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Original Article

Evaluation of geometric parameters of the lumbosacral vertebae: a radiographic study of indigenes, resident in Yenagoa

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Abstract

BACKGROUND AND AIM: Dimensions of geometric variables of the lumbar vertebrae are important for proper planning and implant design in the management of low back pain. Variations in the dimensions have been observed across different populations hence the objective of this study to provide reference values for the population under study. This study evaluates the geometric parameters of the lumbosacral vertebrae, focusing on the lumbosacral angle (LSA), lumbar lordosis angle (LLA), and lumbosacral disc angle (LSDA).
MATERIALS AND METHODS: Normal lumbosacral spine x-rays of 200 adult (96 males and 104 females) aged from 18-60 years were used for this study. The lumbosacral angle (LSA), lumber lordotic angle (LLA) and lumbosacral disc angle (LSDA) were measured using a goniometer. Simple random sampling technique was used and all data subjected to statistical analysis with p-value 0.05 as statistically significant.
RESULTS: The mean LSA° for all ages in our study population is 39.35°±6.04, while the mean of LLA° is 42.58°±7.27 and that for LSDA is 13.54°±2.60.
No significant difference was seen in the values between males and females in LSA°, LLA° and LSDA°.
CONCLUSION: In conclusion this study determined the values of LSA, LLA and LSDA in the study population which will be of value in the intervention and management of low back pain in our population.

Keywords:
lumbosacral spine, morphometry, spine, radiograph, Nigerians

INTRODUCTION

The lumbosacral area of the vertebral spine, comprising the lumbar and sacral vertebrae, is essential for stability, weight support, and movement facilitation. The most significant portion of the spinal column regarding movement and weight-bearing is this area. The cervical and lumbar vertebrae exhibit lordosis, while the thoracic and coccygeal vertebrae display kyphosis (Waxenbaum *et al.*, 2017).
The vertebral spine has regional curvature in the sagittal plane that are intended to absorb impact, diminish longitudinal stiffness, and enhance muscular performance (Gelb *et al.,* 1995). Measurements of the sagittal curve of the spine exhibit significant heterogeneity across normal individuals, frequently including a broad spectrum of variation. There is seen a correlation between elevated lumbar angles and overweight in certain African population (Onyemaechi *et al.*, 2016). The radiography of the lumbosacral angle (LSA) concerning spinal curvature and measured by Ferguson's approach is pertinent in managing low back pain resulting from inflammation and degeneration. Flexion relaxation (FR) in the lumbar region transpires when the burden shifts from the spinal extensor muscles to the passive tissues (Mukherjee *et al.,* 2021). The sacral angle (SA) is a crucial metric in the degeneration of lumbosacral discs. The diminutive intervertebral discs in degenerative spondylolisthesis may serve as a predisposing factor for the condition's progression. Males exhibit a greater interpedicular distance than females. The spine is a mobile, weight-bearing structure, and its sagittal alignment comprises self-regulating reciprocal curves that consistently strive to maintain equilibrium, so promoting energy conservation and overall health quality. Alterations in lumbar lordosis result in low back pain (LBP) (Hosseinifar *et al.*, 2017). Demographic variables significantly influence patient-specific spinal therapy. The standard values of the radiography parameter are essential for assessing sagittal and spinal pelvic balance in people.
Low back pain (LBP) is a prevalent issue that results in significant morbidity and socio-economic detriment

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within the population (Dincer *et al*., 2007), with a lifetime incidence ranging from 50% to 90%. Consequently, assessing lumbosacral geometry is a significant factor in determining the potential etiology of low back pain (Bryner and Moussali 1992). Therefore it is important to understand these parameters to aid in diagnoses, proper interventions and optimizing patient outcome. Also it is a well-known fact that demographic variations play a functional role in patient specific spinal treatment (Singh *et al,* 2018). For this, there is need for a comprehensive radiographic study to evaluate the geometric parameters and their clinical implications among populations. This study aims to contribute to the understanding of the geometric variables of the lumbosacral spine anatomy in this population which will be of value in the proper management of low back pain.

