J Turk Spinal Surg 2023;34(3):113-117
DOI: 10.4274/jtss.galenos.2023.33042

NORMATIVE VALUES FOR CERVICAL AND LUMBAR RANGE OF MOTION IN HEALTHY YOUNG ADULTS

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ABSTRACT

Objective: The cervical and lumbar spines are the more mobile parts of the spinal column than the thoracic spine. Reference range of motion (ROM) measurements is one of the important clinical outcome measures used in patient assessment and follow-up of treatment efficacy. The aim of this study was to obtain normative values of cervical and lumbar ROM in young adults.

Materials and Methods: The sample comprised 300 healthy volunteers (198 female, 102 male, mean age: 21.4±1.9 years, range, 18-29 years). Cervical (C) and lumbar (L) ROM values were measured in three planes with a two-arm digital goniometer according to the American Academy of Orthopaedic Surgeons (AAOS) criteria. The mean ROM measurements were analyzed according to gender using the Mann-Whitney U test.

Results: Cervical ROM values were determined to be: cervical flexion 57.7±8.2°, extension 59.1±10.2°, right-left lateral flexion 42.1±7.9°-41.4±7.7°, and right-left rotation 71.1±10.5°-70.2±9.7°. There was no statistically significant difference between the genders with respect to the cervical ROM (p>0.05). The lumbar ROM values were determined to be lumbar flexion 69.9±14.5°, extension 40±10.2°, right-left lateral flexion 36.3±6.4°-36.2±6.6°, and right-left rotation 38.4±8.7°-38.6±9.4°. The lumbar flexion ROM values were statistically significantly higher in females than in males (p=0.043).

Conclusion: The flexion and extension angles of the lumbar spine in the sagittal plane were higher in females than in males, and there was no difference between the genders regarding all the other cervical and lumbar joint ROM values. These goniometrically measured cervical and lumbar ROM values were found to be generally similar to the widely used reference values of AAOS and Kendall McCreary. Further research is needed on the effects of individual differences such as physical activity or inactivity.

Keywords: Range of motion, cervical, lumbar, goniometer, spine

INTRODUCTION

The entire set of vertebrae which constitutes the spinal column typically comprises 33 bony vertebral segments, divided into five regions. These are seven cervical segments, twelve thoracic, five lumbar, five sacral, and four coccygeal segments[1,2]. The widest ranges of motion are in the cervical and lumbar segments, which can move in three planes.

The movements that occur in the spine are flexion and extension in the sagittal plane, axial rotation in the horizontal plane and lateral flexion in the frontal plane. Axial rotation occurs by sliding and rotation, while other movements occur by sliding in the intervertebral joints. The degree of movement of the spinal column varies in the cervical, thoracic, and lumbar regions because of the anatomic differences of the vertebrae at different levels. The thoracic region has less range of motion (ROM) than the other regions due to the rib cage, which is connected to the costae and sternum[1-3]. The greatest flexion and extension movements of the cervical spine occur between C5-C6, axial rotation movements occur between C1-C2 and lateral flexion movements occur between C4-C5[1,3,4].

In the lumbar spine, the greatest flexion and extension occur between L4-L5, the greatest lateral flexion between L2-L3, and the greatest axial rotation occurs between the L5-S1 vertebrae[5,6]. It is important for the spine to have normal ROM values in order to maintain daily life activities without limitations. At the same time, it is very important for a stable spine that the movement remains within normal limits. The movement provided by the active functioning of the muscles in the spine is limited by the facets, capsule, disc, anterior and posterior ligaments and stability is maintained[1,2].

Normal ROM measurements are one of the important clinical outcome measures used in patient assessment and follow-up of treatment efficacy and illness progression. However, there is great variation in the normal ROM values in the literature, which can be attributed to differences in study design, gender, age, cultural characteristics, physical activity and sports activities[1,7,8].

