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Cormic Index and Thoracic Kyphosis Angle among Medical Students at Universitas Jambi, Class of 2025

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Abstract

This study aimed to describe the Cormic Index and thoracic kyphosis angle among medical students at Universitas Jambi, class of 2025. A quantitative descriptive study with a cross-sectional design was conducted in September 2026 using total sampling. A total of 128 eligible students participated. Standing height and sitting height were measured using a digital microtoise, and the Cormic Index was calculated as the ratio of sitting height to standing height multiplied by 100%. Thoracic kyphosis was assessed using a 50 cm flexicurve ruler along the C7–T12 spinal region. Data were analyzed descriptively using medians, interquartile ranges (IQRs), minimum–maximum values, frequencies, and percentages. The median Cormic Index was 52.90% (IQR = 2.10; range = 49.4–55.4%), while the median thoracic kyphosis angle was 33.90° (IQR = 11.00°; range = 20.3°–62.4°). Based on predefined operational thresholds, 95 students (74.2%) exhibited normal thoracic kyphosis, whereas 33 students (25.8%) were classified as having hyperkyphosis. These findings provide population-specific descriptive evidence of relative trunk proportions and thoracic spinal curvature. The results may support subsequent anthropometric and postural investigations, although no statistical association between the two variables or clinical diagnosis was established.

Keywords: *Anthropometry, Cormic Index, Hyperkyphosis, Medical Students, Thoracic Kyphosis.*

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INTRODUCTION

Postural health has become an increasingly relevant concern in young adult populations, particularly among university students whose academic activities frequently involve prolonged sitting, computer-based learning, and sustained postural demands. The thoracic spine contributes to sagittal alignment, mechanical stability, and the distribution of gravitational forces, while variations in its physiological curvature may influence the positioning and functional relationships of adjacent spinal segments. Excessive thoracic curvature, commonly described as hyperkyphosis, represents a measurable alteration in spinal alignment that requires careful interpretation because its clinical significance depends on individual characteristics, measurement procedures, and established classification thresholds (Kłapeć et al., 2025; Zappalá et al., 2021). Investigations involving university students have identified variations in sagittal spinal curvature associated with physical activity patterns, sedentary behavior, and somatic characteristics, suggesting that postural assessment should account for both habitual behavior and individual morphology rather than relying exclusively on generalized assumptions regarding poor posture (Grabara & Witkowska, 2024; Marijančić et al., 2023). Evidence concerning sex-specific spinal responses to sedentary behavior further indicates that thoracic and lumbar spinal regions may exhibit different patterns of postural adaptation, although these associations cannot independently establish causal mechanisms (Zemková et al., 2023). Smartphone-related postural behavior has also been associated with musculoskeletal discomfort among adolescents, illustrating the potential relevance of sustained flexed postures during educational and recreational activities (Tsang et al., 2023). The functional importance of thoracic alignment extends beyond external posture because investigations have examined its relationship with respiratory parameters, cervical sensorimotor function, and compensatory sagittal alignment, although findings from clinical populations cannot be directly generalized to healthy university students (Çelik et al., 2025; Moustafa et al., 2023; Xia et al., 2021). These developments establish a scientific

rationale for examining thoracic curvature among medical students while recognizing that anatomical proportions, habitual postural characteristics, and pathological spinal deformities represent distinct dimensions of musculoskeletal assessment.

Current research on thoracic spinal morphology and anthropometric proportions has developed through several complementary approaches involving population-based postural assessment, body-proportion measurement, biomechanical evaluation, and technological refinement of spinal curvature measurements. Studies involving female allied health students and male university students have demonstrated the feasibility of characterizing thoracic hyperkyphosis within educational populations, although differences in participant characteristics and assessment procedures complicate direct comparisons of prevalence estimates (Ahmed et al., 2024; Fujimoto et al., 2023). Research involving younger populations has similarly examined sagittal spinal alignment, indicating the relevance of developmental stage and population characteristics when interpreting postural measurements (Koyama et al., 2025). Anthropometric investigations provide a complementary framework by demonstrating that standing height alone cannot fully represent proportional differences between the trunk and lower extremities. The Cormic Index, calculated from the relationship between sitting height and standing height, provides a standardized indicator of relative trunk proportion and has been applied in studies examining body proportions, population characteristics, and specific health conditions (Bogin & Varela-Silva, 2010; Asafa et al., 2022). Research using sitting height and related anthropometric dimensions further demonstrates the applicability of proportional measurements across different populations, although evidence obtained from children, individuals with disproportionate short stature, or specific demographic groups requires cautious interpretation when applied to healthy young adults (Tang et al., 2024; Hoover-Fong et al., 2025; Żurawiecka & Wronka, 2022). Methodological developments have simultaneously expanded the available approaches for assessing thoracic curvature, including flexicurve measurements, smartphone-based inclinometers, inertial measurement units, automated image analysis, and machine-learning applications (Elpeze et al., 2023; de la Encarnación Simarro & Martínez González-Moro, 2024; Koca & Koca, 2025; Kocak et al., 2025). Research on clinical measurement reliability has established the importance of standardized procedures and examiner consistency, while recent systematic evidence emphasizes that the measurement properties and clinical usefulness of different instruments must be considered when interpreting kyphosis angles (Lewis & Valentine, 2010; Barrett et al., 2013; Nepomuceno et al., 2025). The contemporary literature consequently provides substantial methodological foundations for anthropometric and postural assessment, although these two measurement domains have frequently been investigated independently.

