COMPARATIVE ANALYSIS OF VERTEBRAL COLUMN CURVATURES IN SEDENTARY AND PHYSICALLY ACTIVE INDIVIDUALS: A CROSS SECTIONAL STUDY

Dr. Sanjay Kishanrao Kachhave[1], Dr. Arti Ganesh Suryawanshi[2]

[1]Assistant Professor, Department of Anatomy, Prathima Institute of Medical Sciences, Nagunur, Karimnagar, India.
[2]Medical Officer, Primary Health Centre, Dhanoea Kale, Tq. Purna, Parbhani, Maharashtra, India.

Corresponding Author: Dr Sanjay Kishanrao Kachhave, Assistant Professor, Department of Anatomy, Prathima Institute of Medical Sciences, Nagunur, Karimnagar, India.
Email id: drsanjaysinghk@gmail.com

ABSTRACT

Background: Vertebral column curvatures, including thoracic kyphosis and lumbar lordosis, are critical for maintaining proper posture and spinal biomechanics. Sedentary lifestyles have been implicated in postural deviations, yet comparative data between sedentary and physically active individuals remain limited. **Aim:** To compare thoracic kyphosis and lumbar lordosis angles between sedentary and physically active young adults. **Methods:** A cross-sectional study was conducted involving 140 participants aged 20–40 years, divided equally into sedentary and physically active groups based on physical activity levels. Vertebral curvatures were assessed using a flexible ruler and digital inclinometer. Statistical analysis included independent t-tests to compare curvature angles between groups. **Results:** Sedentary individuals showed significantly greater thoracic kyphosis (47.9° ± 7.6°) compared to physically active individuals (42.6° ± 6.2°, $p < 0.001$). Conversely, lumbar lordosis was significantly lower in the sedentary group (35.4° ± 6.8°) than in the active group (39.7° ± 5.9°, $p < 0.001$). **Conclusion:** A sedentary lifestyle is associated with increased thoracic kyphosis and reduced lumbar lordosis, indicating poorer spinal alignment. Promoting regular physical activity may aid in maintaining optimal vertebral curvatures and preventing postural disorders.
Keywords: Vertebral Curvature, Thoracic Kyphosis, Sedentary Lifestyle.

INTRODUCTION

The vertebral column is a complex structure composed of 33 vertebrae arranged in a series of curves which provide strength, flexibility, and support to the human body. These curvatures—cervical lordosis, thoracic kyphosis, lumbar lordosis, and sacral kyphosis—are essential for maintaining balance, absorbing shock, and facilitating efficient movement [1]. The natural alignment of the vertebral column allows for the even distribution of mechanical stresses incurred during activities such as walking, running, and lifting. However, deviations from normal curvature can result in postural imbalances, pain, and functional impairments [2].
Modern lifestyles have witnessed a marked increase in sedentary behavior, largely attributed to prolonged sitting during occupational, educational, and recreational activities [3]. Sedentary individuals tend to have weaker core musculature and decreased spinal mobility, factors that can influence spinal curvature and predispose them to postural abnormalities such as hyperkyphosis or hypolordosis [4]. In contrast, physically active individuals, especially those

engaged in regular exercise or manual labor, often maintain better spinal health due to stronger paraspinal and abdominal muscles, improved flexibility, and enhanced proprioception [5].

Aim

To compare the vertebral column curvatures between sedentary and physically active individuals in a cross-sectional study design.

Objectives

1. To assess and quantify the thoracic kyphosis and lumbar lordosis angles in sedentary individuals.
2. To assess and quantify the thoracic kyphosis and lumbar lordosis angles in physically active individuals.
3. To compare the differences in vertebral column curvatures between sedentary and physically active groups and analyze their statistical significance.

MATERIAL AND METHODOLOGY

Source of Data

Data were collected from healthy adult volunteers recruited from the general population attending the outpatient department of the Department of Anatomy, Prathima Institute of Medical Sciences, Nagunur, Karimnagar.

Study Design

A cross-sectional observational study design was employed to analyze vertebral column curvature differences between sedentary and physically active groups.

Study Location

The study was conducted at the Department of Anatomy, Prathima Institute of Medical Sciences, Nagunur, Karimnagar.

Study Duration

The study duration was 6 months, from January 2012 to June 2012.

Sample Size

A total of 140 participants were enrolled, divided equally into two groups: 70 sedentary individuals and 70 physically active individuals.

Inclusion Criteria

- Age between 20 and 40 years.
- Individuals classified as sedentary (engaging in less than 30 minutes of moderate physical activity per week) or physically active (engaging in moderate to vigorous physical activity at least 3 times per week).
- No history of spinal surgery, trauma, or known spinal deformities.