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The use of active or passive ROM measurements, correct stabilization and positioning of the participant during the measurement and the methods used for measurement may also lead to different results. Goniometers (universal, digital, electrical and fibreoptic) are the most commonly used devices for the ROM measurements. More sophisticated methods such as flexible ruler, inclinometer, Schober test, X-ray radiography, videofluoroscopy, ultrasonography or computerized analyses can also be used to determine ROM[7-10].

Currently, the American Academy of Orthopaedic Surgeons (AAOS) or Kendall values are used as reference for normal ROM values. To the best of our knowledge, no studies have been conducted to determine normative spinal ROM values in Turkey[9-12].

Due to the complex structure of the columna vertebralis and the occurrence of multiple movements at the same time (spinal coupling) and the limited movement in the thoracic region, normal ROM measurements of the spine are generally performed in the cervical and lumbar regions. Therefore, the aim of this study was to determine the normative values for range of movement of the cervical and lumbar regions of the spine in a Turkish population.

MATERIALS AND METHODS

This descriptive, cross-sectional study was performed according to the STROBE criteria. All the study procedures were in compliance with the Declaration of Helsinki and the study protocol was approved by the Bandırma Onyedi Eylül University Health Sciences Non-Interventional Research Ethics Committee (decision no: 2023-64, date: 13.04.2023). All participants were informed about the study and signed informed consent forms.

The study inclusion criteria were defined as age 18-30 years, good general health, and voluntary participation. Patients were excluded from the study if they had any orthopedic, neurological or rheumatic disease, any congenital deformity, had a history of spinal surgery, had experienced trauma or undergone surgery in the last 6 months, were suspected or definitely pregnant, or were using any neurological or psychiatric medication. The study included 300 healthy voluntary participants (198 female, 102 male) who were studying at Marmara University, Faculty of Health Sciences between April and May 2023. The ROM measurements were performed by a highly experienced physical therapist in a screened-off section of the physiotherapy practice laboratory.

Demographic information was recorded according to the statements of the participants. Height was measured using a wall-mounted Mesilife, Q100 height meter, and body weight using scales sensitive to 0.1 kg. The active ROM in all planes was evaluated using the measurement methods defined by the AAOS[10,11]. A two-arm digital goniometer (Baseline® Digital Absolute + Axis®) with a 360 degree dial was used to measure the ROM of the spine. The axis of rotation (Pivot) connecting the movable arms of the goniometer was placed on the axis of motion determined for the cervical and lumbar spine[8,10,13]. When the measurements were being taken, the participants were correctly and comfortably positioned and care was taken not to change the desired movement. For each of the movements, oral and visual explanations were given before the measurement. All the joints were positioned according to the anatomic position, which was then considered as the starting point of 0 degrees. All the joint movements that were within the 180° ROM from the starting position of 0 degrees were evaluated[9,10]. When taking the measurements, care was taken to ensure that the goniometer was not in contact with the body parts in order not to interfere with the movement. Each measurement was repeated three times and repetitions with no more than 5% difference between them were recorded as ROM.

Range of Motion Measurements

All the cervical spinal ROM measurements were taken with the subject seated upright on a stable stool. For the measurement of cervical flexion and extension ROM, the subject was seated sideways to the physiotherapist. The pivot point was placed on the lateral projection of the acromion, the fixed arm of the goniometer was kept parallel to the ground, and the moving arm of the goniometer followed the midline of the tragus during movement[10-14].

During the cervical lateral flexion ROM measurement, the physiotherapist sat behind the subject. The pivot of the goniometer was placed on the 7th cervical vertebral spinous process (C7), the fixed arm was kept parallel to the ground, and the moving arm followed the spinal protrusions of cervical spine. If the cervical spinous processes were not visible, the moving arm of the goniometer followed the midline of the cervical spine during the movement. Care was taken not to rotate the head while taking the measurement[10-14].

The physiotherapist stood behind the seated subject during the cervical rotation ROM measurements. The pivot of the goniometer was placed on the superior midpoint of the head, the fixed arm of the goniometer was placed parallel to the opposite shoulder to be rotated, and the moving arm was placed to follow the tip of the nose[10-14].

