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Assessment of thoracic and lumbar curvature among physical education trainees of Mangalore University

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Abstract

Objective: The purpose of this study was to assess thoracic and lumbar spinal curvatures among male physical education trainees at Mangalore University using the Idiag M360 Spine Mouse. The study aimed to identify postural alignment in standing, flexion, and extension positions, and to analyze variations based on body mass index (BMI) and type of sport played.

Methods: A total of 30 male physical education trainees, aged 18-25 years, participated in the study. Height, weight, and BMI were recorded using standard tools. Spinal curvatures were measured using the Idiag M360 Spine Mouse in three sagittal postural conditions: upright standing, forward flexion, and extension. Data were grouped and analyzed based on sports background (football, hockey, volleyball, others) and BMI categories. Descriptive statistics (mean and standard deviation) were used to compare values against normative references. Results: The average thoracic curvature in upright standing was 32.17°, within the normal kyphotic range (20°-45°). Lumbar curvature averaged -19.85°, slightly below the normative range for lordosis. Pelvic tilt was 20.22°, with high variability. In forward flexion, thoracic and lumbar curvatures increased to 44.87° and 28.92°, respectively, and pelvic tilt rose to 53.05°. In extension, lumbar curvature deepened to -36.37°, while pelvic tilt reduced to 17.92°. Sport-specific differences showed that volleyball players had the deepest lumbar curves (-30.44°), and football players had the highest thoracic curvature (35.53°). Higher BMI values were associated with increased pelvic tilt and curvature variability. Conclusion: The study concluded that although mean spinal curvature values fell within normative ranges, significant individual and group differences were observed. Sport type and BMI influenced spinal alignment. Regular postural assessments using tools like the Idiag M360 Spine Mouse are recommended for early detection of abnormalities and improved training outcomes in physically active individuals.

Keywords: Spinal curvature, thoracic kyphosis, lumbar lordosis, physical education and postural assessment

Introduction

The spinal cord, also known as the vertebral column, spinal column, or backbone, forms a major part of the body's central structure. It contributes to approximately two-fifths of a person's total height and is composed of a series of bones called vertebrae. Along with the ribs and sternum (breastbone), the vertebral column makes up the trunk skeleton of the human body. While the spinal cord itself consists of nervous and connective tissues, the vertebral column that surrounds and protects it is made of bone and connective tissue (Adams, 2005) [1].

The vertebral column includes 24 individual movable vertebrae, the sacrum (formed by the fusion of five bones), and the coccyx (formed by the fusion of four bones). These 24 movable vertebrae are grouped into three regions: seven cervical vertebrae in the neck, twelve thoracic vertebrae in the chest, and five lumbar vertebrae in the lower back. Although the vertebrae have similar structural features, their size and shape vary depending on their location. Cervical vertebrae are the smallest, while lumbar vertebrae are the largest. Each vertebra has a vertebral body at the front and a vertebral arch at the back, enclosing a central space called the vertebral foramen, through which the spinal cord passes (Bauer, 2015) [2].

The spine has a natural curvature that helps maintain balance, support body weight, and absorb mechanical stress during movement. The cervical and lumbar regions curve inward (known as lordotic curves), while the thoracic region curves outward (known as a kyphotic curve). When the curvature in the lumbar region becomes exaggerated, it may result in a condition called lordosis. Kyphosis refers to the normal outward curvature of the thoracic spine, usually ranging between 20 to 40 degrees. Abnormal sideward curvature of the spine is called scoliosis, and it can occur in different regions. Thoracic scoliosis affects the mid-back region and is the most common type. Lumbar scoliosis affects the lower back, while thoracolumbar scoliosis affects both the thoracic and lumbar regions. These curvatures, if abnormal, can negatively affect posture, balance, and physical performance (Braganca, 2020) [3].

There are four normal spinal curves: cervical, thoracic, lumbar, and sacral. These curves, together with the intervertebral discs, help distribute mechanical stress and support movements such as walking, running, and jumping. The spine is commonly divided into three main sections: the cervical spine (seven vertebrae), thoracic spine (twelve vertebrae), and lumbar spine (five vertebrae). Each region has a specific role in supporting the body and allowing flexibility and mobility.

