



# AGE FEATURES OF CHANGES IN THE ANGLE OF THE SPINE AND AGE FEATURES OF ANTHROPOMETRIC INDICATORS OF VARIOUS SECTIONS OF THE SPINE IN BOYS AND GIRLS AGED FROM 11 TO 16 YEARS

**Khamdullaeva Saniya Sultan qizi**

student, Kimyo International University,  
Tashkent, Uzbekistan.

**Nazimova Sevara Bakhodirqizi**

student, Kimyo International University,  
Tashkent, Uzbekistan.

**Akhmedov Jobir Mokhirjonovich**

Senior Lecturer, Kimyo International University,  
Tashkent, Uzbekistan.

## ARTICLE INFO

## ABSTRACT

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The article examines age-related changes in the angle of inclination of various sections of the spinal column, as well as age-related features of anthropometric characteristics of the spinal column in boys and girls aged from 11 to 16 years old, who do not have pathological changes in the spinal column. [12].

The purpose of the study: to study the change in the angle of inclination in various parts of the spinal column, as well as age-related features of anthropometric indicators of various parts of the spinal column in adolescents.

**Keywords:** spinal column, degree of curvature, cervical, thoracic, lumbar, sacrococcygeal, cervical lordosis, thoracic kyphosis, lumbar lordosis, sacral kyphosis.

## Introduction

This article examines changes in the angle of the spinal column and their impact on the functional state of the musculoskeletal system. The main objective of the study is to analyze the causes of changes in the angle of the spine in patients with various types of curvatures (scoliosis, lordosis, kyphosis)[1, 3, 7, 8, 11]. Good physical development and full health of children are possible only if they maintain correct posture. When viewed from the side, correct posture is characterized by a slightly raised chest and tucked-in abdomen, straight lower limbs, and moderately pronounced physiological curves of the spinal column [16]. A high prevalence of scoliosis has been established, characterized by an increase in the number of cases from the period of second childhood to adolescence. During the period of second childhood and adolescence, deformities affect mainly the thoracic spine and have no gender differences, whereas in adolescence, sexual dimorphism begins to appear. Undifferentiated dysplasia of connective tissue complicates scoliotic deformation of the spine with the involvement of all its sections in the pathological process and a wide distribution of S-shaped and Z-shaped forms[9].

Changes in the angle of inclination of the spinal column and their relationship with age-related features of anthropometric indicators of various parts of the spine are also considered [1, 3]. The main objective of the study was to study changes in the angle of inclination of the spine in different age groups, as well as to determine the characteristic age-related anthropometric changes in the cervical, thoracic and lumbar spine [7, 10].

During the work, radiographic and magnetic resonance diagnostic methods were used to assess spinal deformities. The computer topography method, provided that the anatomical landmarks are correctly marked, provides acceptable accuracy in assessing the magnitude of spinal curvature in patients with structural scoliosis when examining them in a natural pose without fixation [13].

The results obtained show a relationship between the degree of angle change and clinical manifestations of pain syndrome, as well as posture disorders. It has been shown that the greatest lateral angle of

scoliosis is observed in lumbar scoliosis, which makes this type of scoliosis prognostically the most dangerous. The average value of the lateral angle of asymmetry, corresponding to the Cobb angle, was significantly higher than in thoracic and thoracolumbar scoliosis [8].

These findings may contribute to the development of more effective methods for the prevention and treatment of spinal diseases. Non-surgical treatment using methods such as physical therapy, a regular exercise program, and over-the-counter anti-inflammatory drugs is always the first line of treatment. Maintaining a healthy body weight and a regular exercise program are excellent ways to minimize the symptoms associated with scoliosis [17].

Surgical treatment of scoliosis improves the patient's quality of life and reduces pain associated with the disease. The results of surgical intervention for spinal deformity in adults are usually very good if it is performed correctly and for the right reasons. However, surgical intervention is associated with significant risk and should be avoided if possible [19].

Complex transformations of the spinal column in the process of evolutionary, phylo- and ontogenic development have led to its insufficient stability and reliability. Various pathological processes developing in the spine are the cause of suffering for people of different ages from early childhood to old age.

Timely detection of deformation of the musculoskeletal system is one of the effective treatment and preventive measures. In this regard, there is a need to study the age characteristics of anthropometric indicators of various parts of the spinal column in adolescents.

The use of combined approaches, modern instrumentation in combination with a comprehensive full examination, careful preoperative planning allows you to get good results in the treatment of patients with secondary spinal deformities [4, 5].

Study of the effect of physical exercise and sports on the human musculoskeletal system. It was found that sports are necessary for the prevention of diseases of the spine and joints. Therefore, it is necessary to lead an active lifestyle and play sports. It is important to find a suitable sport, the practice of which will not lead to deterioration of the spine.

#### **Purpose of the research**

The purpose of the study: to study the change in the angle of inclination in various parts of the spinal column, as well as age-related features of anthropometric indicators of various parts of the spinal column in adolescents.

#### **Material and Methods**

The material for the study was practically healthy teenagers from 11 to 16 years old, schoolchildren of School № 29 in the Almazar district of Tashkent. A total of 210 children were examined, 105 were girls and 105 were boys, aged 11 to 16 years.

#### *Research method*

Height was calculated using a mechanical stadiometer, a Vertebrometer was also used - a special device designed to measure the angles of the spine and assess the condition of the spinal column. It is used in the diagnosis of various spinal deformities, such as scoliosis, kyphosis and lordosis.

The obtained data were statistically processed on a computer using the Microsoft Office Excel 2021 software package, including the use of built-in statistical processing functions.

#### **Results and Discussion**

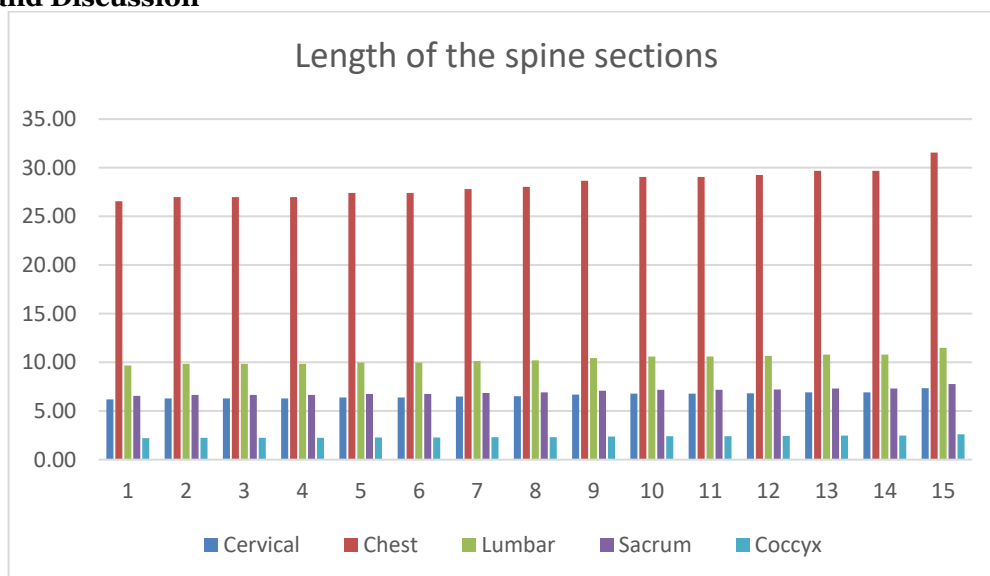


Fig.1.

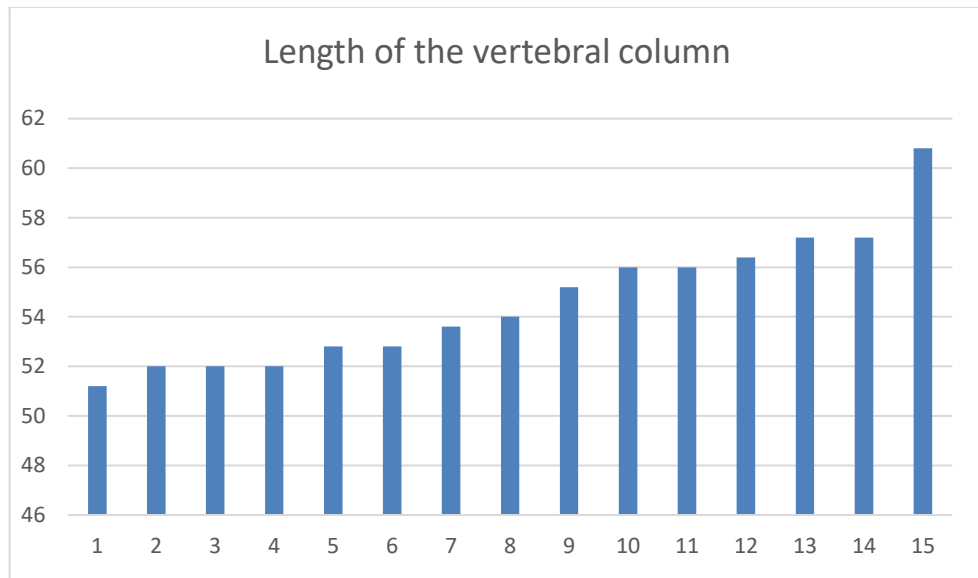


Fig.2.

The study showed that the total length of the spinal column of 11-year-old girls ranged from 51.2 cm to 60.8 cm, with an average of  $54.6 \pm 2.7$  cm. The length of the cervical spine ranged from 6.20 cm to 7.36 cm, with an average of  $6.6 \pm 0.3$  cm. The length of the thoracic spine ranged from 26.57 cm to 31.56 cm, with an average of  $28.3 \pm 1.4$  cm. The length of the lumbar spine ranged from 9.68 cm to 11.49 cm, with an average of  $10.3 \pm 0.5$  cm. The length of the sacral spine ranged from 6.55 cm to 7.78 cm, with an average of  $7.0 \pm 0.3$  cm. The length of the coccygeal spine ranged from 2.20 to 2.61 cm, with an average of  $2.3 \pm 0.1$  (Fig.1. and Fig.2.).

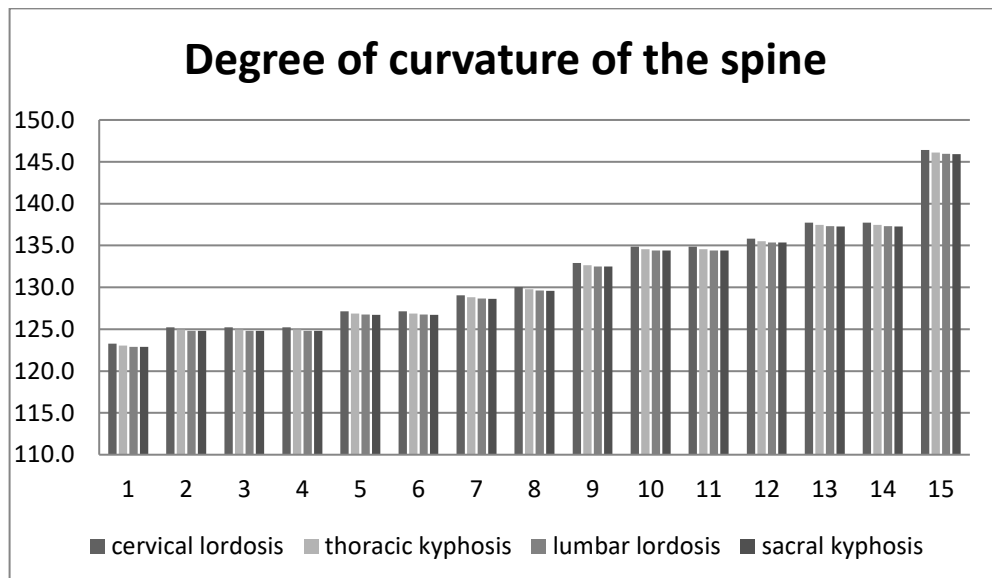


Fig.3.

The degree of curvature of the cervical spine - cervical lordosis in 11-year-old girls ranges from  $123.3^\circ$  to  $146.4^\circ$ , on average  $131.5 \pm 6.4$ . The degree of curvature of the thoracic spine - thoracic kyphosis ranges from  $123.0^\circ$  to  $146.1^\circ$ , on average  $131.2^\circ \pm 6.4$ . The degree of curvature of the lumbar spine - lumbar lordosis ranges from  $122.9^\circ$  to  $145.9^\circ$ , on average  $131.1^\circ \pm 6.4$ . The degree of curvature of the sacral spine - sacral kyphosis ranges from  $122.9^\circ$  to  $145.9^\circ$ , on average  $131.1^\circ \pm 6.4$  (Fig.3).