Despite advances in spinal morphology assessment, several limitations remain in the available evidence concerning the simultaneous characterization of relative trunk proportions and thoracic kyphosis among healthy university students. Existing anthropometric investigations have largely emphasized body proportions in relation to growth, population characteristics, developmental variation, or specific medical conditions, whereas studies of thoracic kyphosis have predominantly concentrated on spinal alignment, physical activity, associated symptoms, or clinical deformities (Asafa et al., 2022; Tang et al., 2024; Grabara & Witkowska, 2024). Investigations addressing sagittal balance have also frequently used radiographic parameters or populations with established spinal disorders, including degenerative kyphosis and adolescent idiopathic scoliosis, creating limitations when their findings are extrapolated to nonclinical student populations (Xia et al., 2021; Katzouraki et al., 2024). Radiographic evidence concerning differences between sitting and standing sagittal alignment further illustrates the influence of measurement position and assessment protocols on spinal parameters, reinforcing the need to distinguish anatomical proportions from position-dependent curvature measurements (Dharnipragada et al., 2024). Although studies of hyperkyphosis among university students provide valuable population-specific findings, their emphasis on spinal curvature does not necessarily establish the accompanying distribution of the Cormic Index within the same participants (Ahmed et al., 2024; Fujimoto et al., 2023). Evidence concerning postural interventions in educational settings has also focused primarily on modifying posture or related functional outcomes rather than establishing descriptive anthropometric profiles (Murakami et al., 2026). A further methodological limitation arises from variations in measurement techniques, operational thresholds, and participant characteristics, which restrict comparisons of thoracic kyphosis distributions across studies (Zappalá et al., 2021; Nepomuceno et al., 2025). The resulting research gap is therefore

primarily descriptive, contextual, and methodological: the literature considered here does not establish a directly comparable, simultaneously measured profile of the Cormic Index and thoracic kyphosis angle among medical students at Universitas Jambi, particularly those entering in 2025. This gap should not be interpreted as evidence of an untested causal relationship between body proportions and spinal curvature, because the absence of population-specific descriptive information constitutes a different scientific problem from determining statistical association or causation.

The absence of integrated descriptive information on trunk proportions and thoracic curvature has implications for the interpretation of student musculoskeletal characteristics and the development of appropriately targeted subsequent investigations. Thoracic kyphosis cannot be evaluated solely from visual appearance because estimates of spinal curvature are influenced by measurement reliability, examination position, anatomical landmarks, and the operational criteria used to categorize postural variation (Barrett et al., 2013; Elpeze et al., 2023; Nepomuceno et al., 2025). Accurate characterization is especially relevant when considering findings from therapeutic exercise research, which indicates that structured interventions may modify thoracic curvature or related functional outcomes in selected adolescent and young adult populations, but does not justify assuming equivalent effects or clinical indications in an unselected university cohort (Elpeze & Usgu, 2022; Yang et al., 2024; Fernández Fernández et al., 2025). Systematic evidence concerning exercise and spinal posture likewise supports further examination of intervention approaches while underscoring the need to distinguish descriptive assessments from studies designed to establish treatment effectiveness (Oliveira-Costa et al., 2025). Experimental investigations involving diaphragmatic myofascial release and corrective exercise, as well as corrective dance-based interventions, demonstrate the breadth of outcomes investigated in hyperkyphotic populations; however, their intervention-specific findings cannot determine the postural characteristics or treatment requirements of medical students without direct assessment (Elabd et al., 2025; Kouchi et al., 2025). Recent developments in automated spinal assessment and artificial intelligence offer potential alternatives for postural evaluation, although technological sophistication does not eliminate the need for clearly defined measurement procedures and population-specific interpretation (Koca & Koca, 2025; Rahman, 2026). For medical education institutions, preliminary anthropometric and spinal curvature data may inform the design of subsequent investigations addressing ergonomic exposure, postural awareness, and musculoskeletal health. Their practical value lies in establishing an empirical description of the population rather than diagnosing spinal pathology, attributing observed curvature to academic behavior, or recommending corrective treatment without additional clinical evidence.

The present study is positioned at the intersection of descriptive anthropometry and nonradiological spinal posture assessment, with its contribution defined by the concurrent measurement of relative trunk proportion and thoracic kyphosis in a specific medical student cohort. Its distinguishing feature is not the introduction of a new anthropometric index or spinal measurement instrument, but the application of established approaches to generate complementary morphological and postural information within the same population. Previous anthropometric work has demonstrated the interpretive relevance of sitting-height proportions, whereas research on spinal curvature has emphasized sagittal alignment, physical activity, and postural variation in young populations (Bogin & Varela-Silva, 2010; Grus et al., 2025). Comparative investigations of university students have provided information on thoracic kyphosis across particular sex and institutional groups, but those findings cannot automatically substitute for direct measurements within the Universitas Jambi cohort (Ahmed et al., 2024; Fujimoto et al., 2023). The proposed assessment addresses this contextual limitation by combining standing-height and sitting-height measurements for calculating the Cormic Index with flexicurve-based estimation of thoracic curvature in habitual standing posture. This approach is consistent with the established use of flexible contour instruments for clinical spinal assessment while recognizing that nonradiological estimates are not interchangeable with radiographic measurements without appropriate validation (Lewis & Valentine, 2010; de la Encarnación Simarro & Martínez González-Moro, 2024). The investigation also distinguishes descriptive characterization from explanatory modeling: although contemporary studies have explored associations between spinal curvature and functional or behavioral variables, such associations cannot be inferred from separate univariate distributions (Çelik et al., 2025; Marijančić et al., 2023). The specific novelty offered by this investigation is therefore a cohort-specific, concurrently collected descriptive dataset encompassing the Cormic Index, numerical thoracic kyphosis angles, and

operational kyphosis categories among medical students at Universitas Jambi from the class of 2025. This contribution fills an identified population-level information gap without claiming that a previously unknown biomechanical relationship has been demonstrated.

This study aims to describe the Cormic Index and thoracic kyphosis angle among medical students at Universitas Jambi from the class of 2025 using a quantitative cross-sectional approach. The specific objectives are to characterize relative trunk proportion through the Cormic Index derived from sitting height and standing height, determine the distribution of thoracic kyphosis angles estimated using a flexicurve ruler, and describe the frequency and proportion of students classified into normal thoracic kyphosis and hyperkyphosis categories according to predefined operational thresholds. The analysis is restricted to descriptive measures of the two principal variables and the distribution of thoracic kyphosis categories; it does not seek to establish a statistical association between the Cormic Index and kyphosis angle, identify determinants of postural variation, or infer causal relationships. The scientific contribution lies in providing a population-specific anthropometric and postural profile that complements existing investigations of spinal alignment and body proportions in young adults. Its methodological contribution involves the concurrent application of standardized anthropometric measurements and a nonradiological spinal curvature assessment within a clearly defined educational cohort. From a practical standpoint, the resulting information may serve as preliminary evidence for future musculoskeletal investigations, the development of more focused postural assessment protocols, and the consideration of ergonomic education within medical training environments. The findings are also expected to provide a reference point for subsequent analytical studies examining potential relationships between body proportions, spinal curvature, and relevant individual or behavioral characteristics while preserving the distinction between descriptive observations and clinically validated diagnoses.