In this context, the present study aims to assess thoracic and lumbar spinal curvature among physical education trainees at Mangalore University. These students are physically active and depend on good posture and proper spinal alignment for optimal performance. Detecting early signs of abnormal spinal curvature can help prevent future musculoskeletal problems and improve posture-related outcomes in physical education. The study uses the Idiag M360 Spine Mouse, a reliable and non-invasive digital device specifically designed to measure spinal curves accurately and efficiently.

Hypothesis of the Study

There was no significant variation in thoracic and lumbar spinal curvature among Mangalore University physical education trainees when compared to the normal normative values.

Materials and methods

Research Design

This study employed an assessment-based research design to evaluate the spinal structure specifically thoracic and lumbar curvature of physical education trainees at Mangalore University.

Selection of Subjects

A total of 30 male physical education trainees from the Mangalore University campus were selected for this study. The participants were between 18 to 25 years of age and were enrolled as students during the academic year 2025.

Instruments Used

- **Stadiometer:** Used to measure the participants' height.
- **Digital Weighing Machine:** Used to measure body weight.
- **Idiag M360 Spine Mouse:** A non-invasive, computerized device designed to assess spinal curvature and mobility in both the sagittal and frontal planes with high precision.

Procedure Using the Idiag M360 Spine Mouse

The Idiag Spine Check plan was selected to measure spinal parameters, including posture, mobility, and muscular stability. The procedure includes scanning in three standard positions:

Initial Assessment and Preparation: The participant was requested to remove upper-body clothing to expose the spine, maintaining modesty using towels or gowns. Basic personal information, including height, weight, age, and any known spinal issues, was recorded. The participant stood barefoot in a neutral relaxed posture.

Positioning the Device

- The examiner palpated and marked key anatomical landmarks such as C7 (base of the neck) and S1 (base of the spine).
- The Idiag M360 Spine Mouse was placed at the S1 level to begin the scan.

Spinal Scanning

- The examiner slowly rolled the device upward from S1 to C7 along the spine.
- The device recorded real-time spinal angles and posture-related data using sensors.
- The scanning process took approximately 1-2 minutes.

Postural and Mobility Assessments (Optional Tests)

The following dynamic postural assessments were included:

A) Sagittal Standing Upright

- The subject stood in a relaxed upright position with arms by the sides.
- The device was rolled from T1 to S1, and data on thoracic kyphosis and lumbar lordosis were collected.
- The procedure was completed using Idiag M360 software connected via Bluetooth and USB.

B) Sagittal Standing Flexion

- The subject bent forward, and spinal flexion was assessed.
- The test measured dynamic curvature during forward flexion using the same procedure.

C) Sagittal Standing Extension

- The subject placed hands on the chest and leaned backward.
- The examiner recorded spinal extension and side flexion range, maintaining the position briefly before measurement.

Statistical Analysis

Descriptive statistics including mean and standard deviation were calculated for thoracic and lumbar curvature values obtained from the Idiag M360 Spine Mouse. The data were then analyzed to compare the trainees' spinal curvatures with standard normative value.

Results

Table 1: Descriptive characteristics of the subjects

Physical characteristics	Mean value	Standard deviation
Height	168.95	7.249934
Weight	61.275	8.805556
BMI	21.41	2.55

The above table no.1 the mean height is 168.95 with a standard deviation of 7.249934, suggesting a moderate spread in height among the subjects. The mean weight is 61.275 with a standard deviation of 8.80556, indicating a similar level of variability in weight as seen in height. The mean BMI is 21.41 with a standard deviation of 2.55 indicating a similar level of Health weight range.

Table 2: Sagittal spinal curvature among Physical Education Trainees (standing upright)

Curvature	Mean value	Standard deviation
Thoracic curvature	32.175	10.3697
Lumbar curvature	-19.85	27.5620
Pelvic tilt	20.225	14.72

In this table no 2 result show that the thoracic curvature was 32.175 degrees with a standard deviation 10.3697 in Physical Education Trainees, the lumbar curvature was -19.85 degrees with a standard deviation 27.5620 in Physical Education Trainees, the pelvic tilt measured 20.225 degrees with a standard deviation 14.72 in Physical Education Trainees.