During the flexion and extension measurements of the lumbar spine, the researcher stood lateral to the participant. The pivot of the goniometer was placed on the hip at the lateral projection of the lumbosacral joint. The fixed arm was held perpendicular to the ground and the moving arm followed the lateral projection of the trunk towards the axilla. Care was taken to ensure that there was no movement from the hip joint during the measurement.

During the lateral flexion measurement, the physiotherapist stood behind the subject. The pivot point of the goniometer was placed at the midpoint of the lumbosacral joint, the fixed arm of the goniometer was kept parallel to the spina iliaca posterior superior and parallel to the ground, and the moving arm followed the spinal processes of the lumbar vertebrae

towards C7. Care was taken to avoid rotation, flexion and extension of the trunk while taking the measurements.
During the lumbar rotation ROM measurement, the physiotherapist stood behind the subject seated on the stool. The pivot point was placed in the centre of the head, the fixed arm of the goniometer was kept parallel to the ground and the moving arm of the goniometer was followed parallel to the acromion opposite to the direction of rotation. In the right and left rotation measurements, care was taken to ensure that the subject did not rotate the cranium.

Statistical Analysis

The data obtained in the study were analyzed statistically using IBM SPSS Statistics vn. 23 software (Statistical Package for Social Sciences). Numerical data were expressed as mean and standard deviation values, and numerical data as frequency and percentages. Conformity of the data to normal distribution was evaluated with the Kolmogorov-Smirnov test. The mean ROM measurements were analyzed according to gender using the Mann-Whitney U test. The minimum number of samples to be included in the study at the 5% margin of error and 90% confidence level is 273 participants.

RESULTS

Evaluation was made of 300 healthy volunteers with a mean age of 21.4±1.9 years (range: 18-29 years), comprising 198 females with a mean age of 21.2±1.8 years and 102 males with a mean age of 21.7±2.2 years.
For the whole study sample, the mean height was 168.7±9 cm and the mean weight was 62.9±12.9 kg, recorded as 163±5.8 cm and 56.4±8.2 kg for females, and 178±6.2 cm and 75.5±10.7 kg for males. The mean body mass index (BMI) was 20.9±2.7 (16.1-31.2) for females and 23.8±3.2 (17.2-35.9) for males (Table 1). Right-side dominance was determined in 296 subjects, and left-side dominance in 4. The cervical and lumbar ROM measurements of the participants are presented in Table 2. The cervical ROM values of female and male participants are presented in Figure 1 and the lumbar ROM values are presented in Figure 2. The lumbar flexion ROM values were determined to be statistically significantly higher in females than in males (p=0.043). No significant difference was determined between the genders in respecct of the cervical ROM values (p>0.05).

Table 1. Demographic variables

Gender	Female (n=198)	Male (n=102)
Age	21.2±1.8	21.7±2.2
Height (cm)	163±5.8	178±6.2
Weight (kg)	56.4±8.2	75.5±10.7
BMI (kg/m^2)	20.9±2.7	23.8±3.2

BMI: Body mass index

Table 2. Mean cervical and lumbar range of motion values

Range of motion (°)		Mean ± SD Median (min-max)
Cervical	Flexion	57.7±8.2 58 (34-78)
	Extension	59.1±10.2 60 (25-82)
	Right lateral flexion	42.1±7.9 42 (20-78)
	Left lateral flexion	41.4±7.7 41 (19-73)
	Right rotation	71.1±10.5 72 (43-95)
	Left rotation	70.2±9.7 70.5 (42-90)
Lumbar	Flexion	69.9±14.5 70.5 (38-120)
	Extension	40±10.2 40 (15-71)
	Right lateral flexion	36.3±6.4 36 (17-60)
	Left lateral flexion	36.2±6.6 36 (16-58)
	Right rotation	38.4±8.7 40 (12-60)
	Left rotation	38.6±9.4 39 (10-69)

