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# AGE-RELATED CHANGES IN THE SPINE: FROM CHILDHOOD TO OLD AGE

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**Annotation:** The article presents the results of a morphometric analysis of the vertebral column at different age periods: childhood (6–12 years), adulthood (20–40 years), and old age (60 years and older). The study was carried out using dry anatomical specimens of vertebrae (cervical — C4, thoracic — Th7, lumbar — L3), as well as data from anatomical atlases. Three parameters of vertebral bodies were measured: height, width, and anteroposterior size. It was found that in childhood, vertebrae are characterized by smaller dimensions, a high content of cartilaginous tissue, and elasticity. In adulthood, maximum morphometric parameters were observed, reflecting the completion of bone tissue formation processes and the greatest functional stability of the vertebral column. In old age, signs of involutional changes were identified: a decrease in vertebral body height, reduction in width and anteroposterior dimensions, osteoporotic processes, and deformities. The obtained data demonstrate the regular changes of the vertebral column throughout human life and are of great importance for clinical practice in the prevention, diagnosis, and treatment of degenerative-dystrophic diseases of the spine.
**Keywords:** vertebral column, age-related changes, morphometry, vertebrae, osteochondrosis, osteoporosis, degenerative changes, human anatomy.

The problem of age-related changes in the spinal column occupies a special place in modern medicine and human anatomy. The spine is not only a supporting structure of the body, but also an essential functional complex that ensures mobility, protects the spinal cord and participates in metabolic processes. Any age-related changes in its bone and cartilage tissue directly affect the quality of human life, limiting motor activity and predisposing to the development of a number of diseases.

With the increase in life expectancy of the population and the growth in the prevalence of degenerative-dystrophic diseases of the musculoskeletal system, the study of the patterns of aging of the spinal column is of particular importance. WHO data show that osteochondrosis, osteoporosis and associated complications (compression fractures, kyphosis, scoliotic deformities) are among the most common causes of chronic pain and disability in people over 60 years of age. On the other hand, understanding the features of spine growth in childhood and adolescence is important for the prevention of scoliosis, kyphosis and postural disorders, which are increasingly common in schoolchildren and students due to a sedentary lifestyle. Thus, a comprehensive study of age-related changes in the spinal column allows us to develop recommendations for early prevention, diagnosis and treatment of pathologies of the musculoskeletal system, from childhood to old age. The relevance of the topic is also determined by its interdisciplinary significance: knowledge of the patterns of aging of the spinal column is necessary for anatomists, physiologists, orthopedists, neurologists, rehabilitation specialists and general practitioners.

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The goal of our work is to identify and describe the regular changes in the spinal column in different age periods - from childhood to old age - based on morphometric analysis.

**Materials and methods of the study.** The study material included dry anatomical preparations of vertebrae from the educational collection of the anatomy laboratory of Kime University, as well as data from anatomical atlases. The study included a morphometric analysis of the vertebral bodies based on dry bone preparations. Three parameters were measured: the height of the vertebral body, its width, and the anteroposterior size. Three age groups were identified for the analysis: children (6–12 years old), adults (20–40 years old), and the elderly (60 years and older). Typical vertebrae were selected for the analysis: cervical — C4, thoracic — Th7, and lumbar — L3. Three parameters of the vertebral bodies were measured:

1. Height (from the upper to the lower endplate in the middle part of the body). 2. Width (maximum transverse size of the anterior surface of the body).

3. Anterior-posterior size (distance from the anterior edge of the body to the posterior surface facing the spinal canal).

The measurements were taken using a caliper with an accuracy of 0.1 mm. In each age group (children 6–12 years old, adults 20–40 years old, elderly 60 years and older), 10 vertebrae of each section were studied. The data were processed by calculating the mean values and the standard error of the mean (M ± m).

The obtained indicators were compared between age groups in order to identify consistent age-related changes in the spinal column.