Table 3: Spinal range of motion in flexion among Physical Education Trainees

Curvature	Mean value	Standard deviation
Thoracic curvature	44.875	18.371
Lumbar curvature	28.925	26.447
Pelvic tilt	53.05	20.895

In this table no 3 result show that the thoracic curvature was 44.875 degrees with a standard deviation 18.371 in Physical Education Trainees, the lumbar curvature was 28.925 degrees with a standard deviation 26.447 Physical Education Trainees, the pelvic tilt measured 53.05 degrees with a standard deviation 20.895 in Physical Education Trainees.

Table 4: Spinal range of motion in extension among Physical Education Trainees

Curvature	Mean value	Standard deviation
Thoracic curvature	28.1	15.581
Lumbar curvature	-36.375	25.578
Pelvic tilt	17.925	16.204

In this table no 4 result show that the thoracic curvature was 28.1 degrees with a standard deviation 15.581 in Physical Education Trainees, the lumbar curvature was -36.375 degrees with a standard deviation 25.578 in Physical Education Trainees, the pelvic tilt measured 17.925 degrees with a standard deviation 16.204 in Physical Education Trainees.

Table 5: Sagittal spinal curvature among Physical Education Trainees (standing upright)

Curvature	Football players	Hockey players	Volleyball players	Other players
Thoracic	35.5385	31.6	28.7778	31.25
Lumbar	-16.385	-21.4	-30.444	-11.625
Pelvic	21.5385	12.3	17.6667	30.875

In this table no 5 result show that the thoracic curvature of football players 35.5385, Hackey player 31.6, Volleyball player 28.7778, Other player 31.25 degrees, the lumbar curvature of Football player was -16.385, Hockey player -21.4, Volleyball player -30.444, Other player -11.625 degrees, the pelvic tilt measured Football players 21.5385, Hockey player 12.3, Volleyball player 17.6667, Other players 30.875 degrees in Physical Education Trainees.

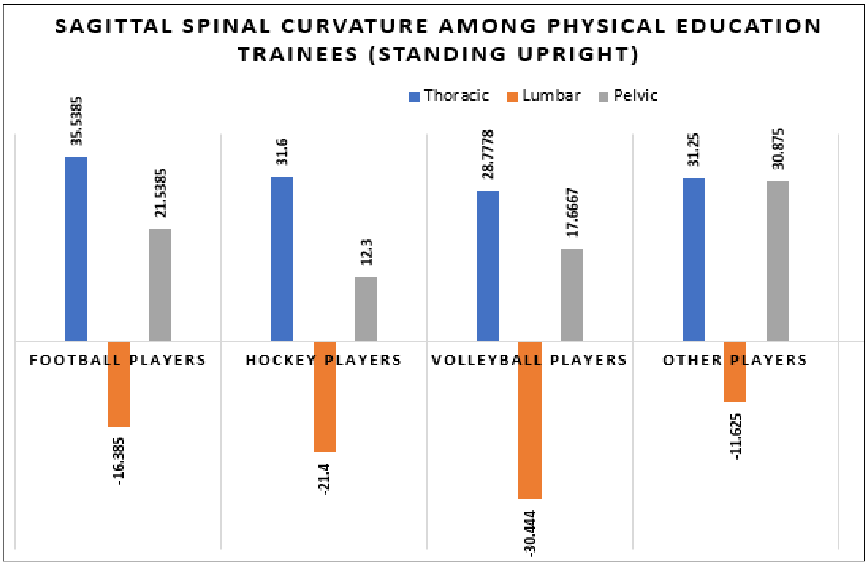

Fig 1: Graphical presentation of mean value of Sagittal spinal curvatures of Physical Education trainees in upright position

The figure 1 was the graphical presentation mean of Sagittal standing upright of Physical Education trainees. The result of the study found that Game related spinal thoracic, lumbar and pelvic curvature of Physical Education Trainees.

Table 6: Spinal range of motion in flexion among Physical Education Trainees

Curvature	Football players	Hockey players	Volleyball players	Other players
Thoracic	42.38	52.8	45.33	38.5
Lumbar	29.54	37.4	32.22	13.62
Pelvic	51.85	45.4	68.22	47.5

In this table no 6 result show that the thoracic curvature of football players 42.38, Hackey player 52.8, Volleyball player 45.33, Other player 38.5 degrees, the lumbar curvature of Football player was 29.54, Hockey player 37.4, Volleyball player 32.22, Other player 13.62 degrees, the pelvic tilt measured Football players 51.85, Hockey player 45.4, Volleyball player 68.22, Other players 47.5 degrees in Physical Education Trainees.