SD: Standard deviation, Min-max: Minimum-maximum

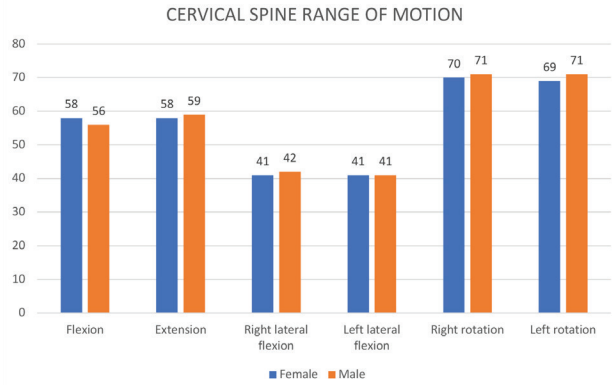

Figure 1. Cervical range of motion values for males and females

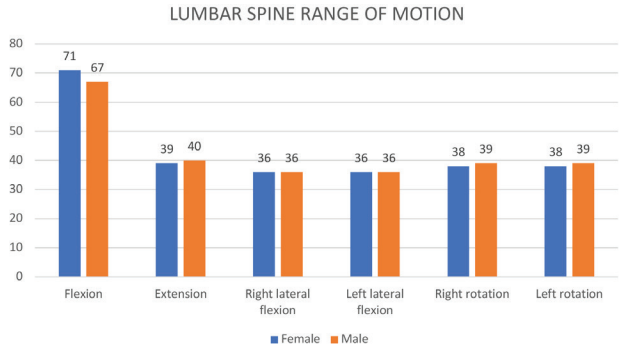

Figure 2. Lumbar range of motion values for males and females

DISCUSSION

The aim of this study was to investigate the normative cervical and lumbar spinal ROM values in the sagittal, frontal and transverse planes, using a digital goniometer on 300 healthy individuals. The results showed that the cervical and lumbar ROM values obtained appeared to be similar to the widely accepted normative references of the AAOS and Kendall et al.[9]. Assessment of cervical and lumbar ROM is an essential diagnostic tool used by healthcare providers to evaluate the mobility and function of the neck and lower back. It involves measuring the degree of movement in different directions, including flexion, extension, lateral flexion, and rotation. Accurate assessment of the cervical and lumbar ROM is important to be able to detect musculoskeletal abnormalities, such as stiffness, pain, and mobility reduction. It is also a method that is used to help determine the effects on spinal mobility of spinal diseases such as wiplash injuries, disc herniation, degenerative joint diseases, spinal stenosis and spondylolisthesis. Moreover, the assessment of ROM is critical in developing an appropriate treatment plan, monitoring the progression of therapy, and determining the effectiveness of interventions. Therefore, precise and consistent measurement of cervical and lumbar ROM is vital for effective patient care and optimal treatment outcomes[7,15-20]. To evaluate the ROM of the cervical and lumbar region, a total of 12 measurements were performed with a digital goniometer, including flexion, extension, lateral flexion to the right and left, and axial rotation to the right and left sides.

Normal cervical flexion-extension ROM values are stated as 45-45 degrees according to the AAOS and 65-50 degrees according to Kendall et al.[9,10]. In this study, the mean cervical flexion-extension ROM was found to be 57-59 degrees (range, 34-78). Thus the cervical extension values obtained in this study were higher than those of both reference sources. In a study in Pakistan of 19 healthy subjects with an average age of 21 years, Farooq et al.[21] determined the mean cervical flexion value to be 46 degrees and cervical extension 47 degrees.

The normative value for cervical lateral flexion is 45 degrees according to the AAOS and 40 degrees according to Kendall et al.[9,10]. In the present study, the right and left lateral flexion values of 42 and 41 degrees were found to be similar to the reference values. Farooq et al.[21] reported mean lateral flexion ROM values of 33 degrees for the right side and 34 degrees for the left side.