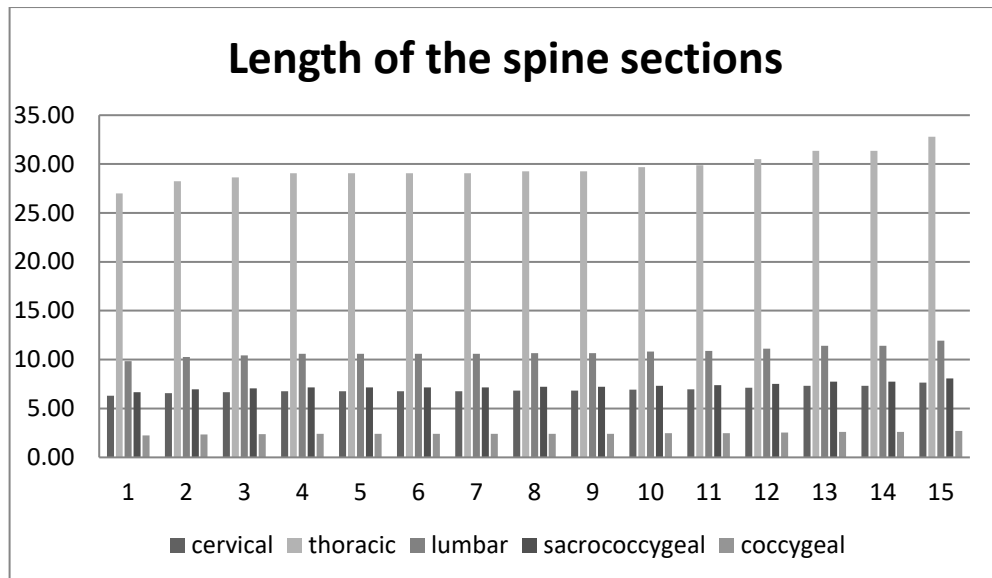


Fig.4.

The total length of the vertebral column of 12-year-old girls ranged from 52 cm to 63.2 cm, with an average of  $57.1 \pm 2.7$  cm. The length of the cervical spine ranged from 6.29 cm to 7.65 cm, with an average of  $6.9 \pm 0.3$  cm. The length of the thoracic spine ranged from 26.99 cm to 32.80 cm, with an average of  $29.6 \pm 1.4$  cm. The length of the lumbar spine ranged from 9.83 cm to 11.94 cm, with an average of  $10.8 \pm 0.5$  cm. The length of the sacral spine ranged from 6.66 cm to 8.9 cm, with an average of  $7.3 \pm 0.4$  cm. The length of the coccygeal spine ranged from 2.24 to 2.72 cm, with an average of  $2.5 \pm 0.1$  (Fig.4.and Fig.5.)

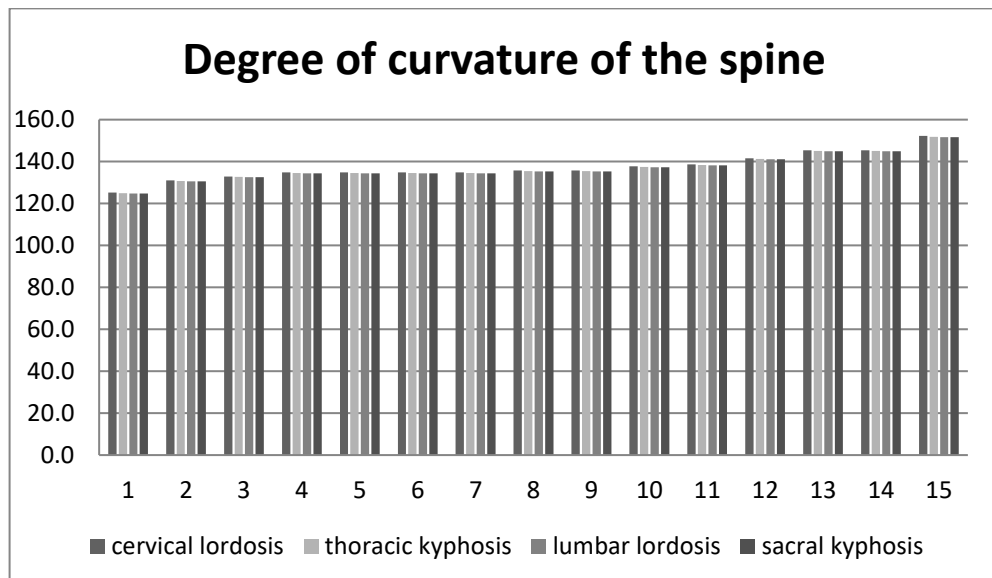


Fig.5.

The degree of curvature of the cervical spine - cervical lordosis in 12-year-old girls ranges from  $125.2^\circ$  to  $152.2^\circ$ , on average  $137.4^\circ \pm 6.6$ . The degree of curvature of the thoracic spine - thoracic kyphosis ranges from  $125.0^\circ$  to  $151.9^\circ$ , on average  $137.1^\circ \pm 6.6$ . The degree of curvature of the lumbar spine - lumbar lordosis ranges from  $124.9^\circ$  to  $151.7^\circ$ , on average  $137.0^\circ \pm 6.6$ . The degree of curvature of the sacral spine - sacral kyphosis ranges from  $124.8^\circ$  to  $151.7^\circ$ , on average  $137.0^\circ \pm 6.6$  (Fig.6).

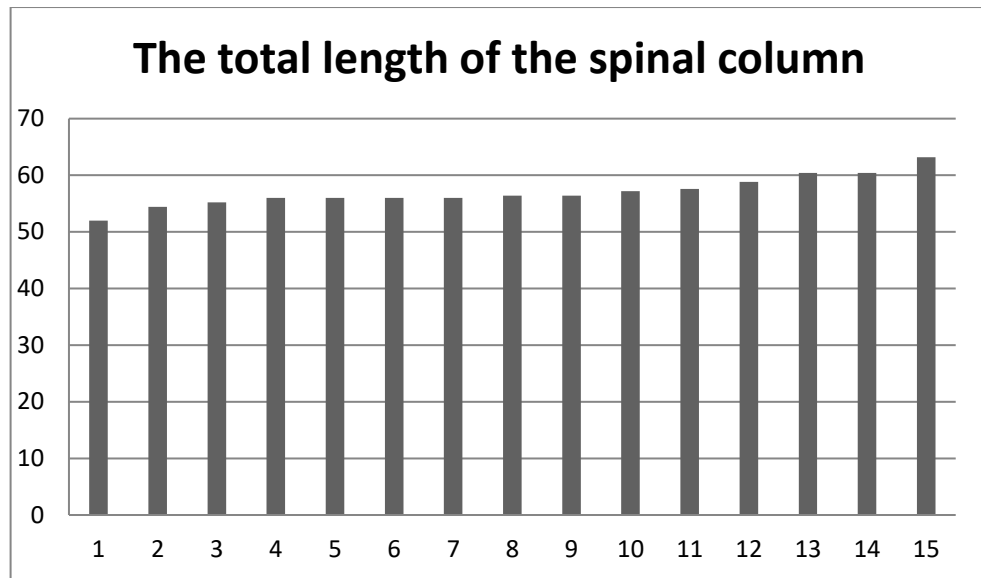


Fig.6.

The study showed that the total length of the spinal column of 13-year-old feboys ranged from 56.4 cm to 64 cm, with an average of  $61.2 \pm 2.5$  cm. The length of the cervical spine ranged from 6.82 cm to 7.74 cm, with an average of  $7.4 \pm 0.3$  cm. The length of the thoracic spine ranged from 29.27 cm to 33.22 cm, with an average of  $31.8 \pm 1.3$  cm. The length of the lumbar spine ranged from 10.66 cm to 12.10 cm, with an average of  $11.6 \pm 0.5$  cm. The length of the sacral spine ranged from 7.22 cm to 8.19 cm, with an average of  $7.8 \pm 0.3$  cm. The length of the coccygeal spine ranged from 2.43 to 2.75 cm, with an average of  $2.6 \pm 0.1$  (Fig.7).

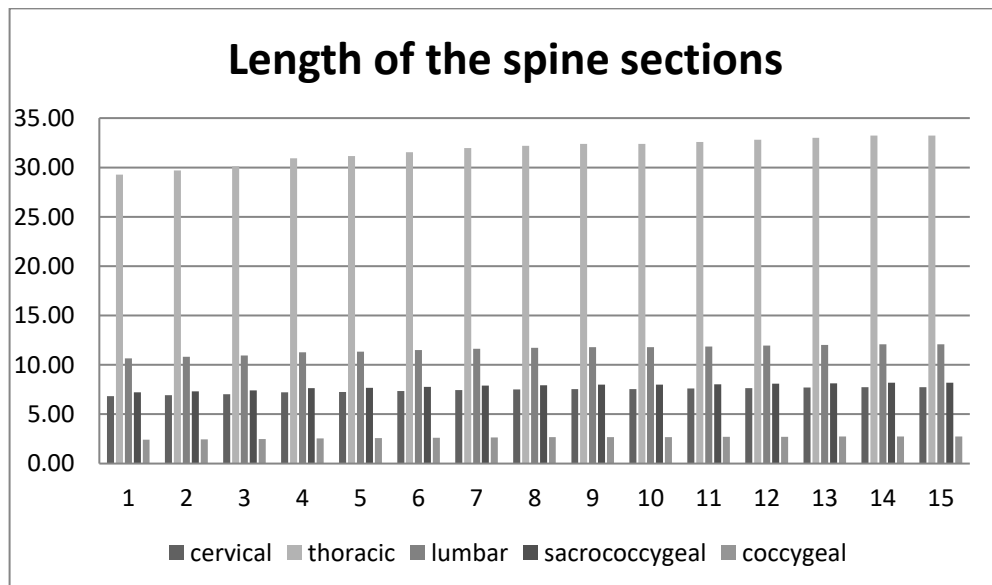


Fig.7.

The degree of curvature of the cervical spine - cervical lordosis in 13-year-old girls ranges from  $135.8^\circ$  to  $154.1^\circ$ , on average  $147.4 \pm 5.9$ . The degree of curvature of the thoracic spine - thoracic kyphosis ranges from  $135.5^\circ$  to  $153.8^\circ$ , on average  $147.1^\circ \pm 5.9$ . The degree of curvature of the lumbar spine - lumbar lordosis ranges from  $135.4^\circ$  to  $153.6^\circ$ , on average  $146.9^\circ \pm 5.9$ . The degree of curvature of the sacral spine - sacral kyphosis ranges from  $135.4^\circ$  to  $153.6^\circ$ , on average  $146.9^\circ \pm 5.9$  (Fig.8. and Fig.9).

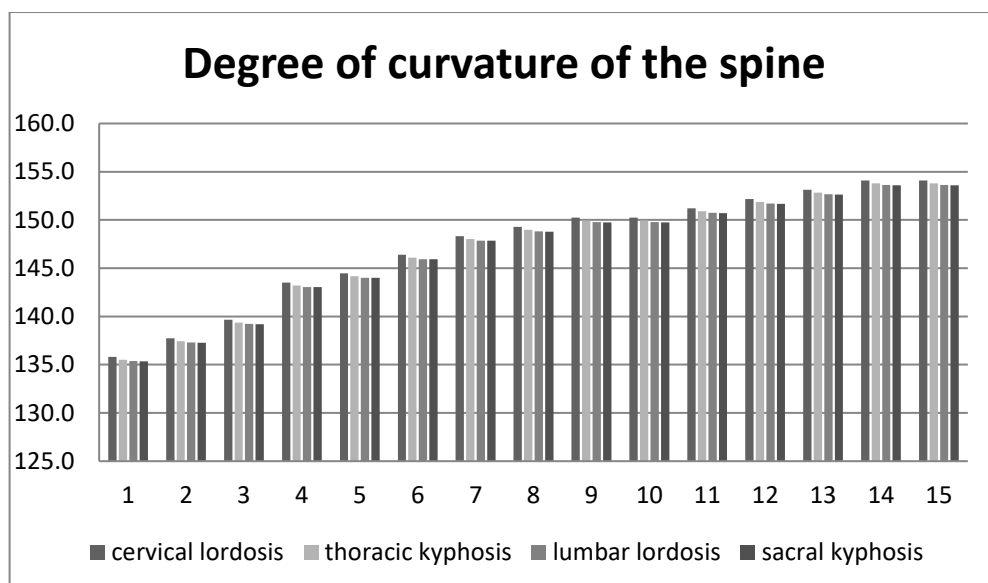


Fig.8.

