PT, PI), with correlation coefficients (r) of 0.826 and 0.985, respectively (both P<0.001). However, age and spine-pelvic parameters (SS, LL) were negatively correlated (r=-0.861, -0.942, both P<0.001). See **Figure 3** for details.

The correlation analysis between the spine-pelvic parameters (PT) and the CAS ratio of L3/4 displayed a negative correlation (r= -0.412, P<0.001), as shown in **Figure 4**.

Univariate analysis of factors associated with lumbar paravertebral muscle degeneration

The results showed that age (OR=0.509, P<0.001), PT (OR=0.509, P<0.001), SS (OR= 1.131, P=0.002), LL (OR=1.203, P<0.001), PI (OR=0.770, P<0.001), CAS ratio of L3/4 (OR=2.424, P=0.009), and CAS ratio of L4/5 (OR=1.838, P=0.024) were significantly associated with lumbar paravertebral muscle degeneration (**Tables 3**, **4**).

Table 3. Definition and assignment

Variable	Number	Assign
Sex	Z1	Male “0”; Female “1”
Age	Z2	Plug in the original value
BMI	Z3	Plug in the original value
Symptom	Z4	Lumbago “0”; Lower extremity muscle strength decreasede “1”; Lower limb numbnesse “2”; No obvious symptoms “3”
Complication	Z5	Hypertension “0”; diabetes “1”; No comorbidities “2”
PT	Z6	Plug in the original value
SS	Z7	Plug in the original value
LL	Z8	Plug in the original value
PI	Z9	Plug in the original value
L3/4	Z10	Plug in the original value
L4/5	Z11	Plug in the original value

Note: BMI, body mass index; PT, Pelvic Tilt; PI, Pelvic Incidence; SS, Sacral Slope; LL, Lumbar Lordosis; L3/4, the disc between the 3rd and 4th lumbar vertebrae; L4/5, the disc between the 4th and 5th lumbar vertebrae.

Table 4. Univariate logistic analysis of factors associated with lumbar paravertebral muscle degeneration

Influencing factors	*B*	*SE*	*Wald*	*P*	OR	95% CI	
						Lower limit	Upper limit
Sex	-1.122	0.800	1.968	0.161	0.325	0.068	1.562
Age	-0.675	0.100	45.339	<0.0001	0.509	0.418	0.620
BMI	0.017	0.173	0.009	0.924	1.017	0.725	1.426
Symptom	0.794	0.600	1.748	0.186	2.211	0.682	7.170
Complication	-0.526	0.601	0.767	0.381	0.591	0.182	1.918
PT	-0.276	0.063	19.295	<0.0001	0.759	0.671	0.858
SS	0.123	0.039	9.960	0.002	1.131	1.048	1.222
LL	0.185	0.045	17.091	<0.0001	1.203	1.102	1.134
PI	-0.262	0.047	31.290	<0.0001	0.770	0.702	0.844
L3/4	0.886	0.339	6.815	0.009	2.424	1.247	4.714
L4/5	0.608	0.269	5.120	0.024	1.838	1.085	3.113

Note: BMI, body mass index; PT, Pelvic Tilt; PI, Pelvic Incidence; SS, Sacral Slope; LL, Lumbar Lordosis; L3/4, the disc between the 3rd and 4th lumbar vertebrae; L4/5, the disc between the 4th and 5th lumbar vertebrae.

Multivariate logistic analysis of risk factors for lumbar paravertebral muscle degeneration

Using degenerative lesions (=1) and non-degenerative lesions (=0) as dependent variables, and above significant indicators as independent variables, multivariate Logistic regression analysis identified age (OR=0.616, $P<0.001$), PT (OR=0.827, $P<0.001$), SS (OR=1.095, $P=0.004$), LL (OR=1.148, $P=0.019$), PI (OR=0.853, $P<0.001$), CAS ratio of L3/4 (OR=1.977, $P=0.002$) and CAS ratio of L4/5 (OR=1.739, P=0.009) levels as independent risk factors for lumbar paravertebral muscle degeneration (all $P<0.05$). See **Table 5** and **Figure 5**.