RESEARCH METHODS

This study employed a quantitative descriptive design with a cross-sectional approach to characterize the Cormic Index and thoracic kyphosis angle among medical students at Universitas Jambi from the class of 2025. The research was conducted in September 2026 at the Faculty of Medicine and Health Sciences, Universitas Jambi, Indonesia. The study population comprised all medical students enrolled in the 2025 cohort, and total sampling was applied to recruit eligible participants. The inclusion criteria required participants to be active medical students from the designated cohort who voluntarily agreed to participate and provided written informed consent. The exclusion criteria included a history of spinal trauma or injury, including vertebral fractures; musculoskeletal disorders affecting posture or spinal curvature; congenital spinal abnormalities; previous spinal surgery; pregnancy; and incomplete participation in the research procedures or withdrawal from the study. Following the assessment of eligibility and verification of data completeness and consistency, 128 students were included in the final analysis. The primary variables were the Cormic Index, representing sitting-height proportion relative to standing height, and the thoracic kyphosis angle, representing the degree of thoracic spinal curvature in the sagittal plane. The study was restricted to descriptive characterization of these variables and did not involve experimental manipulation, therapeutic intervention, or statistical testing of associations between anthropometric proportions and spinal curvature. Ethical approval was obtained from the Health Research Ethics Committee of the Faculty of Medicine and Health Sciences, Universitas Jambi. Before data collection, participants received information regarding the research objectives, anticipated benefits, measurement procedures, and participant rights, and written informed consent was obtained from all participants.

Anthropometric and postural measurements were performed using standardized procedures specified in the research protocol. Standing height was measured without footwear using a digital microtoise, with participants positioned upright and the head aligned in the Frankfort horizontal plane. Sitting height was measured using a digital microtoise while participants maintained an upright seated position on a flat, backless bench measuring 50 × 30 × 40 cm. The Cormic Index was calculated as the ratio of sitting height to standing height multiplied by 100, expressed as a percentage: Cormic Index (%) = (sitting height/standing height) × 100. Thoracic kyphosis was assessed using a 50 cm flexicurve ruler positioned along the posterior spinal contour between the seventh cervical vertebra (C7) and the twelfth thoracic vertebra (T12), with participants maintaining their habitual standing posture. The resulting spinal contour was transferred onto graph paper, and the thoracic kyphosis

angle was estimated using the formula $\theta = 4 \arctan(2H/L)$, where θ represented the estimated kyphosis angle, H represented the maximum perpendicular height of the traced curvature above the reference line, and L represented the length of the reference line connecting C7 and T12. Thoracic curvature was classified according to the study's predefined operational thresholds as normal kyphosis (20°–40°) or hyperkyphosis (>40°). Data were examined for completeness and consistency before statistical processing. The distribution of numerical variables was assessed using the Kolmogorov–Smirnov normality test, which indicated non-normal distributions. Accordingly, the Cormic Index and thoracic kyphosis angle were summarized using medians, interquartile ranges (IQRs), and minimum–maximum values, while thoracic kyphosis categories were presented as absolute frequencies and percentages. The analysis was exclusively univariate, consistent with the descriptive research objectives, and did not include correlation testing, regression modeling, or causal inference. The flexicurve-derived angles were interpreted as nonradiological estimates of thoracic curvature, and the operational classification was not considered sufficient to establish a clinical diagnosis of spinal deformity.

RESULTS AND DISCUSSION

Anthropometric Characteristics Based on the Cormic Index among Medical Students

Anthropometric assessment of 128 medical students from the class of 2025 at Universitas Jambi provided a quantitative description of relative trunk proportions based on sitting height and standing height. The Cormic Index was used to represent the proportion of sitting height relative to total body stature, allowing body proportions to be evaluated independently of absolute height. This measurement is relevant because individuals with similar standing heights may exhibit different distributions of trunk and lower-extremity lengths, reflecting variation in body proportions that cannot be captured through stature alone (Bogin & Varela-Silva, 2010). The findings provide a population-specific anthropometric profile rather than evidence of a structural abnormality or functional impairment.

The descriptive analysis identified a median Cormic Index of 52.90%, with an interquartile range of 2.10 and observed values extending from 49.4% to 55.4%. The median indicates that sitting height represented approximately 52.90% of standing height at the central position of the observed distribution, although this percentage does not represent the mean proportion of every participant. The relatively limited interquartile range indicates that the middle half of the observed Cormic Index values occupied a narrower interval than the complete range, without establishing that individual body proportions were anatomically uniform. Anthropometric studies have demonstrated that the interpretation of relative body proportions requires attention to population characteristics, developmental history, and measurement conditions (Asafa et al., 2022; Żurawiecka & Wronka, 2022).

The numerical findings are presented in Table 1 to characterize the central tendency, dispersion, and observed range of the Cormic Index within the study population. Because the distribution did not satisfy the normality assumption according to the Kolmogorov–Smirnov test, the median and interquartile range were selected instead of the mean and standard deviation. This reporting approach permits interpretation of the observed distribution without assuming symmetry or a Gaussian pattern, although it does not establish the underlying sources of anthropometric variability (Hoover-Fong et al., 2025). The reported minimum and maximum values provide complementary information concerning the extent of observed differences in relative trunk proportion.

Table 1. Distribution of the Cormic Index among Medical Students at Universitas Jambi, Class of 2025

Variable	n	Median	IQR	Minimum–Maximum
Cormic Index (%)	128	52.90	2.10	49.4–55.4

Note. IQR = interquartile range. The Cormic Index was calculated as sitting height divided by standing height, multiplied by 100.

Table 1 demonstrates that the observed Cormic Index distribution was centered at 52.90%, while the difference between its highest and lowest values was 6.0 percentage points. This range

indicates measurable variation in relative trunk proportions among participants despite their membership in the same academic cohort. Anthropometric investigations involving different populations have documented variation in sitting-height proportions, supporting the interpretation that proportional body dimensions should be considered independently from absolute stature (Tang et al., 2024). The present findings cannot determine whether the observed distribution differs significantly from those of other populations because no comparative group or inferential analysis was included in the research design.

The Cormic Index is particularly relevant to the morphological characterization of young adults because it expresses the proportional contribution of the trunk to total standing height rather than measuring spinal curvature directly. A higher value indicates a greater sitting-height proportion relative to total stature, whereas a lower value indicates a comparatively smaller sitting-height proportion, but neither measurement independently establishes the presence of a postural disorder. Research addressing body proportionality emphasizes that anthropometric interpretation must account for individual and population variation rather than treating differences in body dimensions as evidence of pathology (Bogin & Varela-Silva, 2010; Hoover-Fong et al., 2025). The observed values should consequently be interpreted as descriptive characteristics of the sampled students without assigning unvalidated categories of short-trunked or long-trunked body morphology.