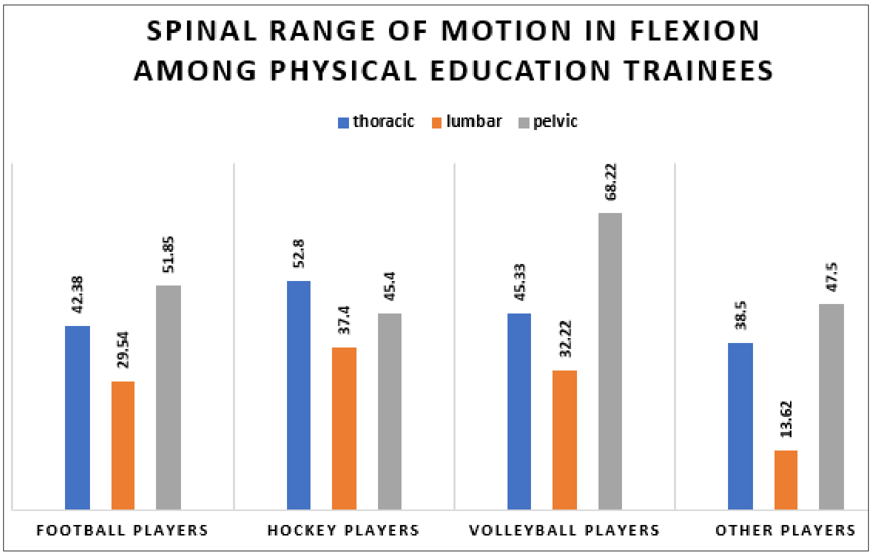

Fig 2: Graphical presentation of mean value of Spinal range of motion in flexion among the Physical Education trainees

The figure 2 was the graphical presentation mean of Spinal range of motion in flexion among the Physical Education trainees. The result of the study found that Game related spinal thoracic, lumbar and pelvic curvature of Physical Education Trainees.

Table 7: Spinal range of motion in extension among Physical Education Trainees

Curvature	Football players	Hockey players	Volleyball players	Other players
Thoracic	31.46	8.45	27.11	23.5
Lumbar	-35.85	29.43	-50.67	-33.25
Pelvic	18.54	20.77	22.33	16.75

In this table no 7 result show that the thoracic curvature of football players 31.46, Hackey player 8.45, Volleyball player 27.11, Other player 23.5 degrees, the lumbar curvature of Football player was -35.85, Hockey player 29.43, Volleyball player -50.67, Other player -33.25 degrees, the pelvic tilt measured Football players 18.54, Hockey player 20.77, Volleyball player 22.33, Other players 16.75 degrees in Physical Education Trainees.

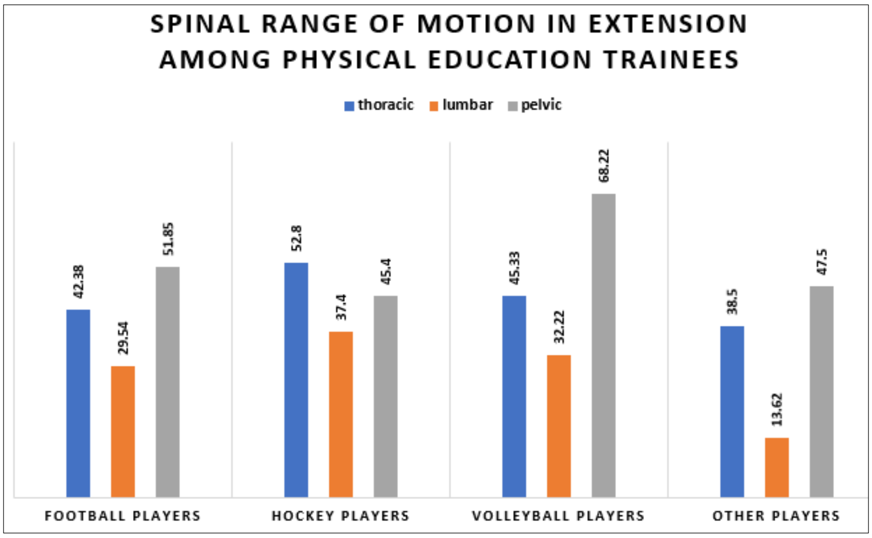

Fig 3: Graphical presentation of mean value of Spinal range of motion in Extension among the Physical Education trainees