Normative cervical rotation values are stated as 60 degrees according to the AAOS and 55 degrees according to Kendall et al.[9,10]. In the present study, the right and left side rotation ROM values were found to be 71 and 70 degrees respectively, slightly higher than the reference values. The mean cervical rotation values were found to be 65 and 66 in the study by Farooq et al.[21]. Wilson-Smith et al.[22] stated cervical lateral flexion to be in the range of 26 to 35 degrees. The mean lumbar flexion ROM value is stated as 80 degrees according to the AAOS and 90 degrees according to Kendall et al.[9,10]. In the present study, this value was found to be 70 degrees (range, 38-120 degrees). In a study by Moromizato et al.[23] in Japan of 78 healthy subjects with a similar average age to the subjects in the present study, the trunk flexion angle was found to be 35 degrees. Chertman et al.[24] evaluated lumbar ROM with a goniometer in 100 athletes and non-athletes aged between 14 and 45 years. Mean lumbar flexion was reported to be 116 degrees and the mean flexion value was seen to be higher in athletes.

The mean values for lumbar extension ROM are stated as 25 degrees according to the AAOS and 35 degrees according to Kendall et al.[9,10]. The results of the present study showed a value of 40 degrees (range, 15-71°). In a study by Moromizato et al. [23], the mean trunk extension was 28 degrees. Chertman et al.[24] reported mean lumbar extension ROM of 37.6 degrees and stated that there was no difference in trunk extension values between athletes and non-athletes. The mean values of lumbar right and left lateral flexion ROM are stated as 35 degrees according to the AAOS and 40 degrees according to Kendall et al.[9,10]. In the present study results, it was found to be 36 degrees, similar to the reference values. In the study by Moromizato et al.[23], the mean trunk extension was specified as 23 degrees.

Axial rotation normal ROM values for the lumbar region are stated as 45 degrees by the AAOS and 35 degrees by Kendall et al.[9,10]. The current study value was found to be 38 degrees, similar to these reference values. In the study by Moromizato et al.[23], this value was determined to be 48 degrees.

The lumbar flexion ROM values of the current study female subjects were statistically higher than those of males. Moromizato et al.[23] also stated that trunk flexion and trunk rotation ROM values were higher in females in a series of 42 male and 36 female participants. Most studies in the literature are related to ROM of the extremities, and there are very few studies that have investigated spine movements. The strong aspects of the current study can be considered to be the fact that more participants were included in this study than in other studies evaluating trunk ROM and that the measurements were repeated three times and the average value was recorded for analysis.

Study Limitations

There were some limitations to this study, primarily the lack of evaluation of different age groups. There was also no evaluation of the flexibility and sporting activities of the participants. Future studies should be conducted with a larger sample and comparisons made according to different ages, BMI values, flexibility, sitting time and physical activity levels. As there was no radiological evaluation of the spine in this study, it was not known whether there were any possible spinal deformities that may have limited the ROM of the joint. Generalised joint hypermobility or connective tissue diseases are also factors limiting joint ROM, and these were not included in the study exclusion criteria.

CONCLUSION

From the results of this study it was seen that the flexion and extension angles of the lumbar spine in the sagittal plane were higher in females than in males, and there was no other difference determined between the genders in respect of the other cervical and lumbar joint ROM values. Cervical and lumbar spine ROM values may vary in healthy individuals depending on various factors such as physical activity level, lifestyle habits, occupational and sporting activities, and ligamentous laxity levels. Further research is needed to examine the effects of personal differences on joint ROM.

Ethics

Ethics Committee Approval: This prospective cross-sectional study was approved by Bandırma Onyedi Eylül University Health Sciences Non-Interventional Research Ethics Review Board with approval number: 2023-64, approval date: 13/04/2023.
Informed consent: Written informed consent was obtained from all participants.
Peer review: Externally and internally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: A.A., T.K.Ç., B.A., Concept: A.A., T.K.Ç., B.A., Design: A.A., T.K.Ç., B.A., Data Collection or Processing: T.K.Ç., Analysis or Interpretation: A.A., T.K.Ç., B.A., Literature Search: A.A., T.K.Ç., B.A., Writing: A.A., T.K.Ç., B.A.
Conflict of Interest: The authors have no conflicts of interest to declare.
Financial Disclosure: The authors declared that this study received no financial support.

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