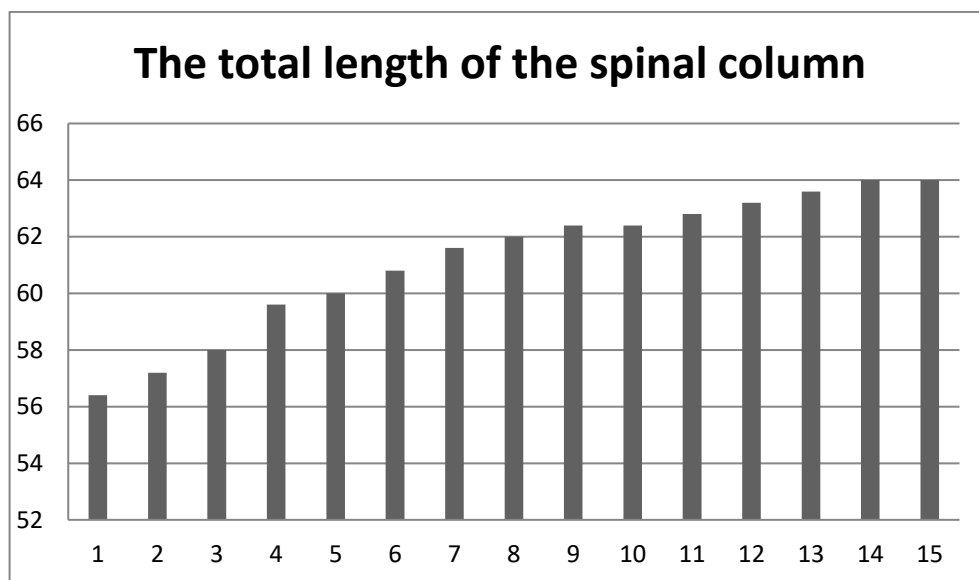


Fig.9.

The study showed that the total length of the spinal column of 14-year-old boys ranged from 56.8 cm to 66 cm, with an average of  $62.5 \pm 2.5$  cm. The length of the cervical spine ranged from 6.87 cm to 7.99 cm, with an average of  $7.6 \pm 0.3$  cm. The length of the thoracic spine ranged from 29.48 cm to 34.25 cm, with an average of  $32.5 \pm 1.1$  cm. The length of the lumbar spine ranged from 10.74 cm to 12.47 cm, with an average of  $11.8 \pm 0.5$ . The length of the sacral spine ranged from 7.27 cm to 8.45 cm, with an average of  $8.0 \pm 0.3$  cm. The length of the coccygeal spine ranged from 2.44 to 2.84 cm, with an average of  $2.7 \pm 0.1$  (Fig.10.).

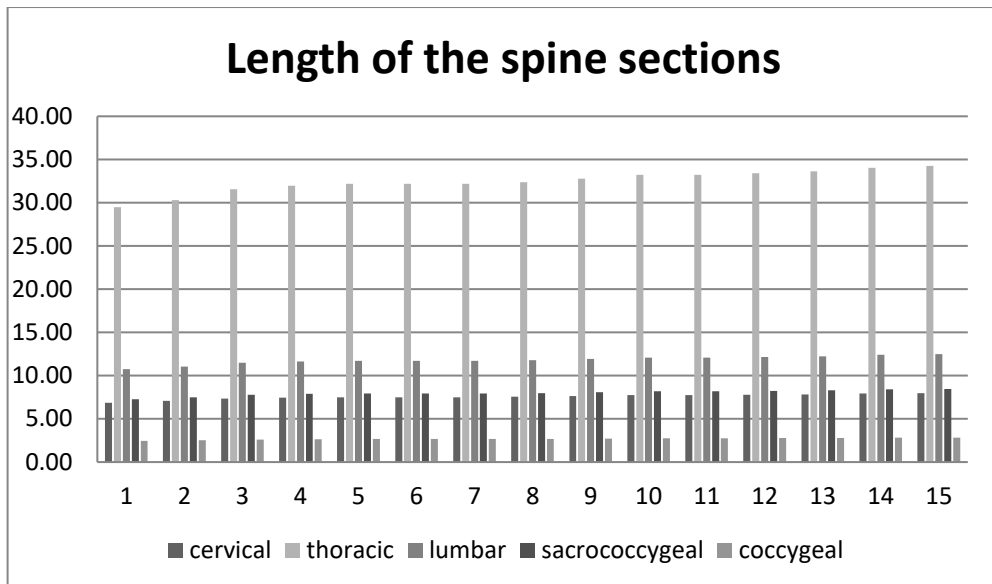


Fig.10.

The degree of curvature of the cervical spine - cervical lordosis in 14-year-old girls ranges from 136.8° to 158.1°, on average 150.6 ±6.1. The degree of curvature of the thoracic spine - thoracic kyphosis ranges from 136.5° to 158.6°, on average 150.3° ±6.1. The degree of curvature of the lumbar spine - lumbar lordosis ranges from 136.3° to 158.4°, on average 150.1° ±6.1. The degree of curvature of the sacral spine - sacral kyphosis ranges from 136.3° to 158.4°, on average 150.1° ±6.1 (Fig.11. and Fig.12).

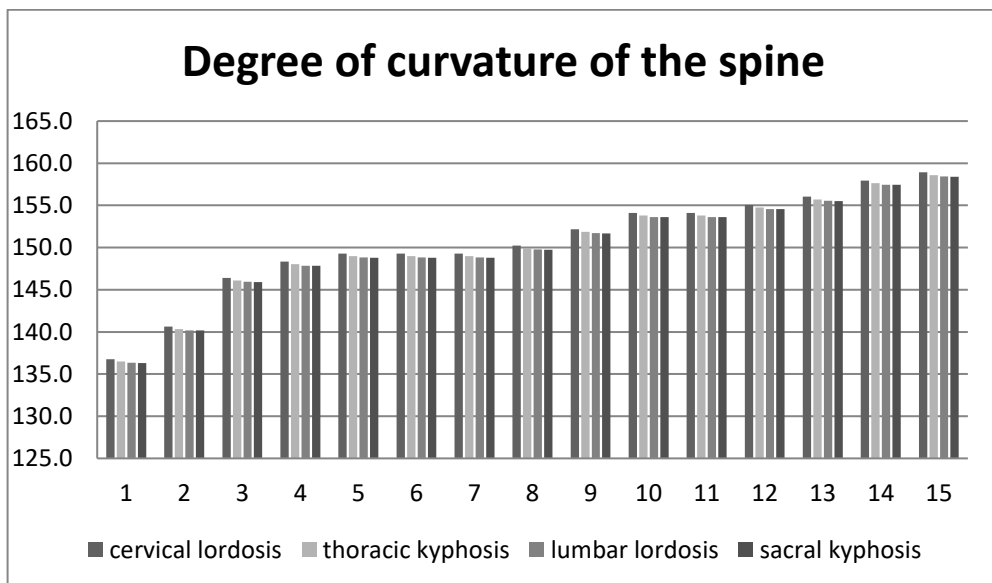


Fig.11.

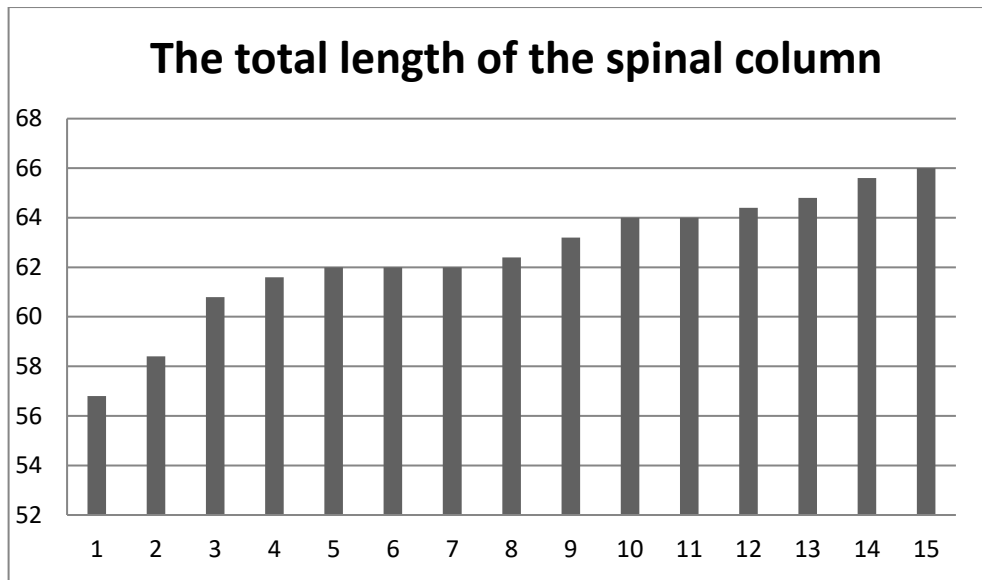


Fig.12.

The study showed that the total length of the spinal column of 15-year-old boys ranged from 56.8 cm to 68 cm, with an average of  $63.6 \pm 3.5$  cm. The length of the cervical spine ranged from 6.87 cm to 8.23 cm, with an average of  $7.7 \pm 0.4$  cm. The length of the thoracic spine ranged from 29.48 cm to 35.29 cm, with an average of  $33.0 \pm 1.1$  cm. The length of the lumbar spine ranged from 10.74 cm to 12.85 cm, with an average of  $12.0 \pm 0.7$ . The length of the sacral spine ranged from 7.27 cm to 8.70 cm, with an average of  $8.1 \pm 0.4$  cm. The length of the coccygeal spine ranged from 2.44 to 2.92 cm, with an average of  $2.7 \pm 0.1$  (Fig.13.).

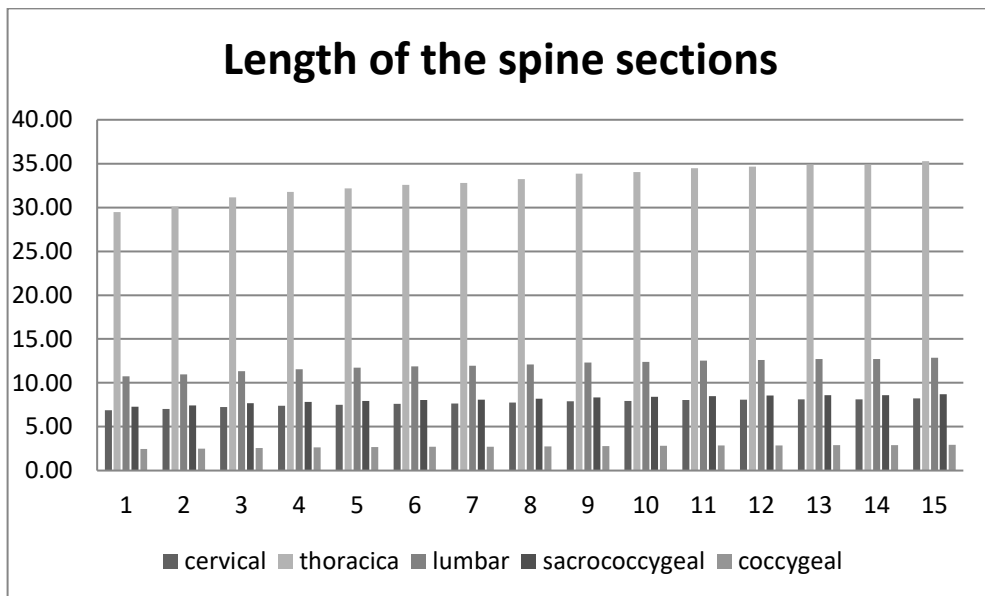


Fig.13.

The degree of curvature of the cervical spine - cervical lordosis in 15-year-old girls ranges from  $136.8^\circ$  to  $163.7^\circ$ , on average  $141.9 \pm 10.6$ . The degree of curvature of the thoracic spine - thoracic kyphosis ranges from  $136.5^\circ$  to  $163.4^\circ$ , on average  $152.9 \pm 8.4$ . The degree of curvature of the lumbar spine - lumbar lordosis ranges from  $136.3^\circ$  to  $163.2^\circ$ , on average  $150.1 \pm 6.1$ . The degree of curvature of the sacral spine - sacral kyphosis ranges from  $136.3^\circ$  to  $163.2^\circ$ , on average  $152.7 \pm 8.4$  (Fig.14. and Fig.15).