Predictive value of influencing factors for the occurrence of lumbar paravertebral muscle degeneration

ROC results showed that the AUCs of age, PT, SS, LL, PI, CAS ratio of L3/4, and CAS ratio of L4/5 for lumbar paravertebral muscle degeneration in middle-aged and elderly people were 0.949, 0.828, 0.642, 0.779, 0.850, 0.683, 0.677, respectively ($P<0.05$), as show in **Table 6** and **Figures 6**, **7**.

Discussion

Paravertebral muscle degeneration involves changes in muscle quantity and quality, primar-

Table 5. Multivariate logistic analysis of risk factors for lumbar paravertebral muscle degeneration

Factors	β	SE	Wald χ^2	*P*	OR	95% CI
Age	-0.484	0.118	16.762	<0.0001	0.616	0.489-0.777
PT	-0.190	0.053	12.986	<0.0001	0.827	0.745-0.917
SS	0.091	0.032	8.258	0.004	1.095	1.029-1.165
LL	0.138	0.059	5.522	0.019	1.148	1.023-1.288
PI	-0.159	0.038	17.247	<0.0001	0.853	0.791-0.919
L3/4	0.681	0.216	9.910	0.002	1.977	1.293-3.022
L4/5	0.554	0.211	6.875	0.009	1.739	1.150-2.631
Constant	-6.536	1.450	20.323	<0.0001	0.001	-

Note: PT, Pelvic Tilt; PI, Pelvic Incidence; SS, Sacral Slope; LL, Lumbar Lordosis; L3/4, the disc between the 3rd and 4th lumbar vertebrae; L4/5, the disc between the 4th and 5th lumbar vertebrae.

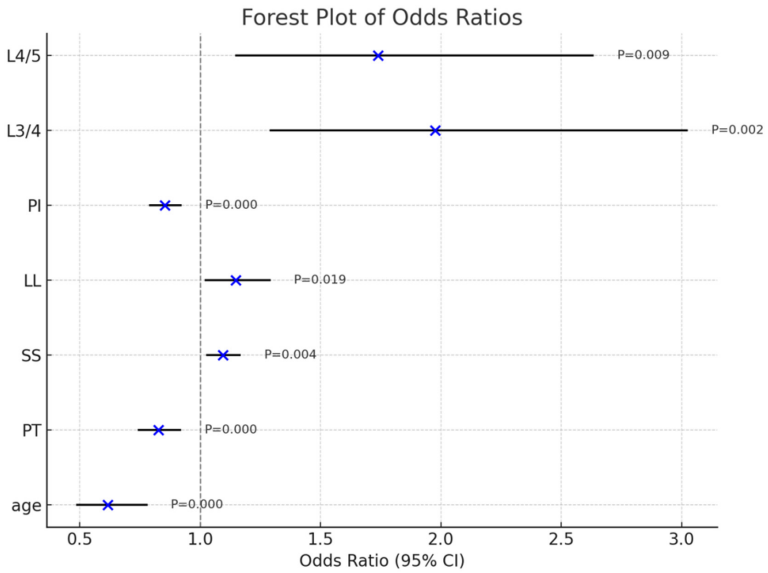

Figure 5. Forest map of risk factors identified in multivariate Logistic regression analysis. Notes: PT: Pelvic Tilt; PI: Pelvic Incidence; SS: Sacral Slope; LL: Lumbar Lordosis; L3/4: the disc between the 3rd and 4th lumbar vertebrae; L4/5: the disc between the 4th and 5th lumbar vertebrae.