Comparisons with previous anthropometric investigations require consideration of differences in the health status, age distribution, and sampling characteristics of the populations examined. Asafa et al. (2022) investigated the Cormic Index alongside other anthropometric parameters among young adults with sickle cell anaemia, demonstrating the application of proportional measurements in a clinically defined population. Their research provides methodological relevance to the use of the index, but the characteristics of individuals with a specific medical condition cannot be assumed to represent those of medical students without comparable eligibility criteria and population characteristics. The present study contributes a separate descriptive profile of students who met the specified inclusion and exclusion criteria, without suggesting that differences from earlier investigations reflect disease status, nutritional factors, or developmental abnormalities.

Variation in relative trunk proportion may also be considered in relation to broader anthropometric research examining the distribution of body dimensions across developmental and demographic groups. Studies involving height and sitting height among school-aged populations illustrate the importance of measuring these dimensions separately when investigating human growth and proportional development (Tang et al., 2024). Research examining adult height and sitting height in young women further indicates that proportional measurements can be studied in relation to developmental characteristics, although such findings do not establish the determinants of the Cormic Index in the present cohort (Żurawiecka & Wronka, 2022). Since the current analysis did not examine developmental history, sex-specific distributions, or additional explanatory variables, the observed Cormic Index variation cannot be attributed to particular biological or environmental influences.

The anthropometric procedures used in this research also influence the interpretation and comparability of the findings. Standing height was measured without footwear using a digital microtoise, while sitting height was obtained in an upright seated position using a flat, backless bench, providing the two measurements required for calculating the Cormic Index. Standardized positioning is necessary because proportional indices incorporate more than one anthropometric dimension, and measurement inconsistencies may affect the resulting ratio (Hoover-Fong et al., 2025). Although the study specified the measurement positions and instruments, it did not report repeated-measurement reliability coefficients or interexaminer agreement, limiting the ability to quantify potential measurement error.

The descriptive profile of relative trunk proportion provides an additional anthropometric dimension for interpreting the characteristics of medical students beyond conventional measures of standing height. Its scientific contribution lies in documenting the distribution of a proportional body index within a defined educational population, rather than demonstrating an association with thoracic spinal curvature or establishing population-specific diagnostic thresholds. Contemporary research on spinal morphology has considered somatic parameters alongside sagittal curvature characteristics, indicating the relevance of integrating anthropometric information into future analytical investigations (Grabara & Witkowska, 2024; Grus et al., 2025). The present Cormic Index findings establish a preliminary empirical reference for the 2025 medical student cohort at Universitas Jambi and provide

a foundation for subsequent studies designed to examine whether relative trunk proportion is statistically associated with thoracic kyphosis angle.

Distribution and Clinical Interpretation of Thoracic Kyphosis Angle among Medical Students

Thoracic kyphosis assessment among 128 medical students from the class of 2025 at Universitas Jambi revealed measurable variation in sagittal spinal curvature within a defined young adult population. The thoracic kyphosis angle was estimated using a 50 cm flexicurve ruler positioned along the spinal contour between the seventh cervical vertebra (C7) and the twelfth thoracic vertebra (T12), providing a nonradiological representation of thoracic curvature in habitual standing posture. The median thoracic kyphosis angle was 33.90°, indicating that the central value of the observed distribution fell within the study's operational normal range of 20°–40°. Thoracic curvature represents an important component of sagittal spinal alignment, although its interpretation requires consideration of anatomical variation, measurement procedures, and population characteristics rather than reliance on a single angular threshold (Zappalá et al., 2021; Kłapeć et al., 2025).

The distribution of thoracic kyphosis angles showed an interquartile range of 11.00°, with individual measurements extending from 20.3° to 62.4°. This variation indicates that the sampled population included students with substantially different estimated thoracic curvature angles despite their shared educational cohort. The median and interquartile range were appropriate descriptive measures because the Kolmogorov–Smirnov test indicated that the numerical observations did not follow a normal distribution. Investigations involving university students have similarly documented heterogeneity in sagittal spinal alignment, suggesting that thoracic curvature should be evaluated as a continuously distributed anatomical characteristic before applying categorical interpretations (Fujimoto et al., 2023; Grabara & Witkowska, 2024).

The observed range of thoracic kyphosis angles also demonstrates the importance of distinguishing anatomical variation from operationally defined hyperkyphosis. Although the maximum estimated angle exceeded the threshold used to identify hyperkyphosis, the distribution alone does not establish the presence of clinically significant spinal deformity or associated functional impairment. Research involving healthy adults has demonstrated substantial variation in reported thoracic kyphosis values across age groups and measurement approaches, indicating that classification thresholds require careful consideration when comparing populations (Zappalá et al., 2021). The numerical distribution and categorical classification of thoracic kyphosis among the participants are presented in Table 2 to clarify the magnitude and frequency of the observed postural characteristics.

Table 2. Distribution of Thoracic Kyphosis Angle and Classification among Medical Students at Universitas Jambi, Class of 2025

Measurement or category	Frequency (n)	Percentage (%)	Descriptive statistics
Thoracic kyphosis angle (°)	128	—	Median: 33.90°; IQR: 11.00°; range: 20.3°–62.4°
Normal kyphosis (20°–40°)	95	74.2	—
Hyperkyphosis (>40°)	33	25.8	—
Total	128	100.0	—

Note. IQR = interquartile range.

Table 2 indicates that 95 students (74.2%) were classified within the normal thoracic kyphosis category, whereas 33 students (25.8%) exceeded the operational threshold of 40°. The presence of hyperkyphosis-category measurements in approximately one-quarter of the participants demonstrates that elevated thoracic curvature angles were not confined to isolated observations within the sampled cohort. Nevertheless, the reported proportion represents the frequency of flexicurve-based measurements exceeding a predefined threshold rather than the prevalence of clinically diagnosed structural hyperkyphosis. Studies among female allied health students and male university students have reported thoracic hyperkyphosis in educational populations, but differences in sampling

characteristics, measurement techniques, and classification criteria prevent direct interpretation of their proportions as equivalent to the present findings (Ahmed et al., 2024; Fujimoto et al., 2023).