MATERIALS AND METHODS

X-ray films from 200 patients (96 males and 106 females) were obtained from Federal Medical Centre Yenagoa, Niger Delta University Teaching Hospital Okolobiri, and Tobi's Clinic, Yenagoa, between March and July 2024 for this study. Demographic data of the name, sex, age, ethnicity and address were collected from each patient with their consent. The study included males and females between 20-60 years with no history of spinal trauma. While Patients having prolonged back pain, pregnant women, spinal stenosis or has undergone spine surgery were excluded. The radiologist reported the x-rays as normal and all data were grouped into five age groups. Measurements were done by placing the radiographs in a viewing screen and with the aid of a goniometer the LSA, LLA and LSDA were determined in degrees.

Simple random probability sampling technique was employed and all data grouped into 5 age groups: (18-26; 27-34; 35-42; 43-51; & 52-60 years).

Ethical clearance was sort and obtained from the university ethical committee (Ref no: 01-132024/009 & FMCY/REC/ECC/2024/MARCH/735) before commencement of this study.

Lumbosacral Angle (LSA)

Using the Ferguson's method, a line parallel to the upper surface of the sacrum is drawn and a horizontal line intersecting the sacral base line is also drawn. The angle formed between these two lines, were measured as the angle of the lumbosacral junction.

Lumbar Lordosis Angle (LLA)

The superior endplate of the first lumbar vertebra (L1) and the superior endplate of the last lumbar vertebra (L5) on a lateral radiograph were identified and lines tangent to the superior endplates of L1 and L5 were drawn. The angle formed between these two lines was measured as the degree of lumbar lordosis.

Lumbosacral Disc Angle (LSDA)

The superior endplate of the last lumbar vertebra (L5) and the inferior endplate of the sacrum (S1) on a lateral radiograph were identified and lines tangent to the superior endplate of L5 and the inferior endplate of S1 were drawn. The angle formed between these two lines were then measured as the angle of the lumbosacral disc.