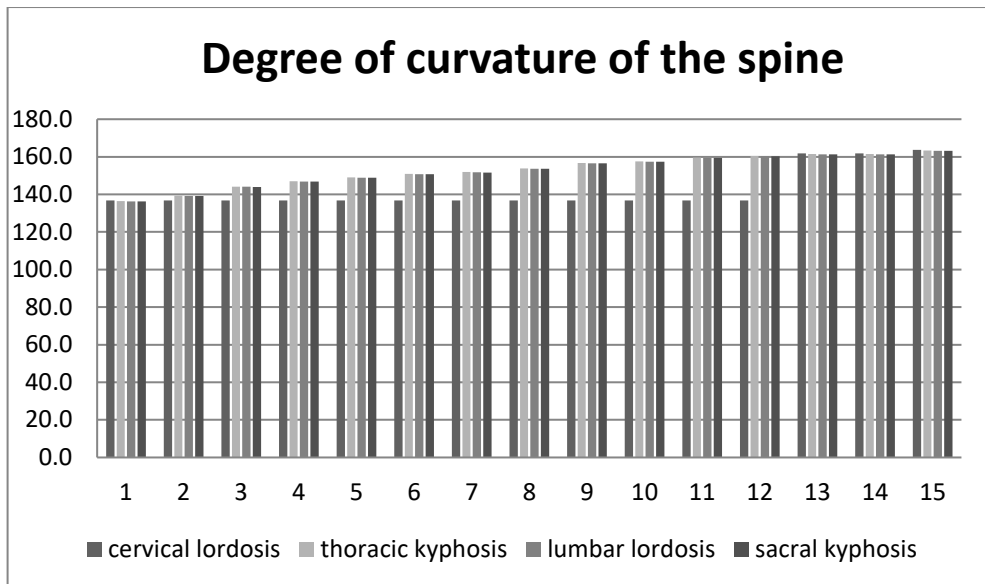


Fig.14.

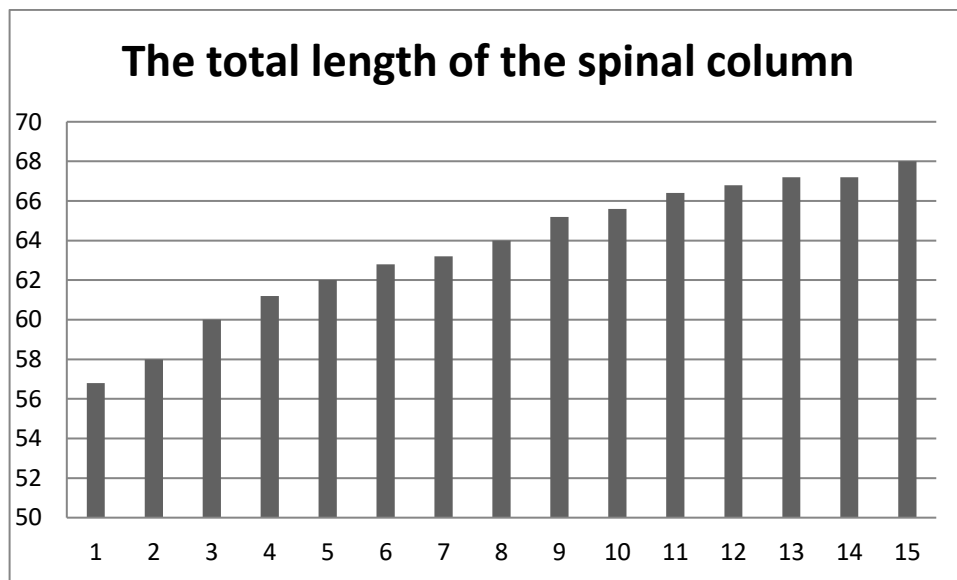


Fig.15.

The study showed that the total length of the spinal column of 16-year-old feboys ranged from 60.8 cm to 71.2 cm, with an average of  $65.4 \pm 2.7$  cm. The length of the cervical spine ranged from 7.36 cm to 8.62 cm, with an average of  $7.9 \pm 0.3$  cm. The length of the thoracic spine ranged from 31.56 cm to 36.95 cm, with an average of  $33.9 \pm 1.4$  cm. The length of the lumbar spine ranged from 11.49 cm to 13.46 cm, with an average of  $12.4 \pm 0.5$ . The length of the sacral region varied from 7.78 cm to 9.11 cm, with an average of  $8.4 \pm 0.4$  cm. The length of the coccygeal region varied from 2.61 to 3.06 cm, with an average of  $2.8 \pm 0.1$  (Fig.16.).

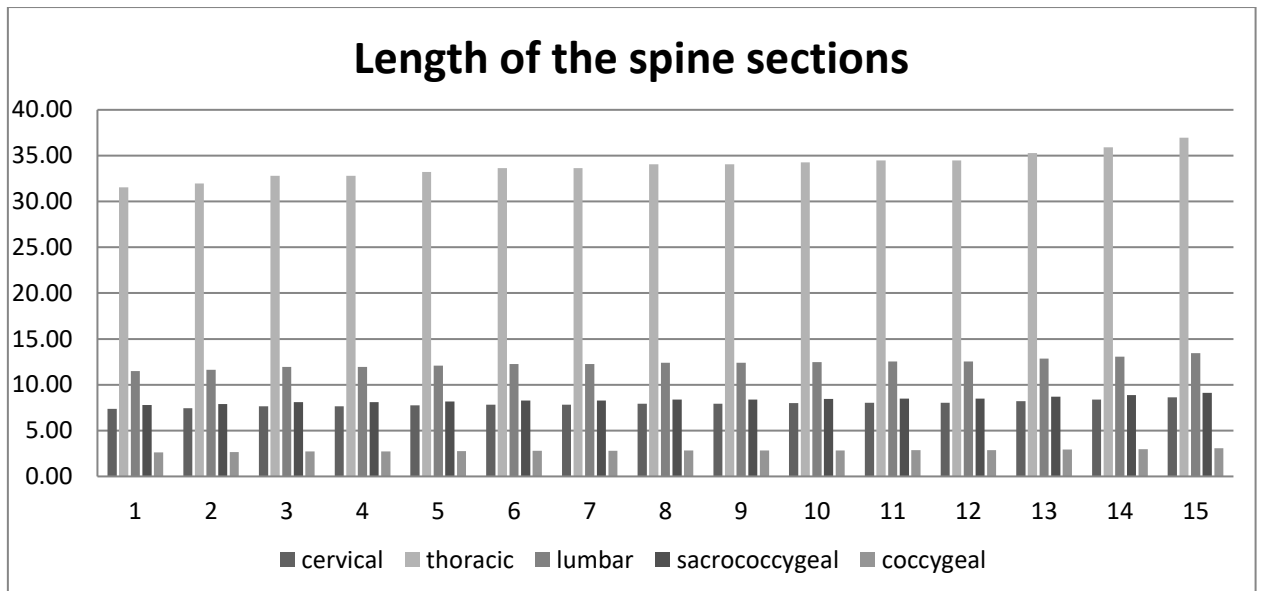


Fig.16.

The degree of curvature of the cervical spine - cervical lordosis in 16-year-old girls ranges from 146.4° to 171.4°, on average 157.4 ±6.6. The degree of curvature of the thoracic spine - thoracic kyphosis ranges from 146.1° to 171.1°, on average 157.1° ±6.6. The degree of curvature of the lumbar spine - lumbar lordosis ranges from 145.9° to 170.9°, on average 156.9° ±6.6. The degree of curvature of the sacral spine - sacral kyphosis ranges from 145.9° to 170.9°, on average 156.9° ±6.6 (Fig.17. and Fig.18.).

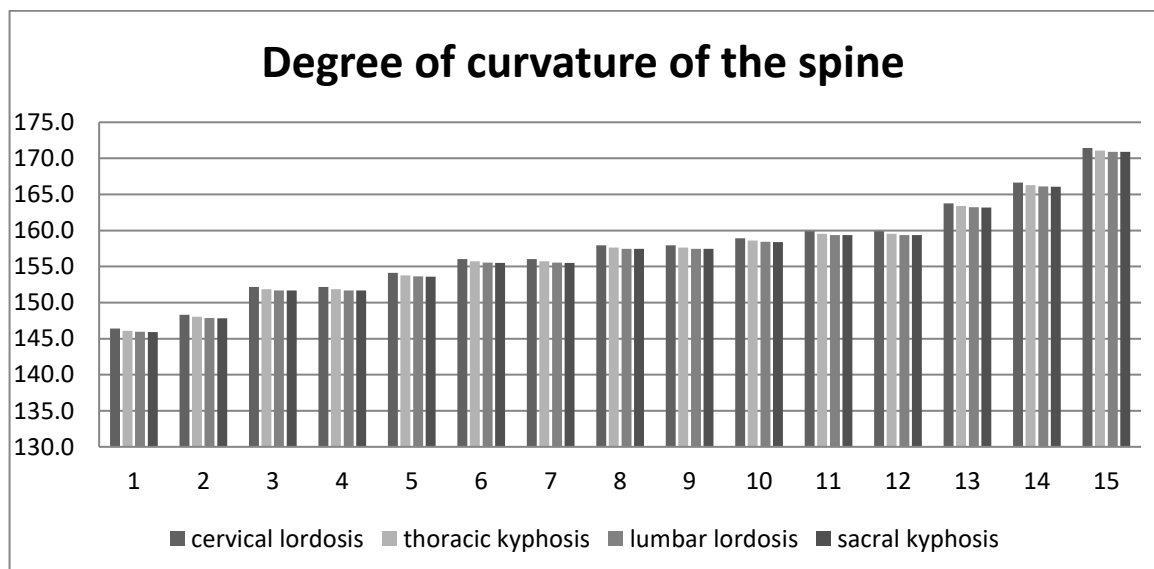


Fig.17.

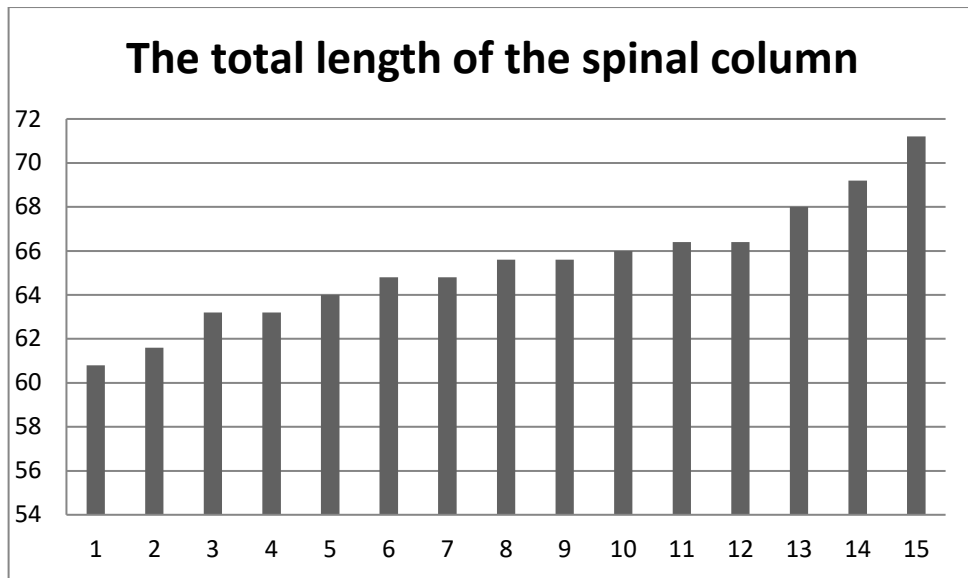


Fig.18.

The study showed that the total length of the spinal column of 11-year-old boys ranged from 48.8 cm to 58 cm, with an average of  $56.3 \pm 3.4$  cm. The length of the cervical spine ranged from 5.90 cm to 7.02 cm, with an average of  $6.8 \pm 0.4$  cm. The length of the thoracic spine ranged from 25.33 cm to 30.10 cm, with an average of  $29.2 \pm 1.8$  cm. The length of the lumbar spine ranged from 9.22 cm to 10.96 cm, with an average of  $10.6 \pm 0.6$  cm. The length of the sacral spine ranged from 5.90 cm to 7.02 cm, with an average of  $6.8 \pm 0.4$  cm. The length of the coccygeal spine ranged from 2.44 to 2.90 cm, with an average of  $2.8 \pm 0.2$  (Fig.19.).