The distinction between normal and elevated thoracic curvature is relevant to understanding the mechanical organization of the vertebral column and its contribution to sagittal balance. Thoracic kyphosis forms part of an interconnected spinal alignment system in which changes in one region may coexist with adjustments in other spinal or pelvic segments, although the direction and magnitude of these relationships depend on individual anatomical characteristics. Radiological research involving degenerative spinal kyphosis has described compensatory musculoskeletal mechanisms associated with altered sagittal alignment, while investigations of adolescent spinal deformity have examined interactions among regional sagittal parameters (Xia et al., 2021; Katzouraki et al., 2024). These studies provide a biomechanical basis for considering thoracic curvature as part of broader spinal morphology, but the current investigation did not measure pelvic alignment, lumbar lordosis, or compensatory mechanisms and cannot determine whether comparable adaptations occurred among its participants.

Variability in thoracic kyphosis has also been examined in relation to physical activity, sedentary behavior, and habitual postural patterns among young adults. Studies of university populations have identified associations between spinal curvature characteristics and somatic or behavioral variables, although their cross-sectional findings do not establish whether these factors precede or result from particular postural configurations (Marijančić et al., 2023; Grabara & Witkowska, 2024). Research involving university students has further suggested that sedentary behavior may be associated with different regional spinal characteristics in men and women, indicating that the anatomical effects of habitual posture should not be assumed to be uniform across populations (Zemková et al., 2023). The present study did not quantify physical activity, sitting duration, or sex-stratified kyphosis distributions, making it inappropriate to attribute the observed proportion of elevated kyphosis angles to academic workload, prolonged sitting, or other behavioral exposures.

The clinical interpretation of elevated thoracic curvature requires particular caution because an angular measurement does not independently establish pain, respiratory dysfunction, restricted movement, or reduced functional capacity. Investigations involving university students have examined relationships between thoracic kyphosis angles and respiratory parameters, while research among individuals with chronic nonspecific neck pain has explored associations involving disability, autonomic function, and cervical sensorimotor control (Çelik et al., 2025; Moustafa et al., 2023). These findings indicate that thoracic curvature may be considered alongside functional outcomes when a study is specifically designed to measure such relationships. No respiratory, neurological, pain-related, or functional outcome measurements were included in the present analysis, so the 33 students classified as having hyperkyphosis cannot be assumed to have associated symptoms or clinically meaningful limitations.

The use of the flexicurve ruler provides a practical approach to estimating thoracic curvature without exposing participants to ionizing radiation, but its measurement characteristics must be distinguished from those of radiographic assessment. Previous reliability investigations have evaluated flexicurve-derived curvature indices and angles, demonstrating the importance of examiner consistency, anatomical landmark identification, and standardized contour measurements when interpreting thoracic kyphosis (Barrett et al., 2013; Lewis & Valentine, 2010). More recent studies have compared nonradiological approaches, including flexicurve measurements and smartphone-based inclinometers, while systematic evidence has emphasized the variability in validity, reliability, and clinical applicability across instruments (Elpeze et al., 2023; de la Encarnación Simarro & Martínez González-Moro, 2024; Nepomuceno et al., 2025). Although the present study employed a defined C7–T12 measurement procedure and a specified angular calculation, it did not report participant-specific radiographic validation or examiner reliability coefficients, restricting the interpretation of its findings to estimated thoracic curvature.

The findings provide a descriptive reference for thoracic kyphosis among medical students at Universitas Jambi while identifying areas requiring further analytical and clinical investigation. The predominance of angles within the operational normal range, alongside a measurable proportion exceeding 40°, supports the relevance of documenting postural variation without equating categorical measurements with clinical diagnoses. Research on corrective exercise has examined potential

changes in thoracic curvature and related outcomes among selected adolescent and young adult populations, but evidence of intervention effectiveness in those groups does not demonstrate that the participants in this study require or would benefit from comparable treatment (Elpeze & Usgu, 2022; Yang et al., 2024; Fernández Fernández et al., 2025). Future investigations incorporating standardized reliability assessment, functional measurements, behavioral exposures, and radiographic confirmation where clinically justified could clarify the significance of elevated thoracic curvature, while the present findings remain a population-specific description of measured angles and their operational classifications.

Integration of Anthropometric and Thoracic Kyphosis Findings: Methodological Implications and Relevance for Postural Assessment

The concurrent assessment of the Cormic Index and thoracic kyphosis angle among medical students at Universitas Jambi provides two complementary descriptions of body morphology and sagittal spinal posture within the same population. The Cormic Index characterizes the proportion of sitting height relative to standing height, whereas the thoracic kyphosis angle represents the estimated curvature of the thoracic spine in habitual standing posture. These measurements describe different anatomical characteristics and should not be interpreted as interchangeable indicators of postural alignment or spinal abnormalities. Anthropometric research emphasizes the importance of relative body proportions, while studies of sagittal spinal curvature identify regional spinal alignment as a separate dimension of musculoskeletal morphology (Bogin & Varela-Silva, 2010; Grabara & Witkowska, 2024). The integration of these measurements provides a broader descriptive profile of the study population without establishing a statistical relationship between trunk proportions and thoracic curvature.

The descriptive findings demonstrated a median Cormic Index of 52.90%, with an interquartile range of 2.10 and observed values between 49.4% and 55.4%. The median thoracic kyphosis angle was 33.90°, with an interquartile range of 11.00° and measurements extending from 20.3° to 62.4°, indicating a wider numerical range in its respective angular measurement scale. Although both variables exhibited measurable variation, differences between their numerical ranges cannot be used to infer differences in biological variability because they represent distinct measurement units and anatomical constructs. Research examining somatic characteristics and spinal curvature supports the scientific relevance of considering anthropometric and postural parameters together, although the interpretation of their potential relationships requires appropriate statistical analysis (Marijančić et al., 2023; Grus et al., 2025). The present univariate approach permits the identification of population-specific distributions but does not determine whether participants with higher Cormic Index values also exhibited greater thoracic kyphosis angles.

The concurrent measurements are summarized in Table 3 to clarify the descriptive relationship between the anthropometric and postural dimensions included in the study. Both variables were measured in the same 128 participants, allowing their respective distributions to be characterized within a consistent sampling framework. The categorical classification of thoracic kyphosis provides an additional description of the frequency of elevated curvature angles, although corresponding Cormic Index values were not cross-tabulated according to kyphosis categories. Previous investigations involving young adults have incorporated anthropometric and sagittal alignment measurements, demonstrating the relevance of multidimensional assessment while emphasizing the need to distinguish descriptive comparisons from statistically established associations (Grabara & Witkowska, 2024; Dharnipragada et al., 2024).