The figure 3 was the graphical presentation mean of Spinal range of motion in Extension among the Physical Education trainees. The result of the study found that Game related spinal thoracic, lumbar and pelvic curvature of Physical Education Trainees.

Table 8: Sagittal spinal curvature among Physical Education Trainees (standing upright)

Curvature	BMI > 18.5	BMI 18.5 - 24.9	BMI 25 - 29.9	BMI <30
Thoracic	30.75	32.33	32.33	0
Lumbar	-19.75	-21.52	-1.67	0
Pelvic	9.75	20.19	34.67	0

In this table no 5 result show that the thoracic curvature of football players 35.5385, Hackey player 31.6, Volleyball player 28.7778, Other player 31.25 degrees, the lumbar curvature of Football player was -16.385, Hockey player -21.4, Volleyball player -30.444, Other player -11.625 degrees, the pelvic tilt measured Football players 21.5385, Hockey player 12.3, Volleyball player 17.6667, Other players 30.875 degrees in Physical Education Trainees.

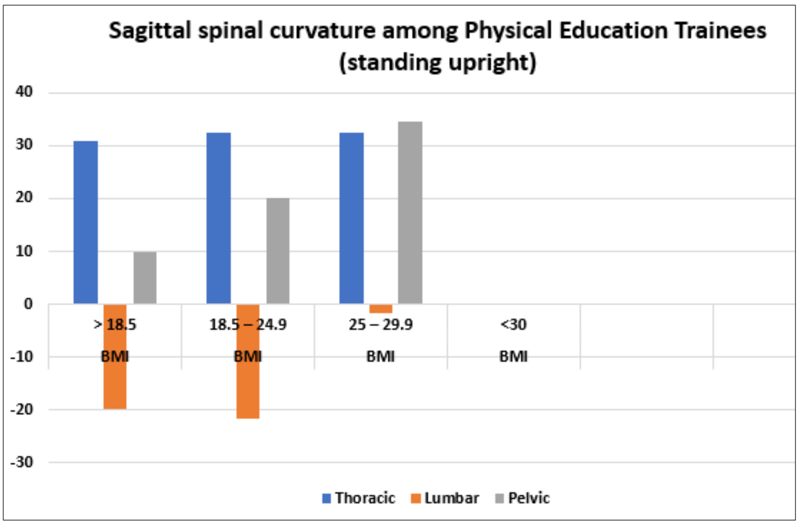

Fig 4: Graphical presentation of mean value of Sagittal spinal curvatures of Physical Education trainees in upright position

The figure 4 was the graphical presentation mean of Sagittal standing upright of Physical Education trainees. The result of the study found that BMI related spinal thoracic, lumbar and pelvic curvature of Physical Education Trainees.

Table 9: Spinal range of motion in flexion among Physical Education Trainees

Curvature	BMI > 18.5	BMI 18.5 - 24.9	BMI 25 - 29.9	BMI <30
Thoracic	24.5	28.12	32.67	0
Lumbar	-38.5	-36.33	-34	0
Pelvic	12.75	18.90	14	0

In this table no 9 result show that the thoracic curvature of BMI less than 18.5 is 42.38, BMI 18.5 to 24.9 is 28.12, BMI 25 to 29.9 is 32.67 degrees, the lumbar curvature of BMI less than 18.5 is -38.5, BMI 18.5 to 24.9 is -36.33, BMI 25 to 29.9 is-34 degrees, the pelvic tilt measured of BMI less than 18.5 is 12.75, BMI 18.5 to 24.9 is 18.90, BMI 25 to 29.9 is 14 degrees in Physical Education Trainees.