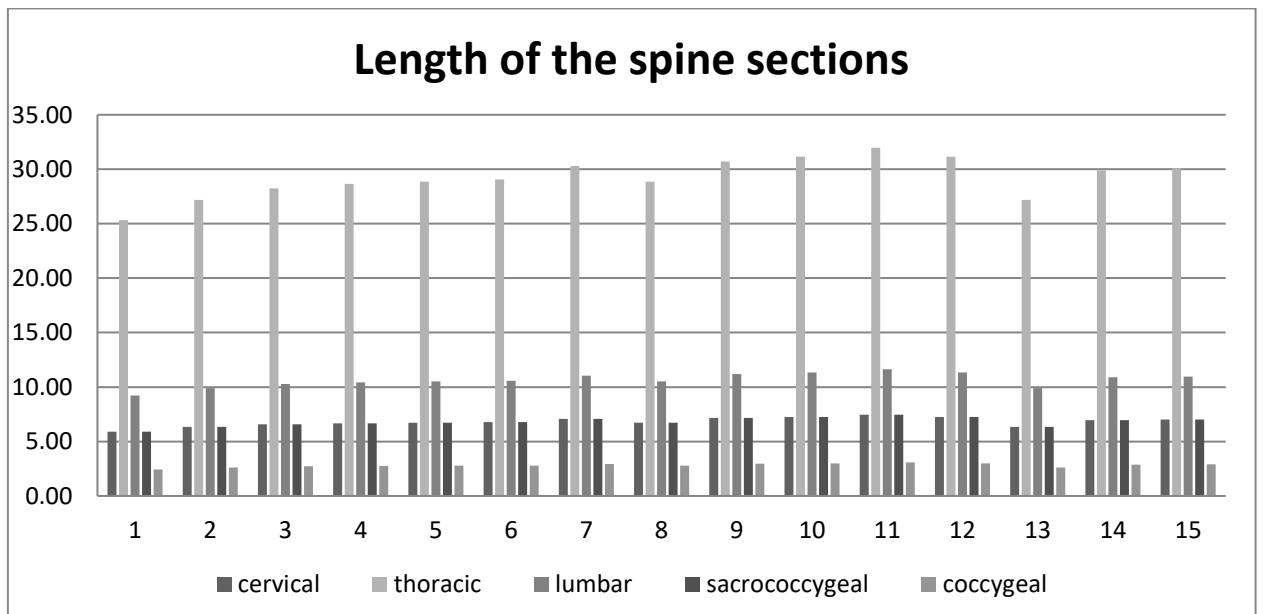


Fig.19.

The degree of curvature of the cervical spine - cervical lordosis in 11-year-old boys ranges from  $117.5^\circ$  to  $139.7^\circ$ , on average  $135.7 \pm 8.3^\circ$ . The degree of curvature of the thoracic spine - thoracic kyphosis ranges from  $117.3^\circ$  to  $139.4^\circ$ , on average  $135.4 \pm 8.3$ . The degree of curvature of the lumbar spine - lumbar lordosis ranges from  $117.1^\circ$  to  $139.2^\circ$ , on average  $135.2 \pm 8.3$ . The degree of curvature of the sacral spine - sacral kyphosis ranges from  $110.7^\circ$  to  $131.6^\circ$ , on average  $127.8 \pm 7.8$  (Fig.20. and Fig.21.).

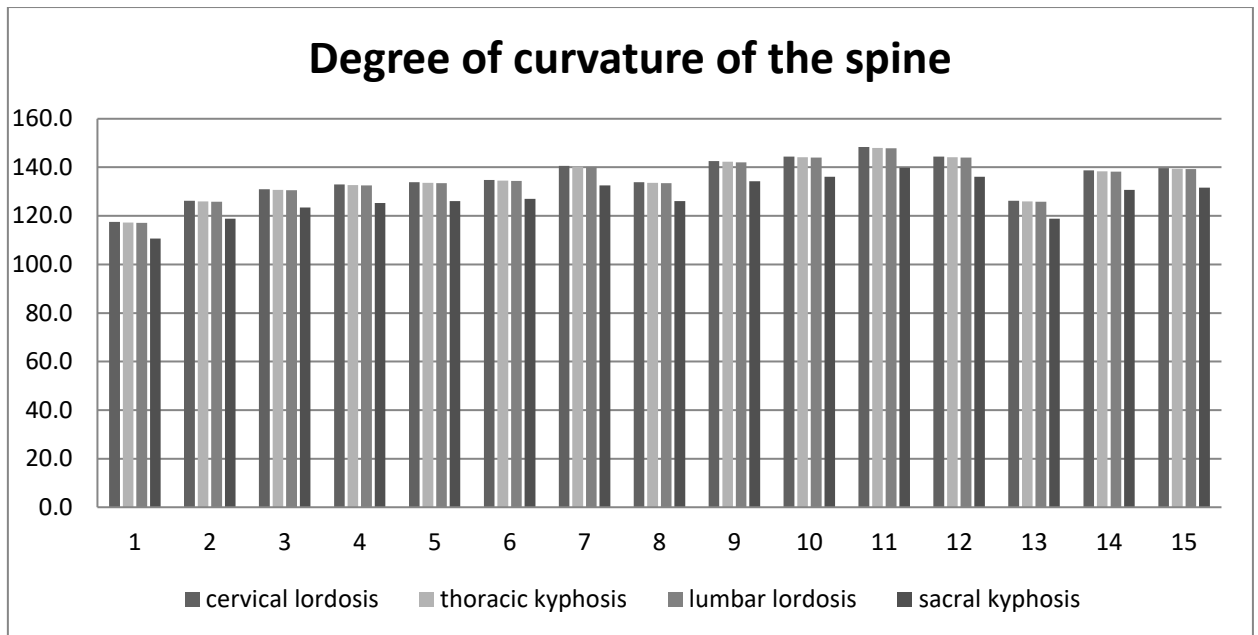


Fig.20.

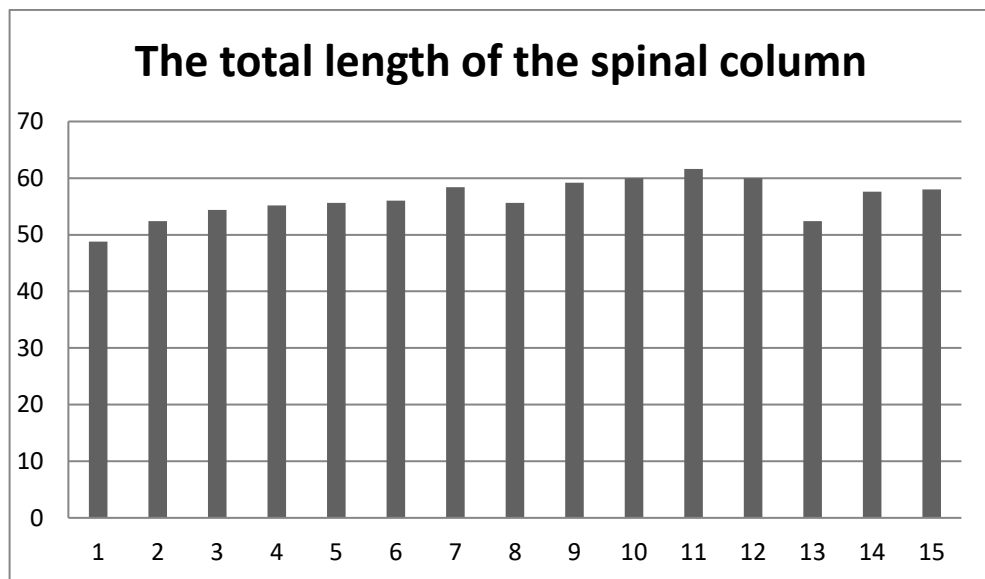


Fig.21.

Studies have shown that the total length of the vertebral column of 12-year-old boys ranges from 54 cm to 62 cm, with an average of  $56.5 \pm 2.3$  cm. The length of the cervical spine ranged from 6.53 cm to 7.50 cm, with an average of  $6.8 \pm 0.3$  cm. The length of the thoracic spine ranged from 28.03 cm to 32.18 cm, with an average of  $29.3 \pm 1.2$  cm. The length of the lumbar spine ranges from 10.21 cm to 11.72 cm, with an average of  $10.7 \pm 0.4$  cm. The length of the sacral spine ranged from 6.53 cm to 7.50 cm, with an average of  $6.8 \pm 0.3$  cm. The length of the coccygeal spine ranged from 2.70 to 3.10 cm, with an average of  $2.8 \pm 0.1$  (Fig.22., Fig.23. and Fig.23.).

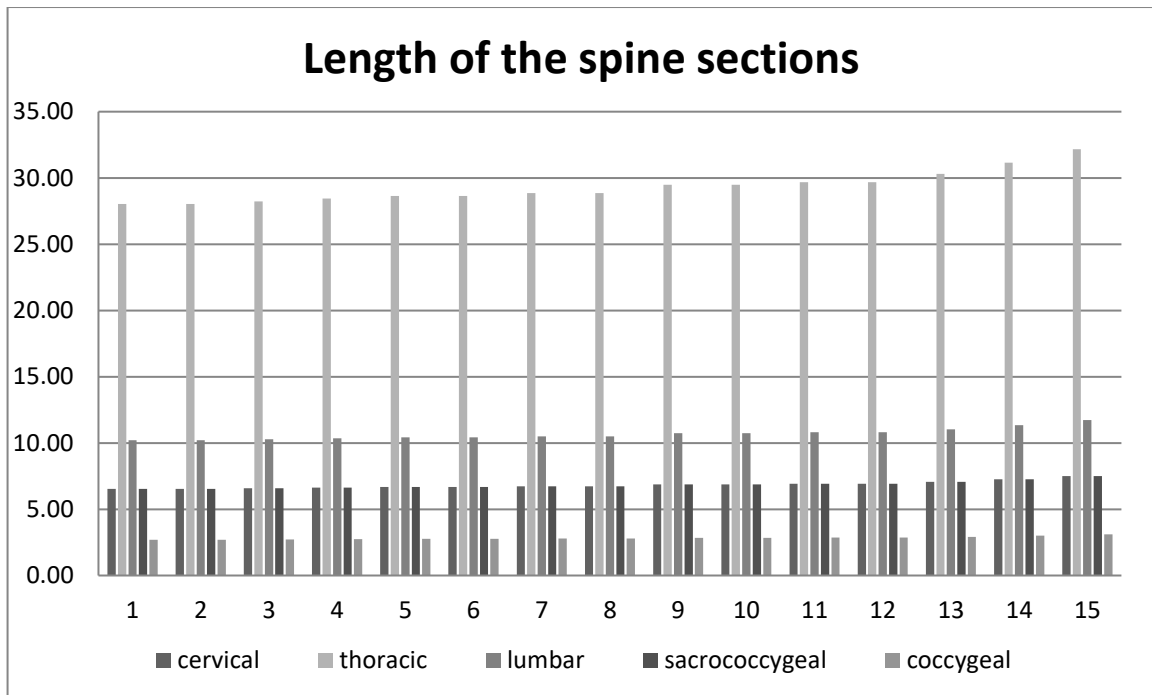


Fig.22.

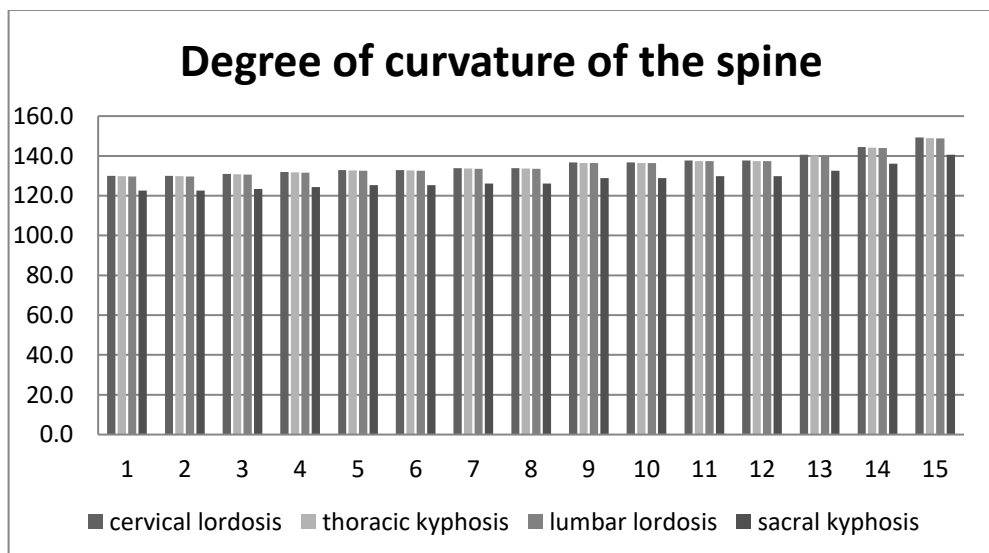


Fig.23.