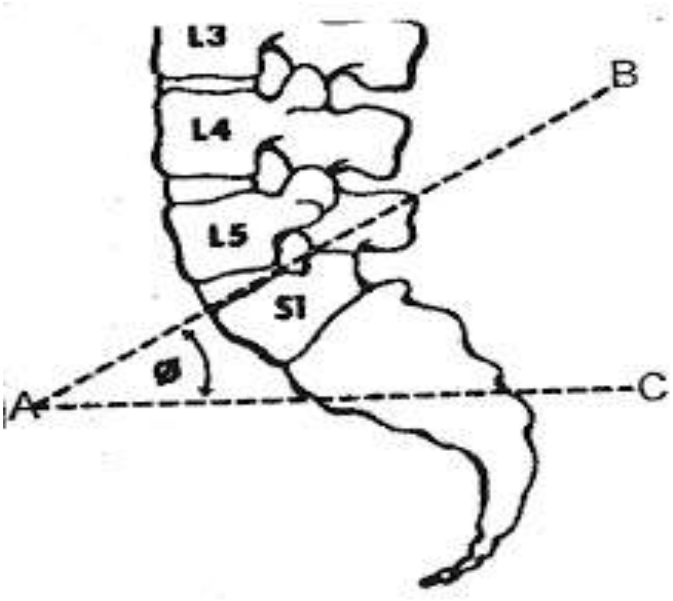

Figure 1. Ferguson's Method of measuring Lumbosacral Angle

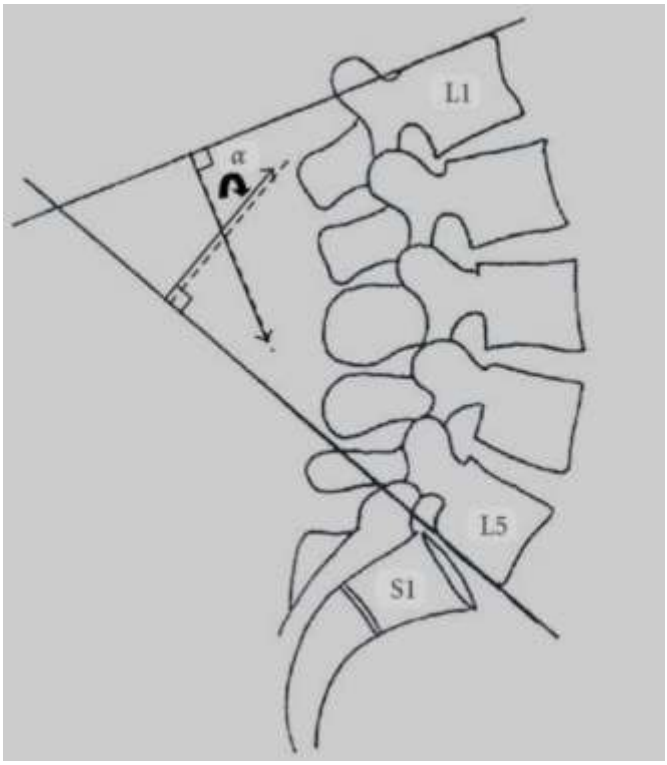

Fig 2 Measurement of Lumbar lordosis Angle (Cobb's Method)

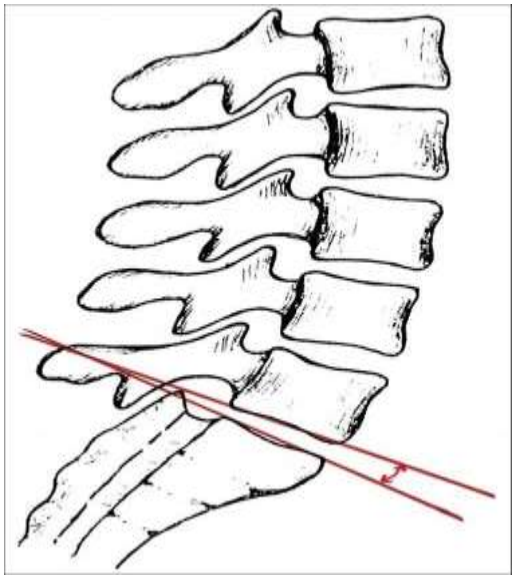

Fig3. Measurement of Lumbosacral Disc Angle

Data Analysis

Microsoft excel (2013) was used to analyze the data. Descriptive analysis including the mean and standard deviation was used to describe quantitatively the selected radiographic measurements and percentage distribution. Comparison of quantitative radiographic measurements between demographic groups was achieved by one-way ANOVA. A p value <0.05 was considered as statistically significant.

RESULTS

Table 3 is a Descriptive statistic of all the quantitative variables. The mean±SD age of the subjects was 44±13.80. The youngest being 18 and the oldest being 60. The mean±SD of LSA was 39.35°±6.04, LLA was 42.58° (±7.27) and LSDA was 13.54°±2.60.

Table 4 shows the LSA, LLA and LSDA measurements across different age groups. The LSA measurements vary across different age groups as evidenced by the differences in mean values. The age group 27-34 has the highest mean LSA measurement (40.56º ± 5.82), while the age group 18-26 has the lowest mean LSA measurement (34.93º± 4.78). The mean LLA measurements vary across different age groups, ranging from 41.68 to 43.84 degrees. There isn't a clear trend of increasing or decreasing LLA measurements with age. The mean LSDA measurements vary across different age groups, ranging from 13.4 to 13.6 degrees. No clear trend of increasing or decreasing LSDA measurements with age is apparent from the data.

Table 5 is a comparative analysis of all quantitative variables between males and females. One-way ANOVA was used to analyze the statistical significance of the measurement and a P-value of <0.05 was considered as statistically significant. From the table, LSA between male and female had a P-Value 0.70, while LLA, and LSDA has P-values of 0.65 and 0.20 respectively. All indicative of a statistical insignificance.