ily characterized by muscle atrophy and fat infiltration. These pathological changes are often attributed to a reduction in muscle volume, cross-sectional area, and overall muscle mass, along with shifts in tissue composition. Collectively, these factors contribute to increased muscle fatigue, compromised functional capacity, and the recurrence of chronic low back pain [7, 8]. Emerging evidence has underscored the critical role of spinal-pelvic sagittal balance in the pathogenesis of lumbar degenerative diseases [9]. As individuals age, significant transformations occur in sagittal spinal parameters, leading to a loss of spinal alignment and contributing to spinal degeneration [10]. In this study, we conducted a comprehensive analysis of the relationships among spine-pelvis parameters, lumbar paravertebral muscle degeneration, and age in middle-aged and elderly individuals. Our findings reveal a significant interplay among these factors, highlighting the importance of changes in spine-pelvis parameter and aging in the development of lumbar paravertebral muscle degeneration.

This study revealed that patients with lumbar paravertebral muscle degeneration had significantly higher average ages compared to those without degeneration, suggesting a significant relationship between the occurrence of lumbar paravertebral muscle degeneration and aging. Both univariate and multivariate analyses confirmed that age is an independent factor influencing the development of lumbar paravertebral muscle degeneration, a conclusion supported by the study of Wan et al. [11]. The underlying mechanism can be attributed to age-related changes in the structure and composition of intervertebral discs. Intervertebral discs are composed of three key components: the nucleus pulposus, the annulus fibrosus, and the cartilage endplate. The nucleus pulposus, primarily made up of water and collagen, plays a crucial role in evenly distributing spinal loads. As a form of connective tissues, the intervertebral disc contains a rich extracellular matrix, with water content dependent on

Table 6. ROC curve analysis

Index	AUC	*P*	95% CI
Age	0.949	<0.0001	0.905-0.993
PT	0.828	<0.0001	0.759-0.897
SS	0.642	0.004	0.549-0.735
LL	0.779	<0.0001	0.700-0.858
PI	0.850	<0.0001	0.779-0.921
L3/4	0.683	<0.0001	0.595-0.772
L4/5	0.677	<0.0001	0.588-0.765

Note: PT, Pelvic Tilt; PI, Pelvic Incidence; SS, Sacral Slope; LL, Lumbar Lordosis; L3/4, the disc between the 3rd and 4th lumbar vertebrae; L4/5, the disc between the 4th and 5th lumbar vertebrae; ROC, Receiver's Operation Characteristics.

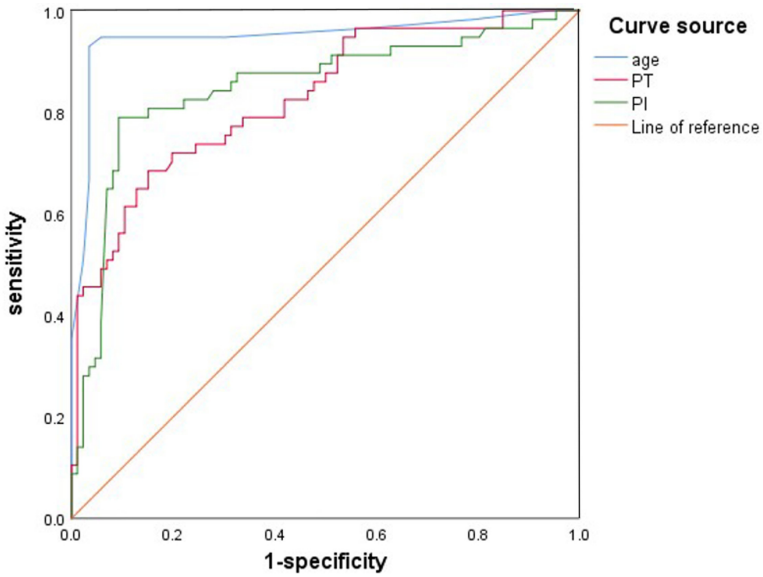

Figure 6. The predictive performance of age, PT and PI for the occurrence of lumbar paravertebral muscle degeneration. Notes: PT: Pelvic Tilt; PI: Pelvic Incidence.

the concentration of proteoglycans. With increasing age, the nutrients available to the cells and stroma within the disc diminish. This hampers cellular nutrient intake, while the accumulation of lactic acid and a decrease in pH further contribute to cellular death and disc degeneration [12, 13]. Progressive nutrient insufficiency and acidity exacerbate degeneration by negatively impacting active cells and increasing the number of necrotic cells [14].