**Results of the own research and their discussion.** In children, the spinal column is characterized by high elasticity and the presence of a significant amount of cartilaginous tissue. Intervertebral discs occupy a relatively large part of the spine height, which ensures flexibility and mobility. The vertebral bodies contain abundant spongy tissue with wide bone marrow spaces in which hematopoiesis processes actively occur. Physiological curves of the spine are formed gradually: first, kyphosis of the thoracic and sacral sections, later - lordosis of the cervical and lumbar sections. In childhood (6-12 years), the vertebral bodies are characterized by smaller sizes, which is associated with the predominance of cartilaginous tissue and active growth of ossification zones. The cervical vertebrae had a height of 10-12 mm, a width of 12-14 mm and an anterior-posterior size of 9-11 mm (Table 1). The thoracic vertebrae are somewhat larger: their height reaches 14–18 mm, their width is 16–21 mm, and their anteroposterior size is 12–15 mm. The lumbar vertebrae are the largest, with a height of 18–22 mm, a width of 22–27 mm, and an anteroposterior size of 16–19 mm. These figures reflect the spine's adaptation to increasing mechanical loads as the body grows. In adolescence and adulthood (18–40 years), the spine reaches its maximum strength and functional stability. The compact substance of the bones thickens, the spongy tissue becomes more organized, and the intervertebral discs retain their elasticity and high water content in the nucleus pulposus. During this period, the optimal balance between flexibility and strength is ensured, which is necessary for active physical activity. At this age, the height of the vertebrae reached 24.1 mm, the width was 30.2 mm, and the

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anteroposterior size was 27.5 mm. Maximum strength of the vertebrae and compaction of the endplates were observed.

In middle age (40–60 years), signs of involutional changes begin to appear. Gradually, the hydration of the intervertebral discs decreases, the height of the intervertebral spaces decreases. Sclerotic changes are observed in the endplates of the vertebrae, osteophytes are formed. These processes contribute to the development of degenerative-dystrophic diseases of the spine, such as osteochondrosis and spondylosis.
1-Table

**Morphometric data of vertebrae depending on age**

| Spine Section | Index | Children's age (6-12 years) | Mature age (20–40 years) | Old age (60 years and older) |
|---|---|---|---|---|
| Cervical (C1–C7) | Body height (mm) | 10–12 | 12–15 | 11–13 |
| | Body width (mm) | 12–14 | 15–17 | 14–15 |
| Thoracic (Th1–Th12) | Anterior-posterior size (mm) | 9–11 | 11–13 | 10–11 |
| | Body height (mm) | 14–18 | 18–24 | 16–20 |
| Lumbar (L1–L5) | Body width (mm) | 16–21 | 20–27 | 18–24 |
| Spine Section | Anterior-posterior size (mm) | 12–15 | 16–20 | 14–18 |
| Cervical (C1–C7) | Body height (mm) | 18–22 | 25–30 | 20–25 |
| | Body width (mm) | 22–27 | 30–35 | 26–32 |
| | Anterior-posterior size (mm) | 16–19 | 20–24 | 18–22 |

At this age, the maximum morphometric values are achieved, which is associated with the completion of bone tissue formation processes and strengthening of the spinal column structures. The height of the cervical vertebrae increases to 12–15 mm, thoracic — to 18–24 mm, lumbar — to 25–30 mm. The width of the bodies at this age varies from 15–17 mm in the cervical to 30–35 mm in the lumbar, while the anterior-posterior dimensions reach 11–13 mm, 16–20 mm and 20–24 mm, respectively. These changes provide the spine with the greatest strength and stability while maintaining the necessary mobility. In old age (over 60 years), degenerative changes become more pronounced. The intervertebral discs become significantly thinner, their shock-absorbing function decreases. Osteoporotic changes develop in the spongy substance of the vertebrae, which increases the risk of compression fractures. Physiological curves of the spine