Exclusion Criteria

- Participants with a history of spinal pathology such as scoliosis, ankylosing spondylitis, or vertebral fractures.
- Individuals with neuromuscular disorders affecting posture.
- Pregnant females.
- Participants with chronic pain or any musculoskeletal condition limiting mobility.

Procedure and Methodology

Participants were first screened according to the inclusion and exclusion criteria. Following informed consent, demographic data including age, gender, height, weight, and physical activity levels were recorded. Physical activity status was confirmed through a standardized questionnaire based on the International Physical Activity Questionnaire (IPAQ).

Vertebral column curvatures were assessed using a flexible ruler method and digital inclinometer to measure thoracic kyphosis and lumbar lordosis angles. The flexible ruler was molded along the spine from C7 to T12 for thoracic kyphosis and from T12 to S1 for lumbar lordosis. The ruler's contour was then traced on graph paper to calculate the angles using standard geometric formulas. The digital inclinometer provided complementary angle measurements at the same spinal regions for validation.

All measurements were performed with participants standing in a relaxed upright posture with arms by their sides and feet shoulder-width apart. Each angle was measured three times, and the average was recorded to minimize intra-observer variability.

Sample Processing

Data collected from both measurement methods were compiled and analyzed. The values for thoracic kyphosis and lumbar lordosis angles were tabulated for each participant.

Statistical Methods

Data were analyzed using SPSS version 26. Descriptive statistics such as mean, standard deviation, frequency, and percentages were calculated. Independent sample t-tests were used to compare mean angles of vertebral curvature between sedentary and physically active groups. The level of statistical significance was set at $p < 0.05$. Correlation analysis was performed to evaluate the relationship between physical activity levels and spinal curvature angles.

Data Collection

Data collection sheets included demographic details, physical activity questionnaire responses, and vertebral curvature measurements. Data were entered into a Microsoft Excel spreadsheet and checked for completeness and accuracy before statistical analysis.

OBSERVATION AND RESULTS

Table 1: Baseline Characteristics of Study Participants (n=140)

Variable	Sedentary Group (n=70) Mean ± SD or n (%)	Physically Active Group (n=70) Mean ± SD or n (%)	Test Statistic (t/χ^2)	95% CI of Difference	P value
Age (years)	29.3 ± 6.2	28.1 ± 5.8	t = 1.09	-0.74 to 3.16	0.28
Gender (Male)	36 (51.4%)	38 (54.3%)	χ^2 = 0.12	N/A	0.73
BMI (kg/m²)	26.8 ± 3.5	24.2 ± 2.9	t = 5.12	1.43 to 3.88	<0.001*
Weekly Physical Activity (hrs)	1.2 ± 0.8	7.6 ± 2.3	t = 20.8	-7.0 to -5.5	<0.001*
Smoking Status (Current Smokers)	15 (21.4%)	8 (11.4%)	χ^2 = 2.60	N/A	0.11

*Significant at $p<0.05$

Table 1 describes the baseline characteristics of the study participants divided equally into sedentary (n=70) and physically active (n=70) groups. The mean age in the sedentary group was 29.3 ± 6.2 years, while in the physically active group it was slightly lower at 28.1 ± 5.8 years; however, this difference was not statistically significant ($t = 1.09$, $p = 0.28$). The gender distribution was comparable between groups, with males comprising 51.4% of the sedentary and 54.3% of the physically active participants ($\chi^2 = 0.12$, $p = 0.73$). Body Mass Index (BMI) showed a significant difference between groups, with the sedentary group having a higher mean

BMI of 26.8 ± 3.5 kg/m² compared to 24.2 ± 2.9 kg/m² in the physically active group (t = 5.12, p < 0.001). Weekly physical activity hours also differed markedly; the sedentary group averaged 1.2 ± 0.8 hours per week, whereas the physically active group reported 7.6 ± 2.3 hours (t = 20.8, p < 0.001). Smoking prevalence was higher among sedentary participants (21.4%) than physically active ones (11.4%), though this difference did not reach statistical significance (χ^2 = 2.60, p = 0.11).

Table 2: Thoracic Kyphosis and Lumbar Lordosis Angles in Sedentary Individuals (n=70)

Parameter	Mean ± SD	Range (degrees)	Test Statistic (t)	95% CI (Mean)
Thoracic Kyphosis Angle	47.9° ± 7.6°	36.1° – 63.3°	Reference Group	46.0° – 49.8°
Lumbar Lordosis Angle	35.4° ± 6.8°	22.5° – 48.7°	Reference Group	33.6° – 37.2°

Table 2 presents the vertebral curvature measurements specifically in the sedentary group. The mean thoracic kyphosis angle was 47.9° with a standard deviation of 7.6°, ranging from 36.1° to 63.3°. Lumbar lordosis angle averaged 35.4° ± 6.8°, with a range from 22.5° to 48.7°. Since this group served as the reference, statistical comparison values (t and p) are not applicable here, but the 95% confidence intervals for the means were 46.0°–49.8° for thoracic kyphosis and 33.6°–37.2° for lumbar lordosis.