Table 3. Integrated Descriptive Profile of the Cormic Index and Thoracic Kyphosis among Medical Students at Universitas Jambi, Class of 2025

Measurement	n	Median (IQR)	Minimum–Maximum
Cormic Index (%)	128	52.90 (2.10)	49.4–55.4
Thoracic kyphosis angle (°)	128	33.90 (11.00)	20.3–62.4
Thoracic kyphosis category	**Frequency (n)**	**Percentage (%)**	
Normal (20°–40°)	95	74.2	
Hyperkyphosis (>40°)	33	25.8	

Total	128	100.0

Note. IQR = interquartile range.

Table 3 demonstrates that the study generated two distinct numerical distributions together with a categorical description of thoracic curvature, providing a complementary anthropometric and postural profile of the participating students. The findings indicate that the median thoracic kyphosis angle was within the operational normal range, while 25.8% of participants had estimated angles exceeding 40°. The coexistence of these observations at the population level does not establish that variations in relative trunk length are associated with the likelihood of hyperkyphosis, because individual-level relationships were not examined. Research on sagittal alignment has identified interactions among spinal regions and compensatory anatomical mechanisms, but these findings concern biomechanical relationships that cannot be inferred from separate descriptive summaries of the Cormic Index and thoracic kyphosis angle (Xia et al., 2021; Katzouraki et al., 2024). The present evidence consequently supports anatomical characterization rather than explanatory conclusions concerning the influence of body proportions on spinal curvature.

The distinction between anthropometric structure and postural configuration is particularly relevant when interpreting the implications of the observed findings. The Cormic Index represents a proportional characteristic derived from sitting and standing height measurements, whereas thoracic kyphosis reflects the contour of a spinal region that may vary with anatomical characteristics and examination position. Studies examining sagittal spinal alignment in sitting and standing positions have identified the relevance of posture-dependent measurement conditions, indicating that spinal curvature should not be treated as a fixed representation of trunk proportion (Dharnipragada et al., 2024). Research on anthropometric variation similarly demonstrates that proportional body dimensions require interpretation according to the population and measurement characteristics under investigation (Hoover-Fong et al., 2025; Asafa et al., 2022). The use of different positions for measuring sitting height and thoracic curvature in this study was consistent with the operational requirements of each variable, but it does not establish a biomechanical connection between the resulting measurements.

The methodological characteristics of the study influence the strength and scope of the conclusions that can be derived from the integrated profile. The application of a digital microtoise for anthropometric measurements and a flexicurve ruler for thoracic curvature estimation provided noninvasive procedures for collecting complementary measurements in a university population. Previous investigations have examined the reliability of flexicurve-based measurements, while recent developments in smartphone inclinometers, inertial sensors, and automated curvature detection have expanded available approaches for spinal posture assessment (Barrett et al., 2013; Elpeze et al., 2023; Koca & Koca, 2025; Kocak et al., 2025). These technological developments demonstrate that several assessment strategies are available, although differences in instrumentation and measurement procedures may influence comparability across studies. The present investigation did not include radiographic validation, repeated measurements for reliability estimation, or comparisons between instruments, so its thoracic kyphosis measurements must be interpreted as estimates obtained under the specified research protocol.

The educational setting provides a relevant population for documenting anthropometric and spinal posture characteristics, particularly because university students may experience prolonged periods of seated academic activity. Previous studies have examined associations between sedentary behavior, physical activity, and spinal curvature in university populations, while research involving smartphone use has identified relationships between sustained postural positions and musculoskeletal discomfort among adolescents (Zemková et al., 2023; Tsang et al., 2023). These findings support further investigation of behavioral characteristics as potential correlates of sagittal spinal alignment, but they do not demonstrate that such exposures explain the thoracic kyphosis distribution observed among medical students at Universitas Jambi. The absence of sitting-duration measurements, physical activity assessments, and information on habitual device use prevents the evaluation of behavioral contributions to the recorded angles. The study therefore provides a descriptive foundation for subsequent research rather than direct evidence that medical education activities contributed to elevated thoracic curvature.

The proportion of participants classified as having hyperkyphosis also raises questions concerning the appropriate interpretation and potential application of posture-related findings in educational health settings. Evidence from corrective exercise research indicates that thoracic curvature and related functional outcomes have been examined as intervention targets in selected populations, including adolescents and young adults with increased kyphosis (Elpeze & Usgu, 2022; Yang et al., 2024; Fernández Fernández et al., 2025). Other investigations have evaluated exercise-based interventions involving respiratory function, scapular positioning, and postural correction, demonstrating the clinical interest in multidimensional approaches to thoracic alignment (Elabd et al., 2025; Kouchi et al., 2025). Nevertheless, the classification of 33 participants above the operational threshold does not establish their need for treatment because no clinical diagnostic examination, functional assessment, or intervention evaluation was undertaken. The findings may inform the planning of future postural assessments and ergonomic education initiatives, provided that decisions concerning individual clinical management are based on appropriate additional evaluation.

The scientific contribution of the study lies in establishing a cohort-specific descriptive reference for relative trunk proportion and thoracic spinal curvature while identifying the analytical questions that remain unresolved. The cross-sectional design and univariate statistical approach allow the distributions of the Cormic Index and thoracic kyphosis angle to be documented, but they do not support conclusions regarding correlation, causal mechanisms, or temporal changes in spinal alignment. Contemporary investigations have explored increasingly sophisticated postural assessment methods, including automated screening technologies, while systematic analyses continue to emphasize the importance of measurement validity and clinical applicability (Rahman, 2026; Nepomuceno et al., 2025). Future research could examine individual-level associations between the Cormic Index and thoracic kyphosis angle using appropriate inferential methods, with consideration of sex, body mass index, physical activity, and sitting duration as potential covariates. The present findings contribute preliminary anthropometric and postural evidence for medical students at Universitas Jambi and provide a defined empirical basis for developing more comprehensive investigations of spinal morphology in young adult educational populations.