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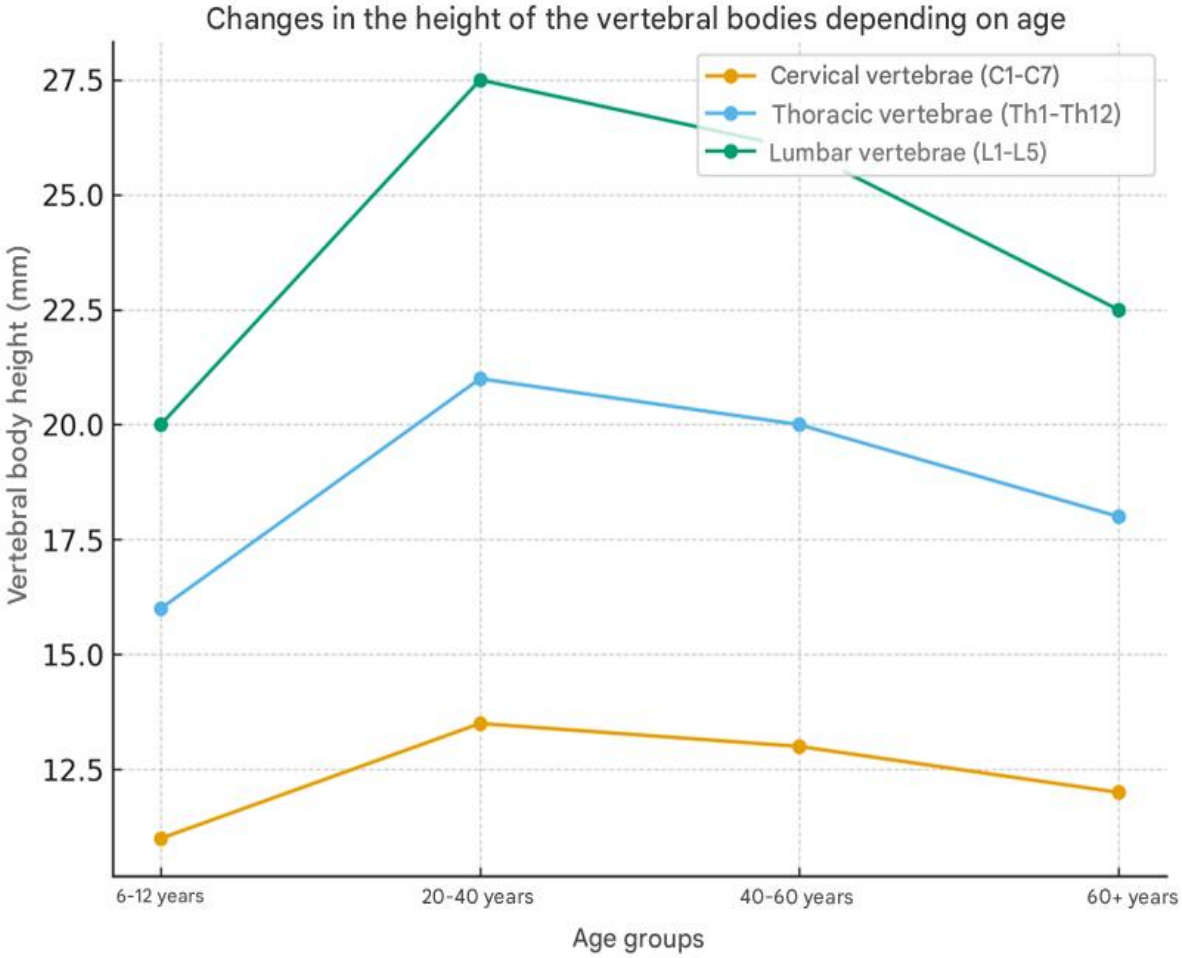
can increase, forming pathological kyphosis or scoliotic deformations. These changes are often accompanied by pain syndrome and limited mobility, reducing the quality of life of older people.




2-figure. Change in the height of the vertebral bodies depending on age.

The presented morphometric data of the vertebral bodies in different age groups reflect the patterns of growth, maturation and involution of the spinal column. The analysis shows that the size of the vertebral bodies gradually increases from the cervical to the lumbar region, which corresponds to an increase in the axial load from top to bottom. At this age, especially the height of the vertebral bodies, which is due to involutional changes in bone tissue, a decrease in mineral density and osteoporotic processes. In the cervical vertebrae, the height decreases to 11-13 mm, in the thoracic - to 16-20 mm, in the lumbar - to 20-25 mm. The width of the bodies also decreases, on average by 1-3 mm compared to mature age, which, combined with a decrease in the anterior-posterior dimensions, reflects a gradual deformation and flattening of the vertebrae (Figure 2). Thus, age-related changes in the spinal column are a complex process that includes the transformation of bone and cartilage tissue, intervertebral discs and ligamentous apparatus. Understanding these patterns is important for clinical practice, as it allows developing measures for the prevention, diagnosis and treatment of spinal diseases at different stages of a person's life. Morphometric analysis has shown that the vertebrae demonstrate clear age-related changes: from

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active growth in childhood to maximum strength in maturity and gradual degradation in old age. These data emphasize the need for osteoporosis prevention and early diagnosis of degenerative diseases of the spine.

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