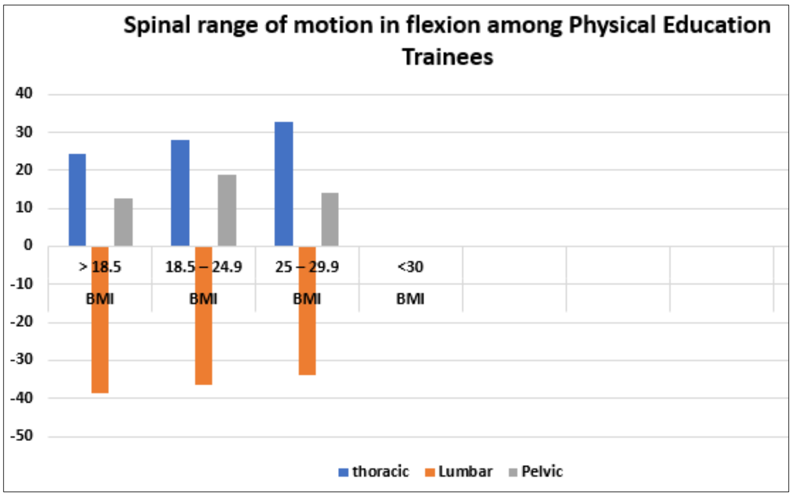

Fig 5: Graphical presentation of mean value of Spinal range of motion in flexion among the Physical Education trainees

The figure 5 was the graphical presentation mean of Spinal range of motion in flexion among the Physical Education trainees. The result of the study found that BMI related spinal thoracic, lumbar and pelvic curvature of Physical Education Trainees.

Table 10: Spinal range of motion in extension among Physical Education Trainees

Curvature	BMI > 18.5	BMI 18.5 - 24.9	BMI 25 - 29.9	BMI <30
Thoracic	5.5	16.75	15.67	0
Lumbar	65.5	61.12	66.67	0
Pelvic	51.75	36.84	56	0

In this table no 10 result show that the thoracic curvature of BMI less than 18.5 is 5.5, BMI 18.5 to 24.9 is 16.75, BMI 25 to 29.9 is 15.67 degrees, the lumbar curvature of BMI less than 18.5 is 65.5, BMI 18.5 to 24.9 is 61.12, BMI 25 to 29.9 is degrees, the pelvic tilt measured of BMI less than 18.5 is 51.75, BMI 18.5 to 24.9 is 36.84, BMI 25 to 29.9 is 56 degrees in Physical Education Trainees.

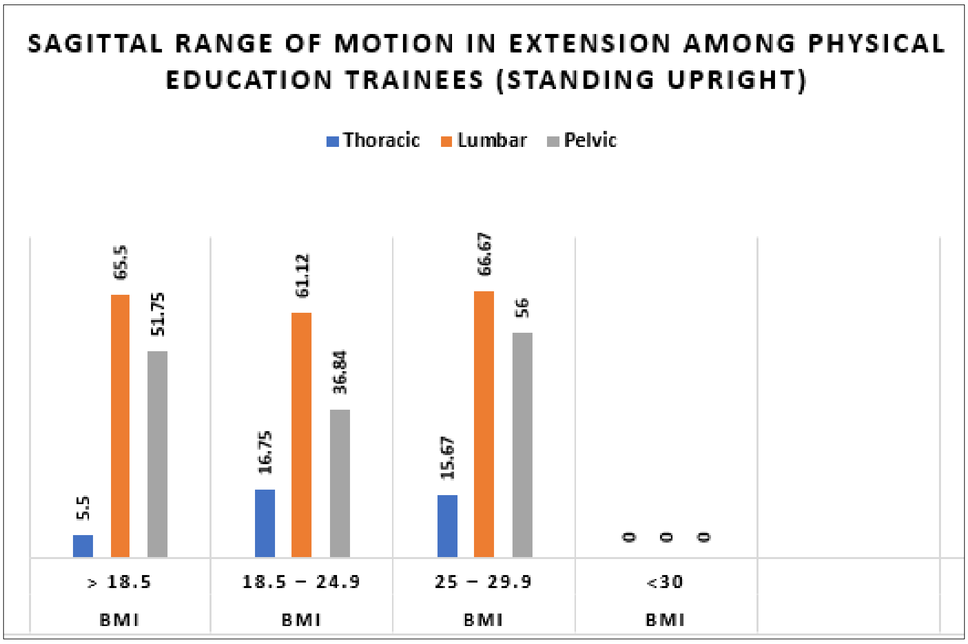

Fig 6: Graphical presentation of mean value of Spinal range of motion in extension among the Physical Education trainees

The figure 6 was the graphical presentation mean of Spinal range of motion in Extension among the Physical Education trainees. The result of the study found that BMI related spinal thoracic, lumbar and pelvic curvature of Physical Education Trainees.

