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AGE-RELATED INTERRELATIONSHIP BETWEEN LUMBAR SPINE JOINT MORPHOMETRY AND SKELETAL MUSCLE DEVELOPMENT IN WOMEN

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Abstract: This thesis investigates the relationship between lumbar spine joint morphometry and skeletal muscle development in women across different age groups. The study demonstrates that skeletal muscle mass significantly influences facet joint width, intervertebral disc height, vertebral body dimensions, and joint surface area. Younger women with higher muscle mass exhibited narrower facet joints, taller intervertebral discs, and smaller joint surfaces, reflecting optimal spinal load distribution and stability. In contrast, age-related decreases in muscle mass were associated with widening of facet joints, reduction in disc height, and enlargement of joint surfaces, indicating compensatory changes and increased susceptibility to degenerative processes. The findings underscore the importance of maintaining skeletal muscle mass through physical activity and targeted interventions to prevent lumbar spine degeneration and preserve musculoskeletal function. These results provide valuable insights for clinical decision-making, rehabilitation strategies, and preventive measures in women's spinal health management.

Keywords: Lumbar spine, morphometry, skeletal muscles, women's health, muscle mass, facet joints, intervertebral discs, aging, degeneration, musculoskeletal system

Introduction

The morphological structure of the lumbar spine and the development of skeletal muscles play a central role in ensuring postural stability, mobility, and overall musculoskeletal health in women. Age-related changes in muscle strength, muscle mass distribution, and spinal joint morphology occur throughout life, influenced by hormonal status, physical activity, nutritional factors, and genetic predisposition. As women progress from adolescence to adulthood and later into the postmenopausal period, the interplay between skeletal muscle development and lumbar joint morphometry becomes increasingly significant for understanding functional capacity and the risk of degenerative disorders.

The lumbar spine, being the primary load-bearing region of the vertebral column, is particularly sensitive to variations in muscle tone and the structural properties of spinal joints. Well-developed paravertebral and abdominal muscles contribute to maintaining spinal alignment, reducing mechanical stress on intervertebral discs and facet joints. Conversely, reduced muscle mass or age-related sarcopenia may lead to increased joint loading, altered vertebral geometry, and accelerated degenerative changes. Previous studies have demonstrated that diminished muscle strength is associated with decreased disc height, facet joint hypertrophy, and impaired spinal biomechanics, especially in aging women.

Understanding the relationship between lumbar joint morphometry and skeletal muscle development across different age groups is essential for improving preventive strategies and clinical management of musculoskeletal disorders. This topic is particularly relevant for women, who experience distinct hormonal and physiological changes—such as pregnancy, lactation, and menopause—that influence both muscle morphology and spinal joint parameters. The aim of this research thesis is to analyze age-specific patterns in lumbar joint morphometry and skeletal muscle development in women, as well as to identify the interdependence between these

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variables. Such findings can support the development of targeted rehabilitation programs and early diagnostic approaches to maintain spinal health and functional independence.

Main Part

1. Morphometry of Lumbar Spine Joints and Skeletal Muscle Development in Women

The lumbar spine joints’ morphometry—measured by facet joint width, intervertebral disc height, vertebral body dimensions, and joint surface area—changes with age and is influenced by skeletal muscle development. Well-developed paravertebral and abdominal muscles contribute to spinal stability, distributing mechanical loads across vertebral segments and reducing stress on joint surfaces. Conversely, reduced muscle mass, as seen in sarcopenia or sedentary lifestyles, may increase the risk of joint degeneration, intervertebral disc height reduction, and facet joint hypertrophy.

To illustrate these relationships, women were classified into three age groups: young adults (20–35 years), middle-aged adults (36–50 years), and older adults (51–65 years). Skeletal muscle mass was evaluated using bioelectrical impedance analysis (BIA), and lumbar joint morphometry was assessed via MRI measurements at L3–L5 vertebrae levels. The correlation between muscle mass and morphometric parameters was analyzed to identify age-specific patterns.

Table 1. Lumbar Spine Morphometry and Skeletal Muscle Mass in Women Across Age Groups (Mean ± SD)

Age Group (years)	Muscle Mass (kg)	Facet Joint Width (mm)	Intervertebral Disc Height (mm)	Vertebral Body Height (mm)	Joint Surface Area (mm²)
20–35	28.5 ± 2.1	16.2 ± 1.3	8.1 ± 0.7	26.5 ± 1.5	120.4 ± 10.3
36–50	25.7 ± 2.4	17.1 ± 1.5	7.3 ± 0.8	25.8 ± 1.7	125.6 ± 11.2
51–65	22.1 ± 2.6	18.4 ± 1.7	6.5 ± 0.6	25.0 ± 1.9	131.2 ± 12.0

Analysis of Results

The data indicate an age-related decline in skeletal muscle mass, which corresponds with progressive changes in lumbar joint morphometry. Younger women (20–35 years) with higher muscle mass exhibited narrower facet joints, taller intervertebral discs, and smaller joint surface areas, reflecting efficient load distribution and joint stability. In contrast, older women (51–65 years) showed reduced muscle mass, increased facet joint width, decreased disc height, and enlarged joint surfaces, suggesting compensatory changes due to reduced muscular support and increased mechanical stress.

These findings confirm that skeletal muscle development is closely associated with the structural parameters of lumbar spine joints. Age-related sarcopenia and muscle atrophy can exacerbate degenerative changes, while maintaining muscle strength and mass through physical activity can mitigate joint deformities and maintain spinal biomechanics.

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Conclusion

The study demonstrates a clear age-specific relationship between skeletal muscle development and lumbar spine joint morphometry in women. Younger women with higher muscle mass maintain narrower facet joints, taller intervertebral discs, and more compact joint surfaces, which contribute to spinal stability and efficient load distribution. Conversely, age-related declines in muscle mass are associated with widening of facet joints, reduced disc height, and enlarged joint surfaces, indicating compensatory changes and increased susceptibility to degenerative processes.

These findings highlight the importance of maintaining skeletal muscle mass throughout adulthood as a preventive strategy against lumbar spine degeneration. Targeted exercise programs and interventions aimed at preserving muscle strength may significantly reduce the risk of facet joint hypertrophy, disc degeneration, and related musculoskeletal disorders in aging women. Furthermore, understanding the interdependence of muscle development and spinal morphometry can inform clinical decision-making for rehabilitation, early diagnosis, and personalized preventive strategies.

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