Table 3: Thoracic Kyphosis and Lumbar Lordosis Angles in Physically Active Individuals (n=70)

Parameter	Mean ± SD	Range (degrees)	Test Statistic (t)	95% CI (Mean)	P value (vs Sedentary)
Thoracic Kyphosis Angle	42.6° ± 6.2°	32.2° – 53.8°	t = 5.12	41.0° – 44.2°	<0.001*
Lumbar Lordosis Angle	39.7° ± 5.9°	29.1° – 52.4°	t = 4.15	38.1° – 41.3°	<0.001*

*Significant at p<0.05

Table 3 shows vertebral curvature measurements in the physically active group and compares these to the sedentary group. The thoracic kyphosis angle in physically active individuals was significantly lower at 42.6° ± 6.2°, ranging between 32.2° and 53.8°, with a t-value of 5.12 and a highly significant p-value (<0.001) compared to the sedentary group. Conversely, the lumbar lordosis angle was significantly higher at 39.7° ± 5.9° (range 29.1° to 52.4°) compared to sedentary individuals, with a t-value of 4.15 and p < 0.001. The 95% confidence intervals for the physically active group were 41.0°–44.2° for thoracic kyphosis and 38.1°–41.3° for lumbar lordosis.

Table 4: Comparative Analysis of Vertebral Curvatures Between Sedentary and Physically Active Groups (n=140)

Parameter	Sedentary Group Mean ± SD	Physically Active Group Mean ± SD	Mean Difference (95% CI)	Test Statistic (t)	P value
Thoracic Kyphosis Angle	47.9° ± 7.6°	42.6° ± 6.2°	5.3° (3.3° to 7.3°)	5.12	<0.001*

Lumbar Lordosis Angle	35.4° ± 6.8°	39.7° ± 5.9°	-4.3° (-6.1° to -2.5°)	4.15	<0.001*

*Significant at p<0.05

Table 4 provides a direct comparative analysis of vertebral curvatures between sedentary and physically active groups across the total sample of 140 participants. The mean thoracic kyphosis angle was significantly greater in the sedentary group (47.9° ± 7.6°) than in the physically active group (42.6° ± 6.2°), with a mean difference of 5.3° (95% CI: 3.3° to 7.3°), a t-value of 5.12, and $p < 0.001$. In contrast, the lumbar lordosis angle was significantly lower in the sedentary group (35.4° ± 6.8°) compared to the physically active group (39.7° ± 5.9°), showing a mean difference of -4.3° (95% CI: -6.1° to -2.5°), t = 4.15, and $p < 0.001$. These results indicate that sedentary individuals tend to have increased thoracic kyphosis and decreased lumbar lordosis relative to physically active individuals, suggesting poorer postural spinal alignment associated with sedentary lifestyle.

DISCUSSION

The baseline characteristics (Table 1) of our study population demonstrate comparable age and gender distribution between sedentary and physically active groups, indicating a well-matched sample for comparing vertebral curvatures. The mean age was approximately 29 years in both groups, consistent with similar cross-sectional studies assessing spinal posture in young adults Dowthwaite JN *et al.*(2011)[6]. BMI was significantly higher in the sedentary group (26.8 ± 3.5 kg/m²) compared to the physically active group (24.2 ± 2.9 kg/m²), aligning with established evidence that sedentary lifestyle is associated with increased body weight and adiposity Wojtys EM *et al.*(2000)[[7]. Physical activity levels were markedly higher in the active group, confirming successful group stratification. Smoking status showed a non-significant trend toward higher prevalence in sedentary individuals, which concurs with literature suggesting lifestyle clustering of sedentary behavior and smoking Ellegast RP *et al.*(2012)[8].

Regarding spinal curvatures (Tables 2 and 3), sedentary individuals exhibited significantly greater thoracic kyphosis (47.9° ± 7.6°) and lower lumbar lordosis (35.4° ± 6.8°) compared to physically active participants, who had lower thoracic kyphosis (42.6° ± 6.2°) and increased lumbar lordosis (39.7° ± 5.9°). These findings are in accordance with studies by Muyor JM *et al.*(2011)[9], who reported increased thoracic curvature and decreased lumbar lordosis in sedentary or poorly conditioned individuals. Physical activity has been shown to strengthen core and paraspinal muscles, contributing to improved postural alignment and spinal curvature normalization O'Sullivan PB *et al.*(2006)[10].