CONCLUSION

This study provides a descriptive characterization of the Cormic Index and thoracic kyphosis angle among 128 medical students at Universitas Jambi from the class of 2025. The median Cormic Index was 52.90% (IQR = 2.10; range = 49.4–55.4%), indicating measurable variation in relative trunk proportions within the study population. The median thoracic kyphosis angle was 33.90° (IQR = 11.00°; range = 20.3°–62.4°), with 95 students (74.2%) classified as having normal thoracic kyphosis and 33 students (25.8%) categorized as having hyperkyphosis according to the predefined operational thresholds. These findings demonstrate that most participants exhibited thoracic curvature within the study's normal classification, while approximately one-quarter had estimated angles exceeding 40°. The concurrent assessment of anthropometric proportions and thoracic spinal curvature contributes population-specific descriptive evidence concerning body morphology and postural characteristics in young adults. The findings may serve as preliminary reference data for subsequent musculoskeletal assessments and the development of further research on postural health among medical students. Nevertheless, the cross-sectional design, single-institution sample, nonradiological curvature measurements, and exclusively univariate analysis limit the generalizability and explanatory scope of the findings. No statistical association between the Cormic Index and thoracic kyphosis angle was examined, and the operational classification of hyperkyphosis should not be interpreted as a confirmed clinical diagnosis. Future investigations should incorporate analytical designs, broader student populations, standardized measurement reliability assessments, and relevant anthropometric and behavioral variables to clarify potential relationships between body proportions and thoracic spinal alignment.

REFERENCES

Ahmed, Z. M., Ashique, I., Zafar, A., Ali, Z., Zafar, M., & Rasool, A. (2024). Prevalence of Thoracic Hyperkyphosis Posture Among Female Students of Allied Health Institutes and Its

Association With Rounded Shoulders. Journal of Health and Rehabilitation Research, 4(3), 1–4. https://doi.org/10.61919/jhrr.v4i3.1561

Asafa, A. M., Bolarinwa, R. A., & Oyewole, S. A. (2022). Assessment of Cormic Index and Other Anthropometric Parameters of Young Adults With Sickle Cell Anaemia in Ile-Ife, Nigeria. American Journal of Internal Medicine, 10(5), 102–108. https://doi.org/10.11648/j.ajim.20221005.13

Barrett, E., McCreesh, K., & Lewis, J. (2013). Intrarater and Interrater Reliability of The Flexicurve Index, Flexicurve Angle, and Manual Inclinometer for the Measurement of Thoracic Kyphosis. ISRN Rehabilitation, 2013, Article 475870. https://doi.org/10.1155/2013/475870

Bogin, B., & Varela-Silva, M. I. (2010). Leg Length, Body Proportion, and Health: A Review With a Note on Beauty. International Journal Of Environmental Research And Public Health, 7(3), 1047–1075. https://doi.org/10.3390/ijerph7031047

Çelik, H., Kaban, Y. E., Demir, O. B., & Yılmaz, F. T. (2025). The relationship between thoracic kyphosis angle and respiratory function parameters in university students. Journal of Contemporary Medicine, 15(6), 285–290. https://doi.org/10.16899/jcm.1776303

de la Encarnación Simarro, G., & Martínez González-Moro, I. (2024). Reliability of two smartphone inclinometer apps in the measurement of dorsal kyphosis in three different positions. Journal of Bodywork and Movement Therapies, 40, 1802–1809. https://doi.org/10.1016/j.jbmt.2024.10.001

Dharnipragada, R., Bostrom, N., Bertogliat, M., Denduluri, L. S., Dhawan, S., Ladd, B., Woodrow, S., & Parr, A. M. (2024). Sagittal balance in sitting and standing positions: A systematic review of radiographic measures. Heliyon, 10(7), Article e28545. https://doi.org/10.1016/j.heliyon.2024.e28545

Elabd, O. M., Elsamahy, S. A., Abdelmutilibe, S. M., Mohammed, A. H., Ali, F., & Elabd, A. M. (2025). Effect of adding diaphragmatic myofascial release to corrective exercise on the thoracic curvature angle and pulmonary function testing in hyperkyphotic adolescent girls: A randomized controlled trial. American Journal of Physical Medicine & Rehabilitation, 104(3), 203–209. https://doi.org/10.1097/PHM.0000000000002622

Elpeze, G., & Usgu, G. (2022). The Effect of a Comprehensive Corrective Exercise Program on Kyphosis Angle and Balance in Kyphotic Adolescents. Healthcare, 10(12), Article 2478. https://doi.org/10.3390/healthcare10122478

Elpeze, G., Usgu, G., & Yiğit, S. (2023). Reliability of the Smartphone Application Inclinometer and Flexicurve in Measuring Thoracic Kyphosis. Cureus, 15(3), e35886. https://doi.org/10.7759/cureus.35886

Fernández Fernández, L., Rodríguez-Gude, C., & de Oliveira, I. M. (2025). Effect of therapeutic exercise on the management of hyperkyphosis in adolescence and young adulthood: A systematic review. Physiotherapy Research International, 30(3), Article e70078. https://doi.org/10.1002/pri.70078

Fujimoto, K., Harimoto, K., Misaki, K., Kobayashi, T., Ushio, M., Kato, H., et al. (2023). Characteristics of Sagittal Spinal Alignment of Male University Students in the Upright Standing Position: Focus on Thoracic Hyperkyphosis. Journal of Physical Therapy Science, 35(4), 273–278. https://doi.org/10.1589/jpts.35.273

Grabara, M., & Witkowska, A. (2024). Sagittal Spinal Curvatures of Young Adults in the Context of Their Self-Reported Physical Activity and Somatic Parameters. Scientific Reports, 14(1), Article 12221. https://doi.org/10.1038/s41598-024-62929-9

Grus, C., Lukáčová, E., Škrečková, G., Lenková, R., Kozel, M., & Macej, M. (2025). Spine curvature and physical activity level: A pilot study in young adults. Health Problems of Civilization. https://doi.org/10.5114/hpc.2025.153688

Hoover-Fong, J., Semler, O., Barron, B., Collett-Solberg, P. F., Fung, E., Irving, M., Kitaoka, T., Koerner, C., Okada, K., Palm, K., Sousa, S. B., & Mohnike, K. (2025). Considerations for anthropometry specific to people with disproportionate short stature. Advances in Therapy, 42(3), 1291–1311. https://doi.org/10.1007/s12325-024-03061-y

Katzouraki, G., Vasiliadis, E. S., Kaspiris, A., Evangelopoulos, D.-S., Grivas, T. B., & Pneumatikos, S. G. (2024). Sagittal balance parameters and proximal junctional kyphosis in adolescent

idiopathic scoliosis. Journal of Clinical Medicine, 13(7), Article 1895. https://doi.org/10.3390/jcm13071895