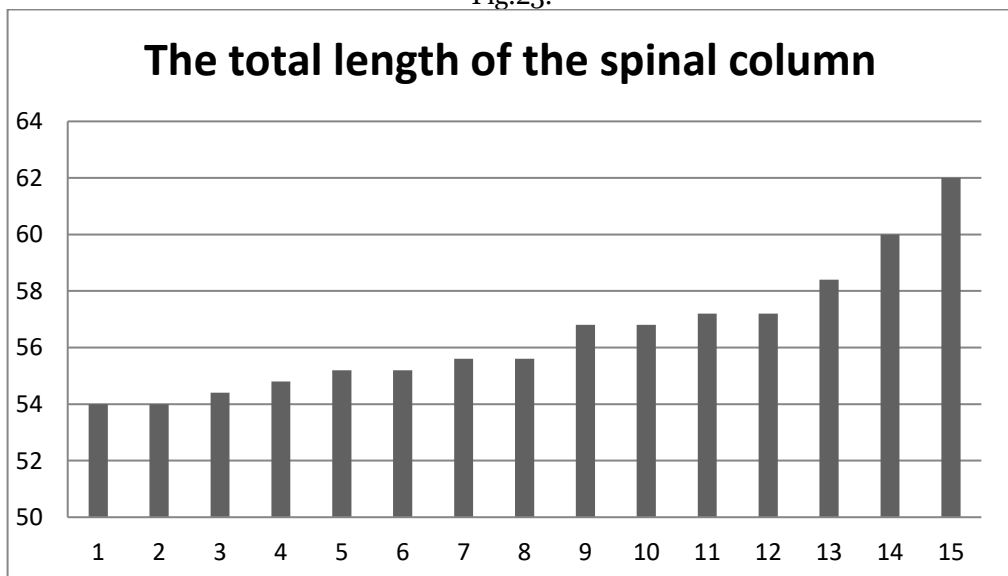


Fig.24.

The degree of curvature of the cervical spine - cervical lordosis in 12-year-old boys ranges from  $130.0^{\circ}$  to  $149.3^{\circ}$ , on average  $136.0 \pm 5.5^{\circ}$ . The degree of curvature of the thoracic spine - thoracic kyphosis ranges from  $129.8^{\circ}$  to  $149.0^{\circ}$ , on average  $135.7^{\circ} \pm 5.5$ . The degree of curvature of the lumbar spine - lumbar lordosis ranges from  $129.6^{\circ}$  to  $148.8^{\circ}$ , on average  $135.6^{\circ} \pm 5.4$ . The degree of curvature of the sacral spine - sacral kyphosis ranges from  $122.5^{\circ}$  to  $140.7^{\circ}$ , on average  $128.1^{\circ} \pm 5.1$  (Fig.25. and Fig.26.).

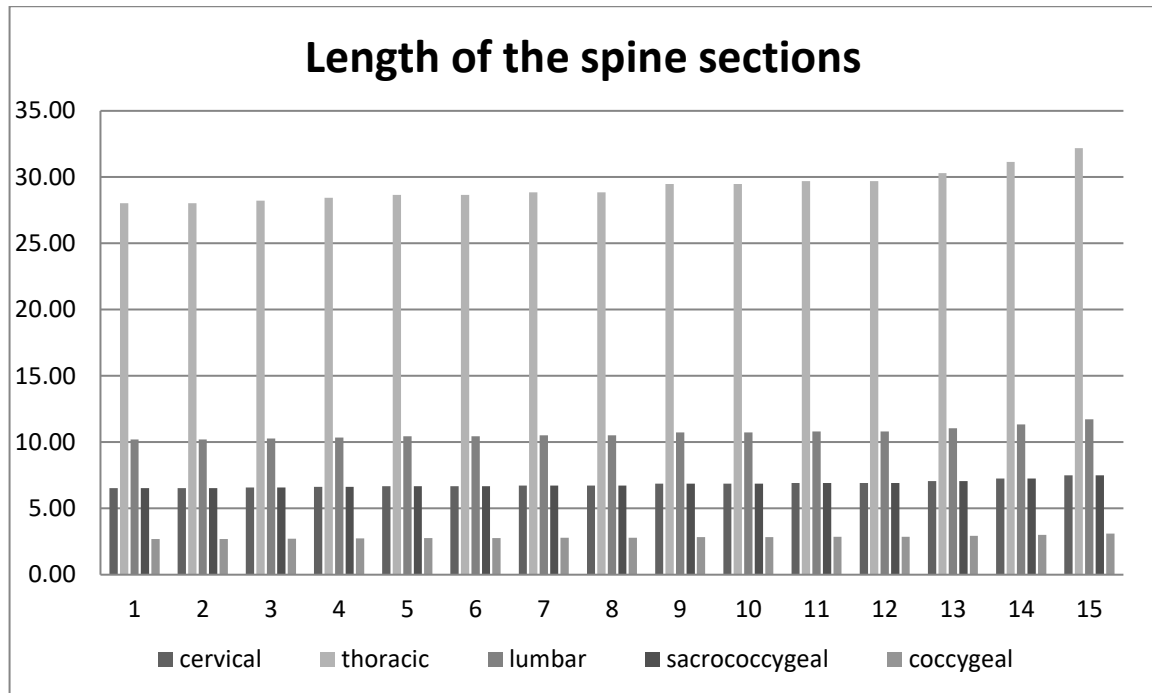


Fig.25.

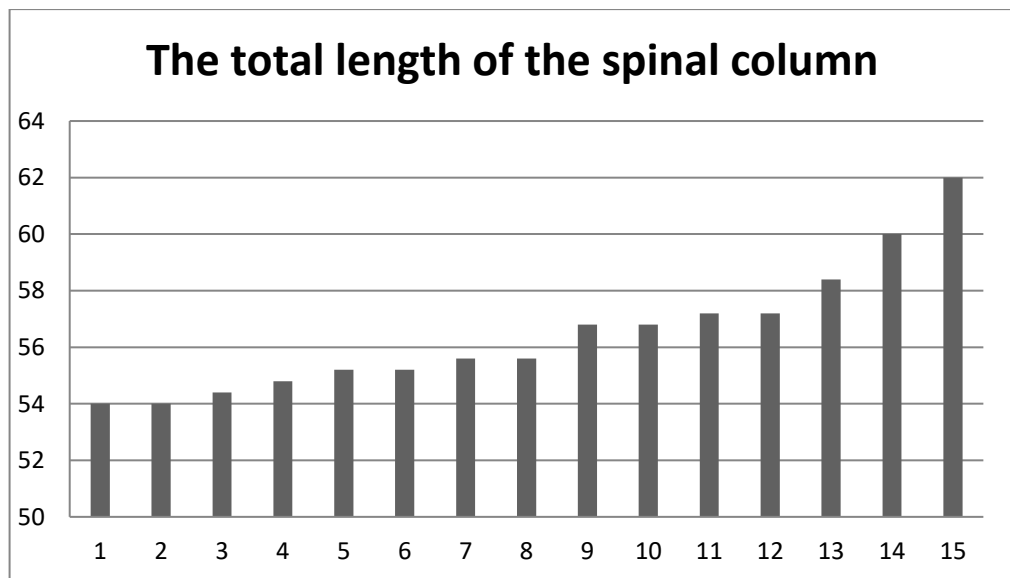


Fig.26.

Studies have shown that the total length of the vertebral column of 13-year-old boys ranges from 56.4 cm to 64 cm, with an average of  $60.2 \pm 2.2$  cm. The length of the cervical spine ranged from 6.82 cm to 7.74 cm, with an average of  $7.3 \pm 0.3$  cm. The length of the thoracic spine ranged from 29.27 cm to 33.22 cm, with an average of  $31.3 \pm 1.1$  cm. The length of the lumbar spine ranged from 10.66 cm to 12.10 cm, with an average of  $11.4 \pm 0.4$  cm. The length of the sacral spine ranged from 6.82 cm to 7.74 cm, with an average of  $7.3 \pm 0.3$  cm. The length of the coccygeal spine ranged from 2.82 to 3.20 cm, with an average of  $3.0 \pm 0.1$  cm.

The degree of curvature of the cervical spine - cervical lordosis in 13-year-old boys ranges from  $135.8^{\circ}$  to  $154.1^{\circ}$ , on average  $145.1 \pm 5.3^{\circ}$ . The degree of curvature of the thoracic spine - thoracic kyphosis ranges from  $135.5^{\circ}$  to  $153.8^{\circ}$ , on average  $144.8^{\circ} \pm 5.3$ . The degree of curvature of the lumbar spine - lumbar

lordosis ranges from  $135.4^{\circ}$  to  $153.6^{\circ}$ , on average  $144.6^{\circ} \pm 5.3$ . The degree of curvature of the sacral spine - sacral kyphosis ranges from  $128.0^{\circ}$  to  $145.2^{\circ}$ , on average  $136.7^{\circ} \pm 5.0$  (Fig.27. and Fig.28.).

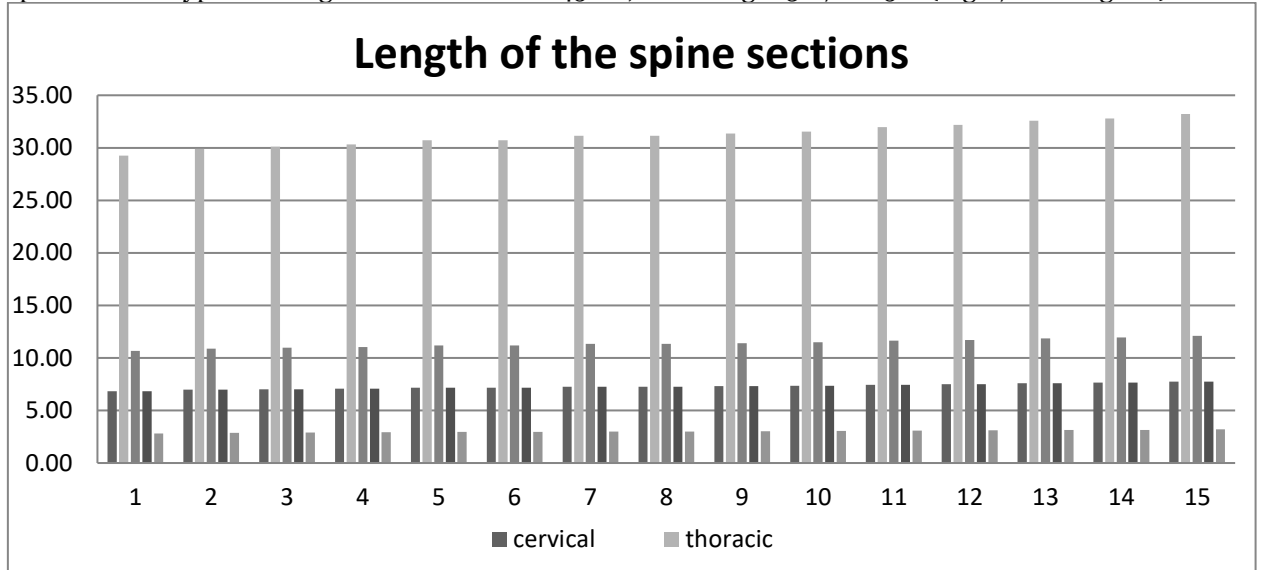


Fig.27.