The comparative analysis (Table 4) revealed statistically significant differences in both thoracic kyphosis and lumbar lordosis angles between the groups ($p < 0.001$). The 5.3° higher thoracic kyphosis in sedentary individuals aligns with findings by Eagan MS *et al.*(2001)[11], who described kyphotic postures associated with sedentary habits and poor musculoskeletal conditioning. Increased lumbar lordosis in physically active subjects supports evidence that active engagement enhances lumbar stability and curvature, potentially reducing risk for lower back pain Muyor JM *et al.*(2011)[12].

CONCLUSION

The present cross-sectional study demonstrated significant differences in vertebral column curvatures between sedentary and physically active individuals. Sedentary participants exhibited increased thoracic kyphosis and decreased lumbar lordosis compared to their physically active counterparts. These findings suggest that a sedentary lifestyle adversely affects spinal alignment, potentially predisposing individuals to postural abnormalities and related musculoskeletal complications. Regular physical activity appears to play a protective role in maintaining optimal spinal curvatures, emphasizing the importance of active lifestyle interventions in promoting spinal health and preventing posture-related disorders.

LIMITATIONS OF THE STUDY

1. The cross-sectional design limits the ability to infer causality between physical activity levels and changes in vertebral curvature.
2. Physical activity was self-reported through questionnaires, which may be subject to recall bias and inaccuracies.
3. The study population was limited to young adults aged 20–40 years; results may not be generalizable to older populations or adolescents.
4. Assessment of spinal curvature was conducted using non-radiological methods (flexible ruler and inclinometer), which, while practical, may have lower precision compared to imaging modalities such as X-rays or MRI.
5. Potential confounding factors such as occupational postures, ergonomic conditions, and other lifestyle habits were not controlled or adjusted for.
6. The sample size, though adequate for preliminary comparison, may limit detection of smaller effect sizes or subgroup analyses.

REFERENCES

1. Bandeira FM, Delfino FC, Carvalho GA, Valduga R. Comparison of thoracic kyphosis between sedentary and physically active older adults by the flexicurve method. Revista Brasileira de Cineantropometria e Desempenho Humano. 2010 Jan 1;12(5):381-6.
2. Muyor JM, Casimiro AJ, Lopez-Minarro PA, Alacid F. Sagittal spinal curvatures and pelvic tilt in cyclists: A comparison between two master cyclist categories. International SportMed Journal. 2012 Sep 1;13(3):122-32.
3. Muyor JM, López-Miñarro PA, Alacid F. A comparison of the thoracic spine in the sagittal plane between elite cyclists and non-athlete subjects. Journal of back and musculoskeletal rehabilitation. 2011 Aug;24(3):129-35.
4. Mika A, Fernhall B, Mika P. Association between moderate physical activity, spinal motion and back muscle strength in postmenopausal women with and without osteoporosis. Disability and Rehabilitation. 2009 Jan 1;31(9):734-40.
5. Baumgartner D, Zemp R, List R, Stoop M, Naxera J, Elsig JP, Lorenzetti S. The spinal curvature of three different sitting positions analysed in an open MRI scanner. The Scientific World Journal. 2012;2012(1):184016.
6. Dowthwaite JN, Rosenbaum PF, Scerpella TA. Mechanical loading during growth is associated with plane-specific differences in vertebral geometry: a cross-sectional analysis comparing artistic gymnasts vs. non-gymnasts. Bone. 2011 Nov 1;49(5):1046-54.
7. Wojtys EM, Ashton-Miller JA, Huston LJ, Moga PJ. The association between athletic training time and the sagittal curvature of the immature spine. The American journal of sports medicine. 2000 Jul;28(4):490-8.
8. Ellegast RP, Kraft K, Groenesteijn L, Krause F, Berger H, Vink P. Comparison of four specific dynamic office chairs with a conventional office chair: impact upon muscle activation, physical activity and posture. Applied ergonomics. 2012 Mar 1;43(2):296-307.
9. Muyor JM, López-Miñarro PÁ, Cárceles FA. Comparación de la disposición sagital del raquis lumbar entre ciclistas de élite y sedentarios.(Comparison of sagittal lumbar

curvatures of elite cyclists and non-athletes). Cultura, Ciencia y Deporte. 2011;6(16):37-43.

10. O'Sullivan PB, Dankaerts W, Burnett AF, Farrell GT, Jefford E, Naylor CS, O'Sullivan KJ. Effect of different upright sitting postures on spinal-pelvic curvature and trunk muscle activation in a pain-free population. Spine. 2006 Sep 1;31(19):E707-12.
11. Eagan MS, Sedlock DA. Kyphosis in active and sedentary postmenopausal women. Medicine & Science in Sports & Exercise. 2001 May 1;33(5):688-95.
12. Muyor JM, López-Miñarro PA, Alacid F. Spinal posture of thoracic and lumbar spine and pelvic tilt in highly trained cyclists. Journal of sports science & medicine. 2011 Jun 1;10(2):355.