Table 1: Frequency distribution of the subjects by age groups

Age group (years)	Frequency	Percent (%)
18 – 26	20	10.0
27 – 34	37	18.5
35 – 42	42	21.0
43 – 51	49	24.5
52 – 60	52	26.0
Total	**200**	**100.0**

Table 2: Distribution of subjects by sex

Sex	Frequency	Percent (%)
Male	94	47.00
Female	106	53.00
Total	**200**	**100.00**

Table 3 Descriptive statistics of all the quantitative variables

Variables	Mean±SD	Range
Age (years)	44.00±13.80	18.00±60.00
LSA°	39.35±6.04	27.00±50.00
LLA°	42.58±7.27	28.00±57.00
LSDA°	13.54±2.60	9.00±19.00

Table 4 Distribution of LSA, LLA & LSD of subjects by age

Age group (years)	LSA ± SD (º)	LLA ± SD (º)	LSDA ± SD (º)
18 – 26	34.93± 4.78	42.67 ± 8.35	13.48 ± 2.35
27 – 34	40.56 ± 5.82	43.84 ± 7.66	13.50 ± 2.02
35 – 42	38.23 ± 6.37	42.37 ± 7.39	13.55 ± 2.56
43 – 51	39.82 ± 6.44	42.74 ± 6.32	13.61 ± 2.95
52 – 60	39.50 ± 5.36	41.68 ± 7.27	13.52 ± 2.84
Total	**39.35 ± 6.04**	**42.58 ± 7.27**	**13.54 ± 2.60**

Table 5 Comparative analysis of all quantitative variables between males and females.

Variables	Male	Female	P value
LSAº	39.56±5.88	38.67±6.16	0.70
LLAº	42.54±7.49	42.62±7.05	0.65
LSDAº	13.28±2.61	13.74±2.60	0.20

DISCUSSION

The lumbosacral region is the most significant portion of the spinal column with regards to movement and weight-bearing and so often, quality of life is affected by debilitating and excruciating low back pain that requires intervention. For effective intervention,

there is need for patient specific data to be generated. Attention has been drawn to the variations in data in context of the values of the lumbosacral angle, lumber lordotic angle and the lumbosacral disc angle across different populations in literature hence the need for this study to generate a baseline data for the Ijaw population of Nigeria resident in Yenagoa.

The age range of our population which is 18 to 60 years was dissimilar to those of Tibrewal and Pearcy (1985); Chernukha *et al.,* (1998); Shao *et al.,* (2002), but similar to that of Nourbakhish *et al.,* (2001).

There is a slight female preponderance in this study which is similar to the reports of Kim *et al.,* (2006) and Eyichukwu and Ogugua (2012). However, this finding differs from the results of Kamali *et al.,* (2004) which showed a male preponderance.

The Lumbosacral angle (LSA) commonly measured by the Ferguson's technique (fig 1) is among the very important radiographic angles to determine when it concerns lower region back pain intervention. Due to demographic characteristics', there have been varying data of LSA in literature. The mean LSA of our study population is similar to that of Naidoo (2008), although his study population comprises only adult females. The values reported by Kim *et al.,* (2006) and Chung *et al.,* (1981) were significantly lower while that reported by Fernand & Fox (1985) were higher than in this study. The LSA has a wide range as noted in this study and this could be explained by the fact that the subjects in the study by Chung *et al.,* (1981) and Kim *et al.,* (2006) were symptomatic individuals diagnosed with mechanical LBP and also they used the erect position while ours was recumbent. The differences in the methods of measuring the LSA could also account for the inconsistent results reported by various authors. Further standardized studies are required to establish the reproducibility and reliability of the various methods of measuring the LSA.