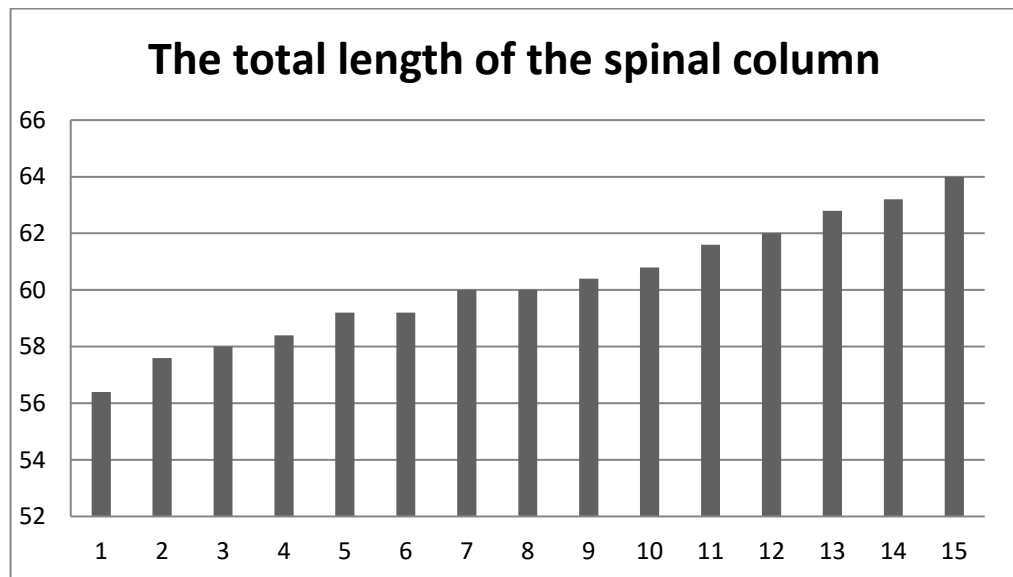


Fig.28.

Studies have shown that the total length of the vertebral column of 14-year-old boys ranges from 55.6 cm to 67.2 cm, with an average of  $62.8 \pm 3.6$  cm. The length of the cervical spine ranged from 6.72 cm to 8.13 cm, with an average of  $7.6 \pm 0.4$  cm. The length of the thoracic spine ranged from 28.86 cm to 34.88 cm, with an average of  $32.6 \pm 1.8$  cm. The length of the lumbar spine ranged from 10.51 cm to 12.70 cm, with an average of  $11.9 \pm 0.7$  cm. The length of the sacral spine ranged from 6.73 cm to 8.13 cm, with an average of  $7.6 \pm 0.4$  cm. The length of the coccygeal spine ranged from 2.78 to 3.36 cm, with an average of  $3.1 \pm 0.2$  (Fig.29.).

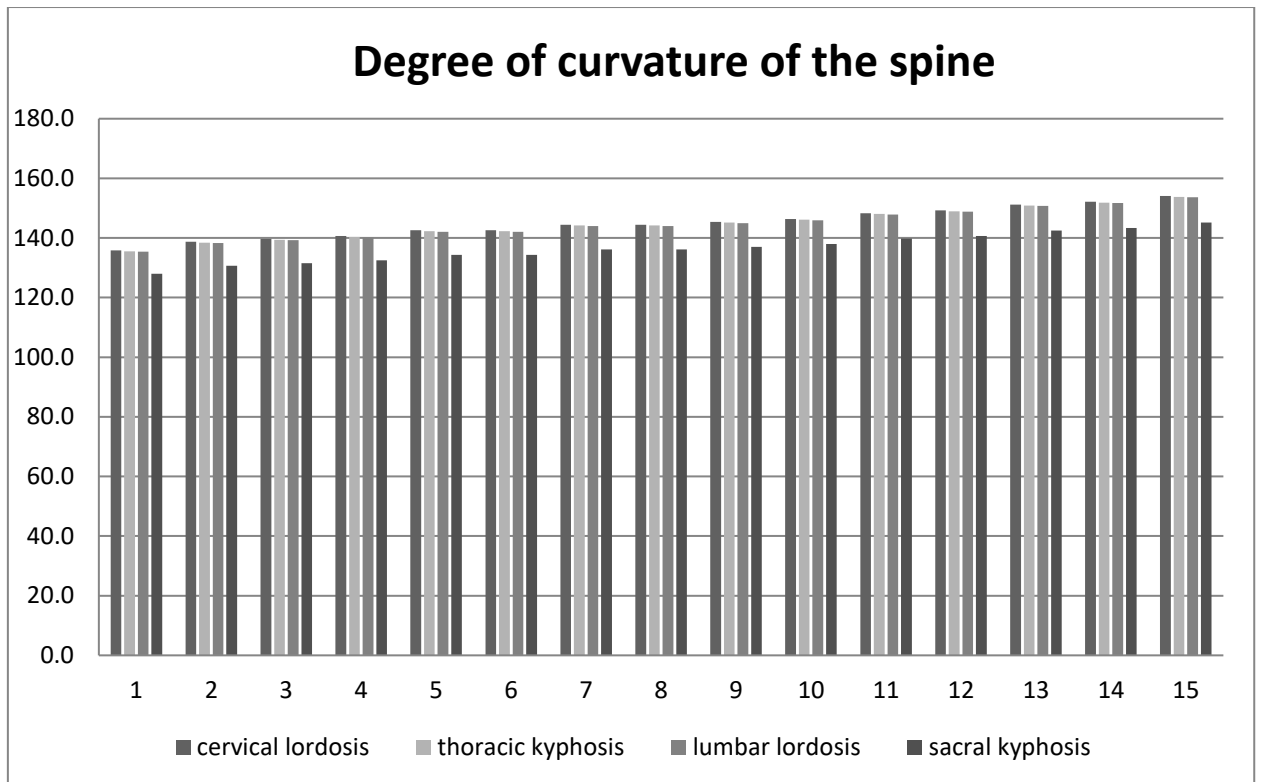


Fig.29.

The degree of curvature of the cervical spine - cervical lordosis in 14-year-old boys ranges from 133.9° to 161.8°, on average 151.2 ±8.6. The degree of curvature of the thoracic spine - thoracic kyphosis ranges from 133.6° to 161.5°, on average 150.9° ±8.5. The degree of curvature of the lumbar spine - lumbar lordosis ranges from 133.5° to 161.3°, on average 150.7° ±8.5. The degree of curvature of the sacral spine - sacral kyphosis ranges from 126.1° to 152.5°, on average 142.5° ±8.1 (Fig.30. and Fig.31).

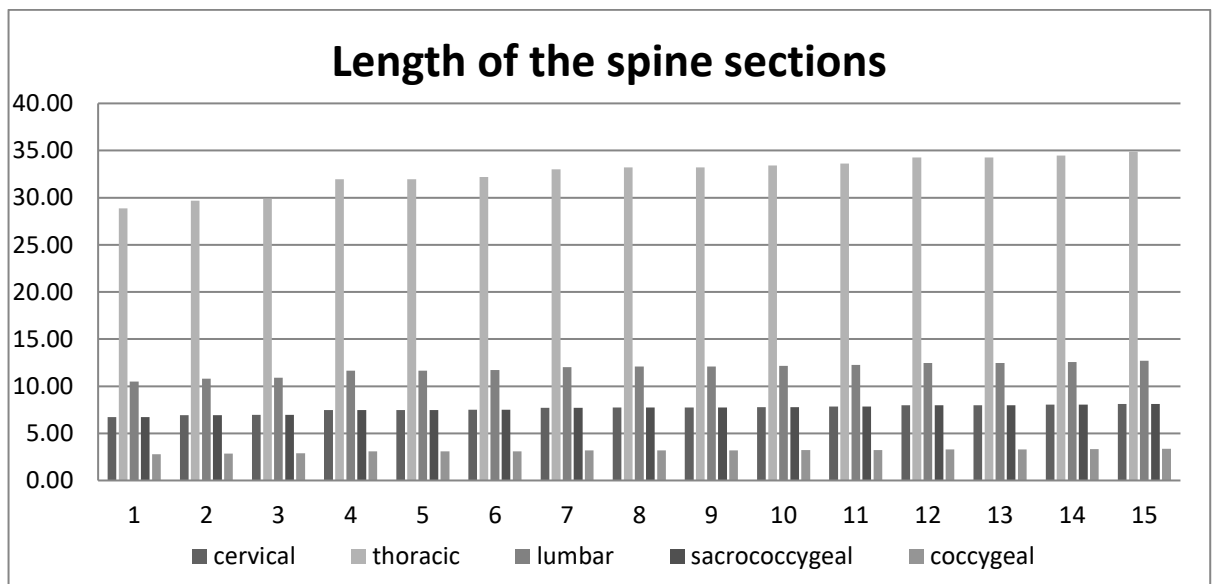


Fig.30.



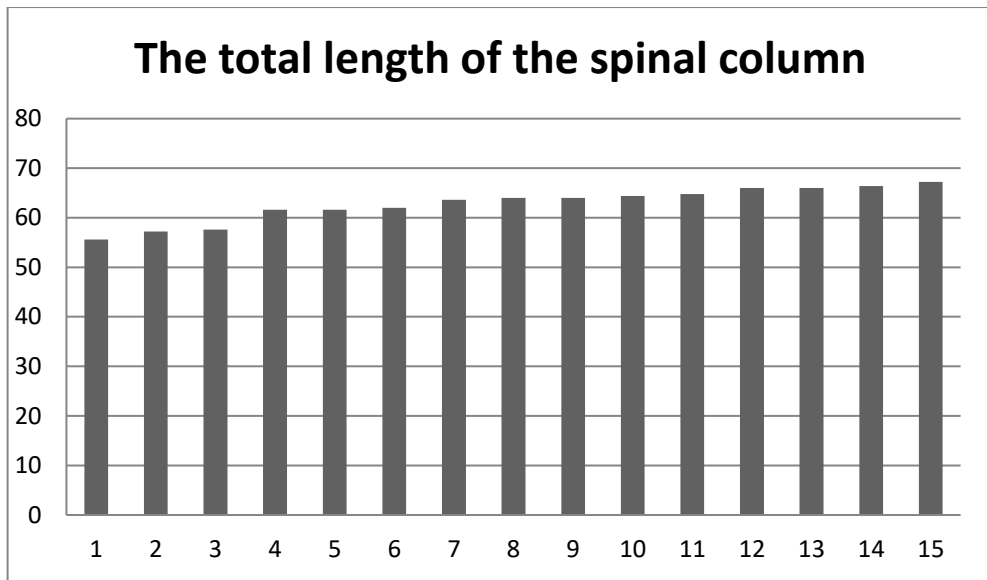


Fig.31

Studies have shown that the total length of the vertebral column of 15-year-old boys ranges from 58 cm to 71.2 cm, with an average of  $63.9 \text{ cm} \pm 4.3 \text{ cm}$ . The length of the cervical spine ranged from 7.02 cm to 8.62 cm, with an average of  $7.7 \pm 0.5 \text{ cm}$ . The length of the thoracic spine ranged from 30.10 cm to 36.95 cm, with an average of  $33.2 \pm 2.2 \text{ cm}$ . The length of the lumbar spine ranged from 10.96 cm to 13.46 cm, with an average of  $12.1 \pm 0.8 \text{ cm}$ . The length of the sacral spine ranged from 7.02 cm to 8.62 cm, with an average of  $7.7 \pm 0.5 \text{ cm}$ . The length of the coccygeal spine ranged from 2.90 to 3.56 cm, with an average of  $3.2 \pm 0.2 \text{ cm}$  (Fig.32).

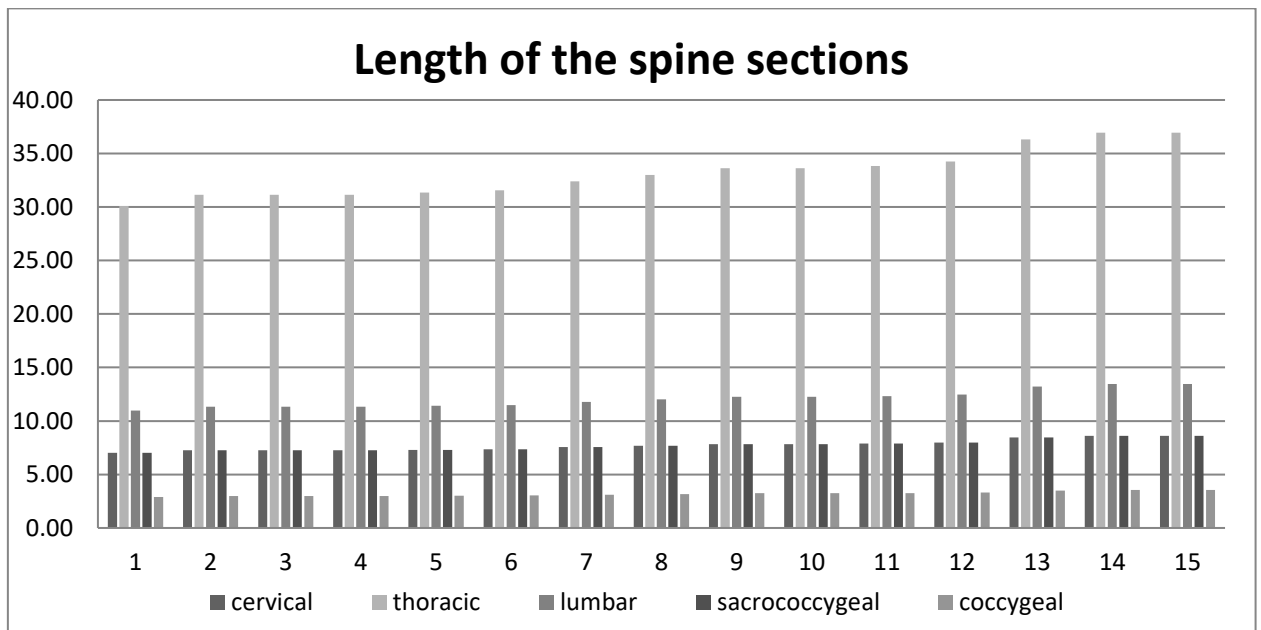


Fig.32.