In this study, a comparative analysis of spine-pelvic parameters and the cross-sectional area (CSA) of paravertebral muscles revealed significant differences between the two groups. This indicates that paravertebral muscle degeneration is not only age-related but also strongly associated with alterations in spine-pelvic parameters and the CSA of these muscles. Degeneration of the lumbar paravertebral muscles is primarily characterized by a reduction in CSA and an increase in fat infiltration. These findings highlight the multifactorial nature of muscle degeneration and its complex interplay with age and biomechanical parameters. Pelvic tilt (PT), as a key parameter of spinal compensation, mitigates sagittal spinal imbalance in lumbar degenerative diseases through the compensatory mechanism of pelvic retroversion [15]. Relevant studies have shown that the position and shape of the pelvis can have a significant impact on the sagittal plane. In this study, PT and PI in the degenerative group were obviously higher than those in the non-degenerative group, while SS and LL were lower. Both univariate and multivariate analysis showed that they were independent influencing factors for the occurrence of lumbar paravertebral muscle degeneration. Position of the spine, in both normal and diseased conditions, is influenced by changes in LL through alterations in SS, which ultimately affect spinal balance. Under normal upright posture, the vertebral body and the intervertebral disc share the body load, ensuring that stress is evenly distributed, and the state of balance is maintained. However, when the spinal alignment is altered, the body load is redistributed, disrupting the stress balance of the vertebral body, thereby increasing certain forces, which in turn induces changes in the lumbar paravertebral muscles [16, 17]. Analyzing these biomechanical parameters can offer valuable insights into the progression of lumbar paravertebral muscle degeneration, helping to evaluate the extent of the condition [18].

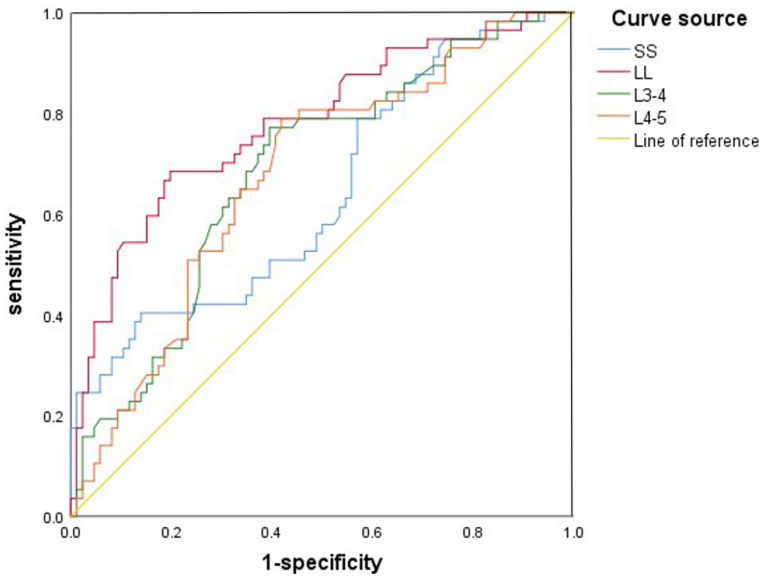

Figure 7. Predictive performance of SS, LL, L3-4, L4-5 for the occurrence of lumbar paravertebral muscle degeneration. Notes: SS: Sacral Slope; LL: Lumbar Lordosis; L3/4: the disc between the 3rd and 4th lumbar vertebrae; L4/5: the disc between the 4th and 5th lumbar vertebrae.