With respect to the association between the LLA and age, the findings in this study support those of Murrie *et al.,* (2003); Nourbakhish *et al.,* (2001) and Korovessis *et al.,* (1998)

This study found no significant difference in the mean lordotic angle between males and females. This was previously documented by Farfan *et al.,* (1973), Stagnara et al. (1982), Youdas *et al*. (2000), Amonoo-Kuofi (1992), Korovessis *et al.* (1998). Fernand and Fox (1985) in their study indicated a higher LLA in women. Also Stagnara *et al*. (1982) observed increased lordosis in women during physical examination, attributing it to a more pronounced curvature of the buttocks due to the absence of radiographic proof.
The association between LBP and LLA has been thoroughly examined, with incongruous findings (Farfan *et al.*, 1972; Magora and Schwartz 1978; Torgerson and Dotter 1976). An increase in the lordotic angle has been documented to elevate shearing strain and stress in the lumbar spine, correlating with a higher incidence of low back pain (LBP). Randomized controlled research are necessary to elucidate this association more definitively.

The mean LSDA in this study was slightly lower when compared with the study by Bryner and Moussali (1992). The range of the LSDA in this study was greater than the range reported by Banks (1983) and Cox (1990). The reason for these observations is not very clear. There was no significant difference in the mean LSDA for both sexes.

Conclusion: The geometric parameters of the lumbosacral angle, lumbar lordotic angle and lumbosacral disc angle analyzed in this study revealed no significant differences between males and females. Age-related differences in these parameters were also not significant in this study.

However variations in the Lumbosacral Angle (LSA), Lumbar Lordosis Angle (LLA), and Lumbosacral Disc Angle (LSDA) are found when compared to previous studies. These findings suggest that while there are established ranges for these parameters, individual variations exist and should be taken into consideration in intervention modalities in the management of low back pain.

REFERENCES

Amonoo-Kuofi, U. S. (1992). Changes in the lumbosacral angle, sacral inclination and the curvature of the lumbar spine during aging. *Cells Tissues Organs*, *145*(4), 373-377.

Banks, S. D. (1983). The use of spinographic parameters in the differential diagnosis of lumbar facet and disc syndromes. *Journal of manipulative and physiological therapeutics*, *6*(3), 113-116.

Bryner, P., & Mousalli, M. E. (1992). Lumbar spine lordosis in low-back pain: an analysis of radiographs. *Chiropr J Aust*, *22*, 42-46.

Chernukha, K. V., Daffner, R. H., & Reigel, D. H. (1998). Lumbar lordosis measurement: A new method: Versus: Cobb technique. *Spine*, *23*(1), 74-79.

Chung, H. S., Lee, K. C., Lee, H. K., Kim, H. D., & Chu, J. W. (1981). Plain roentgenographic findings on Lumbar Disc Herniation. *Journal of Korean Neurosurgical Society*, 557-568.

Cox, J. M. (2012). Low back pain: mechanism, diagnosis and treatment. Lippincott Williams & Wilkins.

Dincer, U., Kiralp, M. Z., Cakar, E., Yasar, E., & Dursan, H. (2007). Caudal epidural injection versus non-steroidal anti-inflammatory drugs in the treatment of low back pain accompanied with radicular pain. *Joint Bone Spine*, *74*(5), 467-471.

Eyichukwu, O., & Ogugua, P. C. (2012). Epidemiology of low back pain in Enugu, Nigeria. *Nigerian Journal of Orthopaedics and Trauma*, *11*(1), 28-37.

Farfan, H. F., Huberdeau, R. M., & Dubow, H. I. (1973). Lumbar intervertebral disc degeneration: the influence of geometrical features on the pattern of disc degeneration—a post mortem study. *JBJS*, *54*(3), 492-510.

Fernand, R., & Fox, D. E. (1985). Evaluation of lumbar lordosis: a prospective and retrospective study. *Spine*, *10*(9), 799-803.

Gelb, D. E., Lenke, L. G., Bridwell, K. H., Blanke, K., & McEnery, K. W. (1995). An analysis of sagittal spinal alignment in 100 asymptomatic middle and older aged volunteers. *Spine*, *20*(12), 1351-1358.