Kłapeć, W., Możdżeń, A., Jaśkowska, J., & Szymonek, P. (2025). The Science of Posture: How the Spine Shapes Health and Mobility. Wiadomości Lekarskie, 78(3), 609–614. https://doi.org/10.36740/WLek/202582

Koca, R., & Koca, Y. B. (2025). Anatomy-based assessment of spinal posture using IMU sensors and machine learning. Sensors, 25(19), Article 5963. https://doi.org/10.3390/s25195963

Kocak, O., Ficici, C., Dogan, I. E., Telatar, Z., & Pekyavas, N. O. (2025). Automated detection of the kyphosis angle using a deep learning approach: A cross-sectional study on young adults. Diagnostics, 15(11), Article 1422. https://doi.org/10.3390/diagnostics15111422

Kouchi, D., Sahebozamani, M., Daneshjoo, A., Amatachaya, S., Alimoradi, M., & Iranmanesh, M. (2025). Effects of an 8-week corrective dance exercises intervention on thoracic hyperkyphosis, scapular position, respiratory function, and happiness in girls aged 10–12 years. Pediatric Exercise Science, 37(3), 252–259. https://doi.org/10.1123/pes.2023-0169

Koyama, K., Ichiba, T., Furushima, K., Sugano, Y., Niitsu, A., Kodachi, Y., Niino, S., Ueno, M., & Adachi, K. (2025). Characteristics of sagittal spinal alignment in Japanese elementary school students in standing position: Focusing on thoracic hyperkyphosis. Anthropological Science, 133(1), 39–43. https://doi.org/10.1537/ase.240503

Lewis, J. S., & Valentine, R. E. (2010). Clinical Measurement of the Thoracic Kyphosis: A Study of the Intra-Rater Reliability in Subjects With and Without Shoulder Pain. BMC Musculoskeletal Disorders, 11, Article 39. https://doi.org/10.1186/1471-2474-11-39

Marijančić, V., Grubić Kezele, T., Peharec, S., Dragaš-Zubalj, N., Pavičić Žeželj, S., & Starčević-Klasan, G. (2023). Relationship Between Physical Activity And Sedentary Behavior, Spinal Curvatures, Endurance And Balance Of The Trunk Muscles—Extended Physical Health Analysis In Young Adults. International Journal of Environmental Research and Public Health, 20(20), Article 6938. https://doi.org/10.3390/ijerph20206938

Moustafa, I. M., Shousha, T., Arumugam, A., & Harrison, D. E. (2023). Is thoracic kyphosis relevant to pain, autonomic nervous system function, disability, and cervical sensorimotor control in patients with chronic nonspecific neck pain? Journal of Clinical Medicine, 12(11), Article 3707. https://doi.org/10.3390/jcm12113707

Murakami, Y., Akiyama, T., & Sugamura, G. (2026). Effects of postural intervention using a risshin chair on physical posture, class time perception, and subjective well-being in junior high school students. British Journal of Educational Psychology, 96(3), 1341–1361. https://doi.org/10.1111/bjep.70087

Nepomuceno, A. P. F. A., Cury, A. C., Pinheiro, L. S. P., Sabino, G. S., Souza, T. R., Fonseca, S. T., Ocarino, J. M., & Resende, R. A. (2025). Validity, reliability, and clinical usefulness of instruments for measuring thoracic kyphosis: A systematic review and meta-analysis. Brazilian Journal of Physical Therapy, 29(5), Article 101246. https://doi.org/10.1016/j.bjpt.2025.101246

Oliveira-Costa, E., Alonso-Fernández, D., & Gutiérrez-Sánchez, Á. (2025). The impact of exercise on spinal posture in adolescents: A systematic review. Revista Paulista de Pediatria, 43, Article e2025013. https://doi.org/10.1590/1984-0462/2025/43/2025013

Rahman, B. (2026). AI based sagittal spinal posture assessment for adolescent screening in low resource school settings. Scientific Reports, 16, Article 7076. https://doi.org/10.1038/s41598-026-36634-8

Tang, Q., Gong, D., Ye, X.-M., Zhang, J., Xu, J.-R., Yang, Y.-C., Yan, L.-J., Zou, L., & Wen, X.-L. (2024). Study of height, sitting height, lower extremity length, and the prevalence of short stature among elementary school students in the Tianyuan District of Zhuzhou City. Medicine, 103(4), Article e36935. https://doi.org/10.1097/MD.0000000000036935

Tsang, S. M. H., Cheing, G. L. Y., & Chan, J. W. K. (2023). Severity of slouched posture during smartphone use is associated with the musculoskeletal discomfort, daily usage, and school year among adolescents. Ergonomics, 66(9), 1340–1353. https://doi.org/10.1080/00140139.2022.2146208

Xia, W., Wang, W., Zhu, Z., Liu, C., Xu, S., & Meng, F. (2021). The Compensatory Mechanisms for Global Sagittal Balance in Degenerative Spinal Kyphosis Patients: A Radiological Analysis

.

of Muscle-Skeletal Associations. BMC Musculoskeletal Disorders, 22, Article 697. https://doi.org/10.1186/s12891-021-04567-6

Yang, S., Yi, Y. G., & Chang, M. C. (2024). The Effectiveness of Exercise Programs in Adolescents With Thoracic Kyphosis: A Narrative Review. Healthcare, 12(15), Article 1503. https://doi.org/10.3390/healthcare12151503

Zappalá, M., Lightbourne, S., & Heneghan, N. R. (2021). The Relationship Between Thoracic Kyphosis and Age, and Normative Values Across Age Groups: A Systematic Review Of Healthy Adults. Journal of Orthopaedic Surgery and Research, 16(1), Article 447. https://doi.org/10.1186/s13018-021-02592-2

Zemková, E., Čepková, A., & Muyor, M. (2023). Sedentary Lifestyle of University Students is Detrimental to the Thoracic Spine in Men and to the Lumbar Spine in Women. Frontiers in Physiology, 14, Article 1246458. https://doi.org/10.3389/fphys.2023.1246458

Żurawiecka, M., & Wronka, I. (2022). Association of age at menarche with adult height and sitting height in young Polish females. Anthropologischer Anzeiger, 79(1), 1–10. https://doi.org/10.1127/anthranz/2021/1264