Correlation analysis in this study revealed that both age and spine-pelvis parameters are significantly associated with lumbar paravertebral muscle degeneration. Pearson correlation analysis further demonstrated that age is positively correlated with PT and PI but negatively correlated with SS and LL. Additionally, PT was negatively correlated with the CAS ratio of L3/4, highlighting that lumbar paravertebral muscle degeneration is influenced not only by age but also by spine-pelvis parameters. Park et al. [19] found that larger SS values were associated with a higher likelihood of adjacent segment degeneration following surgery. Biomechanical studies have shown that restoring LL and the intervertebral space strengthens the ligaments connecting the vertebrae, promoting vertebral fusion and reducing degeneration of adjacent segments. Liu et al. [20] noted that in elderly individuals, changes in LL occur with age, with LL peaking during adolescence. This is attributed to the progressive aging of cells, which, despite remaining alive, lose their ability to synthesize key proteins and perform specialized functions. Age-related changes in the elasticity and strength of the intervertebral disc are linked to alterations in matrix components, particularly elastin and proteoglycans, and the accumulation of collagen crosslinking due to glycosylation. These modifications can contribute to disc degeneration, with glycosylated products potentially initiating tissue degeneration [21, 22]. As degradation molecules accumulate, they impair nutrient supply and waste removal, further disrupting cellular function. Additionally, the repeated deformation of the disc during normal spinal movement can lead to matrix fatigue, resulting in a loss of pressure resistance and subsequent cellular dysfunction [23].

In line with these findings, Yoshimizu et al. [24] found that lumbar degeneration, particularly in terms of degeneration site, type and clinical symptoms, is closely linked to aging. This underscores that age is a primary factor in the degeneration of lumbar paravertebral muscles, and as age increases, degeneration becomes inevitable. A larger PI brings the sagittal position of the lumbosacral vertebrae closer to vertical, increasing the mechanical stress load on the anterior column of the spine. This heightened stress makes adjacent segments more susceptible to degeneration, including conditions such as spondylolisthesis or disc herniation. In addition, LL and PI are significantly correlated with other spinal pelvic sagittal position parameters, which serve as the interface between the pelvis and thoracic vertebrae. These parameters are central to the arrangement and balance of spinal-pelvic sagittal alignment. As a positional parameter, the pelvis can modify LL by adjusting SS, a relationship that persists even in patients with scoliosis. Therefore, there is a certain correlation between the occurrence of lumbar paravertebral muscle degeneration and the changes in spine-pelvis parameters driven by aging.

ROC analysis further demonstrated that the above indexes possess predictive value for the occurrence of lumbar paravertebral muscle degeneration. This finding may be attributed to several reasons: as patients age, the physiological structure and function of various tissue cells decline, resulting in reduced collagen and

elastin synthesis. This, in turn, accelerates the glycosylation process in intervertebral disc tissue cells, increasing the brittleness of lumbar spine and elevating the mechanical stress load on lumbar spine tissue. Consequently, the PT and PI indexes of patients tend to increase. However, an increase in PT and PI brings the lumbosacral vertebrae into a more vertical sagittal position, which can lead to vertebral dislocation and protrusion of adjacent vertebrae. This disrupts the maintenance of the physiological structure of the intervertebral ligaments, leading to a decrease in SS and LL levels, accelerating degeneration in the vertebrae and surrounding tissues, and ultimately resulting in lumbar paravertebral muscle degeneration.

This study highlights that lumbar paravertebral muscle degeneration is influenced not only by aging but also by spine-pelvis parameters. These findings provide a valuable foundation for clinical prevention strategies. However, given the retrospective nature of this study, variations in data and measurement tools across different studies may lead to discrepancies. Future research should focus on improving measurement accuracy and standardization to better guide clinical practice, reduce complications, and enhance the quality of life for middle-aged and elderly individuals.

Disclosure of conflict of interest

None.

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