The degree of curvature of the cervical spine - cervical lordosis in 15-year-old boys ranges from  $139.7^\circ$  to  $171.4^\circ$ , on average  $153.8 \pm 10.3^\circ$ . The degree of curvature of the thoracic spine - thoracic kyphosis ranges from  $139.4^\circ$  to  $171.1^\circ$ , on average  $153.5 \pm 10.3^\circ$ . The degree of curvature of the lumbar spine - lumbar lordosis ranges from  $139.2^\circ$  to  $170.9^\circ$ , on average  $153.4 \pm 10.3^\circ$ . The degree of curvature of the sacral spine - sacral kyphosis ranges from  $131.6^\circ$  to  $161.5^\circ$ , on average  $145.0 \pm 9.7^\circ$  (Fig.33. and Fig.34.).

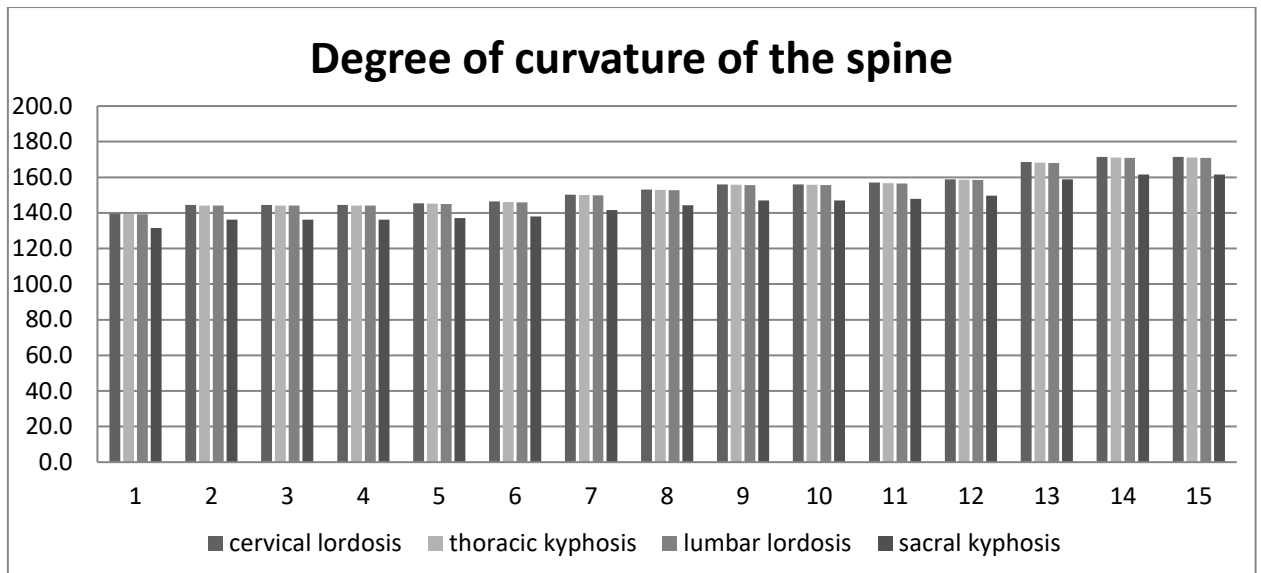


Fig.33.

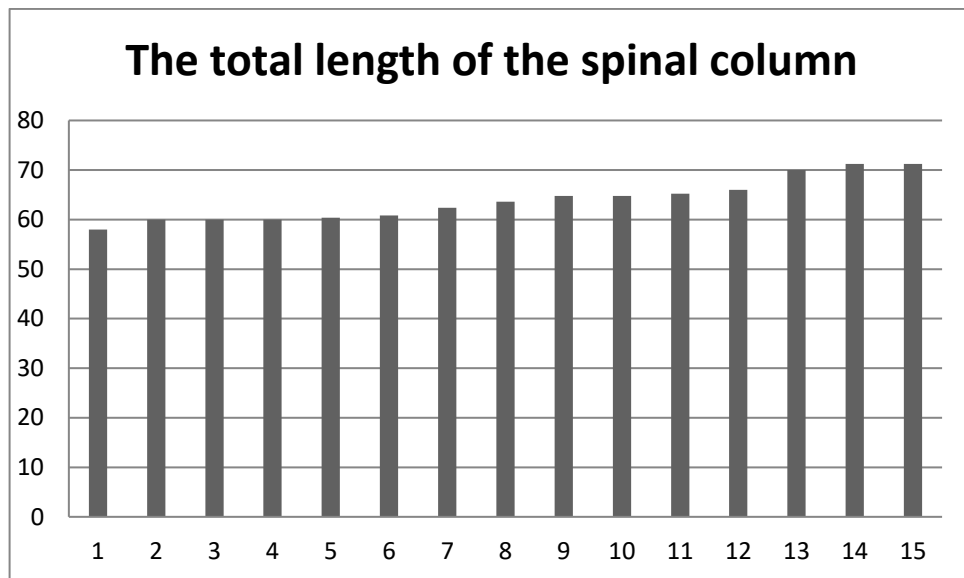


Fig.34.

Studies have shown that the total length of the vertebral column of 16-year-old boys ranges from 58.4 cm to 72.8 cm, with an average of  $65.7 \pm 3.9$  cm. The length of the cervical spine ranged from 7.07 cm to 8.81 cm, with an average of  $7.9 \pm 0.5$  cm. The length of the thoracic spine ranged from 30.31 cm to 37.78 cm, with an average of  $34.1 \pm 2.0$  cm. The length of the lumbar spine ranged from 11.04 cm to 13.76 cm, with an average of  $12.4 \pm 0.3$  cm. The length of the sacral spine ranged from 7.07 cm to 8.81 cm, with an average of  $7.9 \pm 0.5$  cm. The length of the coccygeal spine ranged from 2.92 to 3.64 cm, with an average of  $3.3 \pm 0.2$  cm (Fig.35.).

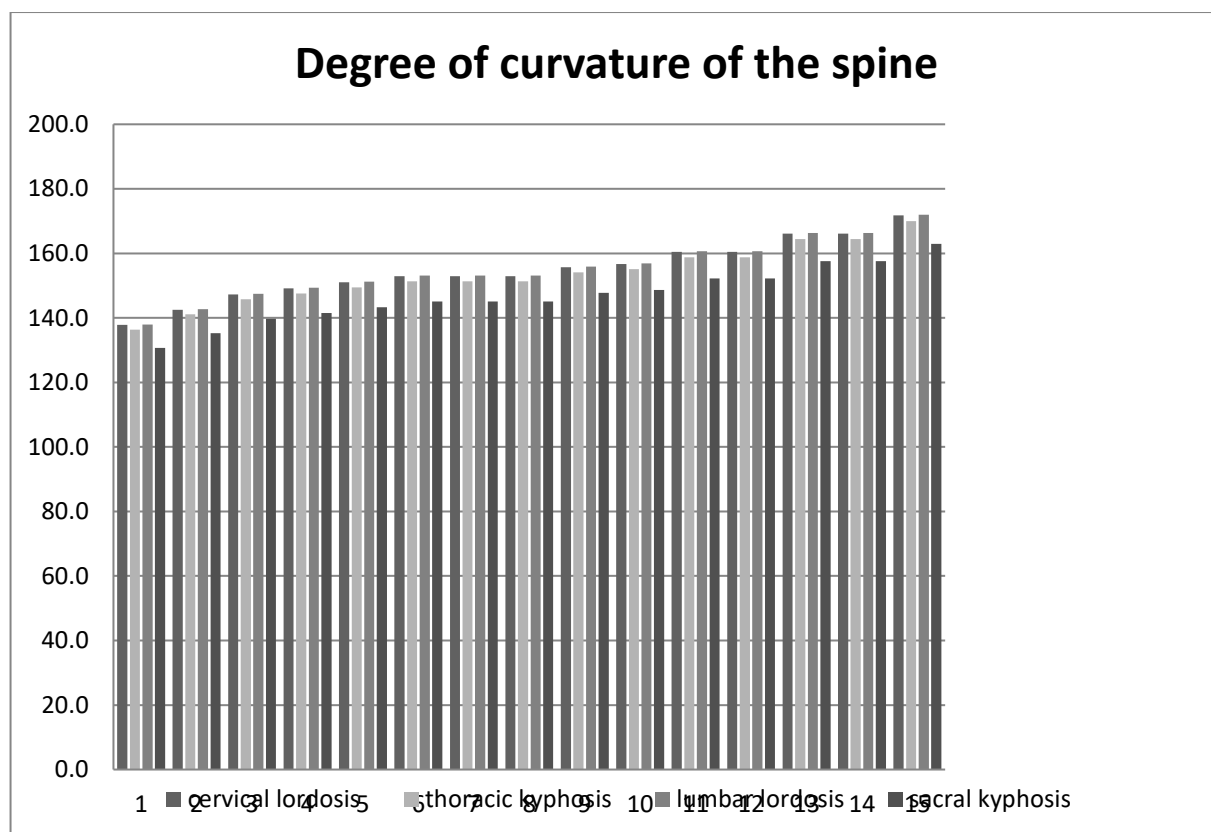


Fig.35.

The degree of curvature of the cervical spine - cervical lordosis in 16-year-old boys ranges from 137.8 ° to 171.8 °, on average  $154.9 \pm 9.1$  °. The degree of curvature of the thoracic spine - thoracic kyphosis ranges from 136.4 ° to 170.0 °, on average  $153.3 \pm 9.0$  °. The degree of curvature of the lumbar spine - lumbar lordosis ranges from 138.0 ° to 172.0 °, on average  $155.1 \pm 9.1$  °. The degree of curvature of the sacral spine - sacral kyphosis ranges from 130.7 ° to 163.0 °, on average  $147.0 \pm 8.7$  °.

### Conclusions

1. The total length of the spinal column in feboys aged 11 to 16 years increases by 1.19 times; in boys aged 11 to 16 years it increases by 1.16 times;
2. The size of the spinal column in boys aged 11 to 12 years increases by 1.00 times, at the age of 12 to 13 years it increases by 1.06 times, at the age of 13 to 14 years it increases by 1.04 times, at the age of 14 to 15 years it increases by 1.01 times, at the age of 15 to 16 years it increases by 1.028 times.
3. The size of the spinal column in boys aged 12 to 13 years and 13 to 14 years increases more intensively than in boys aged 11, 15 and 16 years. The spine increased the least at the age of 11 to 12 years.
4. The size of the spine in feboys at the age of 11 to 12 years increases by 1.04 times, at the age of 12 to 13 years it increases by 1.07 times, at the age of 13 to 14 years it increases by 1.02 times, at the age of 14 to 15 years it increases by 1.01 times, at the age of 15 to 16 years it increases by 1.028 times.
5. The size of the spine in feboys at the age of 11 to 12 years and 12 to 13 years increases more intensively than in feboys at the age of 14, 15 and 16 years. The spine increased the least at the age of 14 to 15 years.
6. Change in the angle of curvature of the spine in feboys aged 11 to 16 years in the cervical spine (cervical lordosis) - increases by 1.19 times. In the thoracic spine (thoracic kyphosis) increases by 1.15 times, in the lumbar spine (lumbar lordosis) increases by 1.19 times and in the sacral spine (sacral kyphosis) increases by 1.19 times.
7. Change in the angle of curvature of the spine in boys aged 11 to 16 years in the cervical spine (cervical lordosis) - increases by 1.14 times. In the thoracic spine (thoracic kyphosis) it increases by 1.13 times, in the lumbar spine (lumbar lordosis) it increases by 1.14 times, and in the sacral spine (sacral kyphosis) it increases by 1.15 times.

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