Discussion

The purpose of this study was to assess thoracic and lumbar curvature among physical education trainees at Mangalore University using the Idiag M360 Spine Mouse. The spinal structure was evaluated in various postural conditions, including upright standing, forward flexion, and extension, and the data were analyzed based on BMI and sports participation. The results provided valuable insights into spinal posture and mobility in physically active young adults.

The overall mean thoracic curvature in the upright posture was 32.17°, which falls within the normal kyphotic range (20°-45°). However, the standard deviation (10.37) indicates a moderate variation among individuals. Lumbar curvature in the upright position averaged -19.85°, which is slightly lower than the normative lumbar lordosis range (-20° to -40°), with a high standard deviation (27.56) suggesting greater variability or potential postural imbalances. Pelvic tilt also showed a wide variation (mean = 20.22°, SD = 14.72), which may be influenced by factors such as muscle tightness or pelvic alignment.

When analyzing spinal movement during flexion, thoracic curvature increased to 44.87°, reflecting expected postural adjustment during forward bending. Lumbar curvature during flexion reached 28.92°, while pelvic tilt showed a substantial increase (53.05°), highlighting active hip and pelvic involvement in forward flexion. These values suggest normal dynamic range in spinal movement, though individual differences remained wide, particularly in the lumbar region.

In the extension test, thoracic curvature was 28.1°, showing a slight reduction compared to upright position, which is consistent with spinal mechanics during backward bending. Lumbar curvature in extension was significantly increased in the negative direction (-36.37°), reflecting pronounced lordosis. Pelvic tilt reduced to 17.92°, likely due to posterior pelvic rotation.

Analysis based on sports participation revealed that football players had the highest thoracic curvature in standing upright (35.53°), followed by hockey and other players. Volleyball players exhibited the lowest thoracic angle (28.77°), possibly due to frequent overhead actions and trunk stability training. Lumbar curvature varied, with volleyball players showing the deepest lordotic curve (-30.44°), which may relate to the sport-specific requirement for core flexibility and lumbar extension.

When assessing based on BMI, participants in the normal BMI range (18.5-24.9) showed more stable thoracic and lumbar curvatures. Interestingly, those with BMI over 25 showed increased pelvic tilt and variability in spinal angles, possibly due to altered load distribution or compensatory posture.

Across all postural conditions, the standard deviations were high, especially in lumbar curvature and pelvic tilt, reflecting significant inter-individual differences. These differences may result from variations in muscular strength, flexibility, movement patterns, training background, and body composition.

This study also supports the effectiveness of the Idiag M360 Spine Mouse as a non-invasive and practical tool for assessing spinal curvature and mobility. Its real-time data collection allowed for detailed and objective measurement in dynamic and static conditions.

Conclusion

This study assessed thoracic and lumbar spinal curvatures in physically active male trainees at Mangalore University. The findings show that while the group averages for thoracic and lumbar curves fell within normative ranges, there were wide variations among individuals, especially in lumbar lordosis and pelvic tilt.

Differences were also observed across BMI categories and types of sports, suggesting that body composition and athletic training influence spinal posture and mobility. Volleyball players demonstrated deeper lumbar curves, whereas those with higher BMI values showed greater pelvic tilt, possibly indicating altered biomechanics.

The results highlight the importance of regular spinal assessments in physical education and sports programs. Identifying deviations from normative spinal curvatures can help prevent musculoskeletal issues, improve posture, and enhance performance. Physical educators and trainers should emphasize postural training, core strengthening, and individualized interventions based on spinal assessment data.

The study confirms that the Idiag M360 Spine Mouse is an effective, reliable tool for assessing spinal health in field settings. Future studies with larger sample sizes, inclusion of female trainees, and longitudinal follow-ups could further enhance understanding of postural dynamics in physically active populations.

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