Hosseinifar, M., Ghiasi, F., Akbari, A., & Ghorbani, M. (2017). The effect of stabilization exercises on lumbar lordosis in patients with low back pain. *Annals of Tropical Medicine and Public Health*, *10*(6), 1779-1784.

Kamali, N., Haji Ahmadi, M., Kashani, M., & Mahboobi, A. (2004). The effect of sex and obesity on the lumbar lordosis. *Journal of Babol University of Medical Sciences*, *6*(3), 37-40.

Kim, H. J., Chung, S., Kim, S., Shin, H., Lee, J., Kim, S., & Song, M. Y. (2006). Influences of trunk muscles on lumbar lordosis and sacral angle. *European Spine Journal*, *15*, 409-414.

Korovessis, P. G., Stamatakis, M. V., & Baikousis, A. G. (1998). Reciprocal angulation of vertebral bodies in the sagittal plane in an asymptomatic Greek population. *Spine*, *23*(6), 700-704.

Magora, A., & Schwartz, A. (1978). Relation between the low back pain syndrome and x-ray findings. 2. Transitional vertebra (mainly sacralization). *Scandinavian journal of rehabilitation medicine*, *10*(3), 135-145.

Mukherjee, U., Kundu, S., Gulati, R., & Mandal, P. (2021). Lumbosacral angle variations in middle aged patients with chronic low back pain-A retrospective study. *pain*, *1*(2), 3.

Murrie, V. L., Dixon, A. K., Hollingworth, W., Wilson, H., & Doyle, T. A. C. (2003). Lumbar lordosis: study of patients with and without low back pain. *Clinical Anatomy: The Official Journal of the American Association of Clinical Anatomists and the British Association of Clinical Anatomists*, *16*(2), 144-147.

Naidoo, M. (2008). *The evaluation of normal radiographic measurements of the lumbar spine in young to middle aged Indian females in Durban* (Doctoral dissertation).

Nourbakhish, M. R., Moussavi, S. J., & Salavati, M. (2001). Effects of lifestyle and work-related physical activity on the degree of lumbar lordosis and chronic low back pain in a Middle East population. *Clinical Spine Surgery*, *14*(4), 283-292.

Onyemaechi, N. O., Anyanwu, G. E., Obikili, E. N., Onwuasoigwe, O., & Nwankwo, O. E. (2016). Impact of overweight and obesity on the musculoskeletal system using lumbosacral angles. *Patient preference and adherence*, 291-296.

Shao, Z., Rompe, G., & Schiltenwolf, M. (2002). Radiographic changes in the lumbar intervertebral discs and lumbar vertebrae with age. *Spine*, *27*(3), 263-268.

Singh R, Yadav, SK., Sood S., Yadav RK., Rohilla R. (2018). Spino-pelvic radiological parameters in normal Indian population. *Sicot- J,* 4:14.

Stagnara, P., De Mauroy, J. C., Dran, G., Gonon, G. P., Costanzo, G., Dimnet, J., & Pasquet, A. (1982). Reciprocal angulation of vertebral bodies in a sagittal plane: approach to references for the evaluation of kyphosis and lordosis. *Spine*, *7*(4), 335-342.

Tibrewal, S. B., & Pearcy, M. J. (1985). Lumbar intervertebral disc heights in normal subjects and patients with disc herniation. *Spine*, *10*(5), 452-454.

Torgerson, W. R., & Dotter, W. E. (1976). Comparative roentgenographic study of the asymptomatic and symptomatic lumbar spine. *JBJS*, *58*(6), 850-853.

Waxenbaum, J. A., Reddy, V., Williams, C., & Futterman, B. (2017). Anatomy, back, lumbar vertebrae. PMID: 29083618

Youdas, J. W., Garrett, T. R., Egan, K. S., & Therneau, T. M. (2000). Lumbar lordosis and pelvic inclination in adults with chronic low back pain. *Physical therapy*, *80*(3), 261-275.