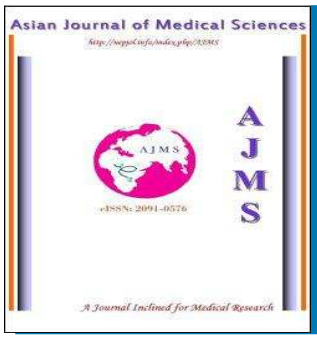

RADIOGRAPHIC EVALUATION OF THE LUMBAR LORDOTIC ANGLE OF THE SPINE IN A POPULATION OF NIGERIANS.

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"Lumbar lordotic angles of Nigerians were lower than literature reported values for Caucasians. Thus racial factors may indeed be relevant in the size of the lumbar lordotic angle and other related dimensions of the lower back in humans"

ABSTRACT

Objectives: For Nigerian Africans, quantitative reference values of osteometric parameters of the human spine are scarce. This study was therefore carried out to metrically evaluate and document the characteristics of the Lumbar lordotic angle, in a population of Nigerians.

Materials & Method: Using the Cobb 4-line method, we studied 300 lateral radiographs selected from three tertiary health facilities. There were 156 females (52%) and 144 males (48%) with age range between 18 and 76years. Results were analyzed statistically with the computer based SPSS Version 17, Chicago IL. Taking a confidence level of 0.05 as indicative of statistical significance, the student's t –test was used to estimate differences between means, and a probability density function curve ,to evaluate the distribution pattern of the angle of lumbar lordosis.

Results: Mean (± SD) of the Lumbar lordotic angle was $48.45^0 \pm (9.28^0)$.
A statistically significant association was found between Lumbar lordotic angle and age ($P<0.05$). Females had significantly higher Lumbar lordotic angles compared with males ($P<0.05$). Variations were also observed between the lumbar lordotic angles of Nigerians and those of Caucasians. These results will be useful in many areas of medical practice, and research.

Key Words: Lumbar Lordotic Angle (LLA), Metric evaluation, Cobb's method, Hyperlordosis and Hypolordosis

INTRODUCTION

The lumbosacral region lies between the relatively mobile trunk above, and the slightly fixed sacrum below, with a scaffolding of musculoskeletal structures held by strong ligaments. Research scientists[1, 3, 4] believe that disorders of the spine occur most commonly, at segments which are normally subjected to repeated motion and stress. These investigators are of the opinion that outside the presence of any of the diseases commonly associated with the musculoskeletal system.

The lumbar lordotic angle is one of the parameters often employed in the evaluation of spine function [1,2 3, 6]

Over the years, consensus on the size of the angle of lordosis in different populations has remained elusive. Yochum and Rowe, Norman Carpenner, and Nairra Kampbell [5,6,8,9], defined lumbar lordotic angle as that, between the superior (cephalad) end plate of L5, and the superior (cephalad) end plate of the S1 base, with parallel lines extended beyond the vertebral borders to meet at intersections. In the traditional 4-line Cobb method, perpendiculars are dropped from two lines, one parallel to the cephalad end plate of the cranial vertebra and a second parallel to the inferior end plate of the caudal vertebra.

It has been argued that low angulation of the lumbar vertebra may be associated with increased tendency to intervertebral disc herniation, and pain in the lower back, but with scarcity of reliable quantitative reference data, therapists and spinal heath Physicians rely more on measurements based on assumptions[2,6,7,10,11].Other investigators,[12and13] posit that even in asymptomatic populations,detailed understanding of vertebral spine morphology is necessary to facilitate rapid evaluation, and diagnostic conclusion. Objectives were then designed to provide reference values, analyze any association between angle of lordosis and selected demographic factors such as age and gender, find out how angle of lardosis of Nigerians compared with those of Caucasians, determine how the analysed normal values interact to maintain normal posture and balance.

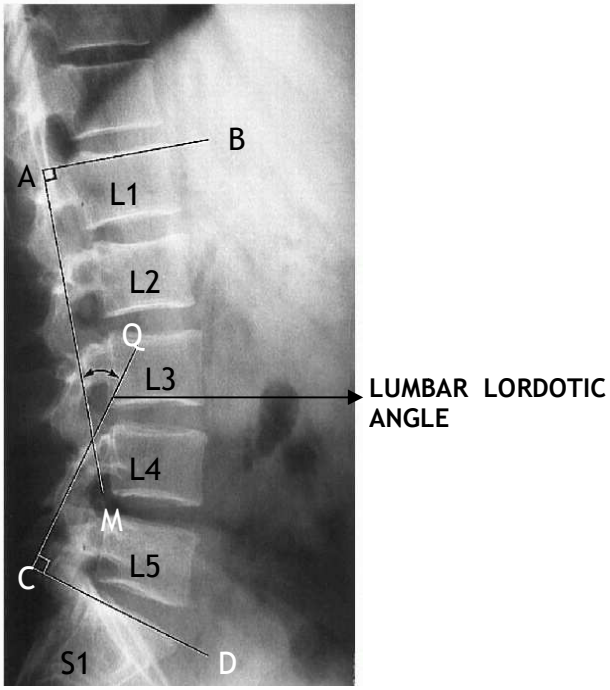
MATERIALS AND METHOD

This research designed in the form of a cross sectional survey, was carried out between September 2009 and October 2010. Lateral radiographs were obtained from the film libraries of four tertiary health centers; Braithwaite Memorial Hospital (BMH) in Port Harcourt. University of Port Harcourt Teaching Hospital (UPTH), University of Benin Teaching Hospital (UBTH) Benin city, and Enugu State University Teaching Hospital (Parklane) Enugu.

Inclusion criteria: Film reports Of Nigerians aged 18-77 years screened and certified free of bony abnormalities were used to ensure that besides the symptom complex that forced the ordering of X-rays, they had no skeletal abnormalities.

Measurement technique: The Cobb 4-line method (Fig 1), was employed for this research; Lines **AB** and **CD** were drawn through and parallel to the inferior end plate (**IEP**) of **T12** and superior end plate (**SEP)** of **S1** respectively ; A line (**AM)** was drawn perpendicular to **AB** caudally, and another one **(CQ**) perpendicular to **CD** drawn cranial. The two lines **AM** and **CQ** were extended to a point where they intersected to form an angle, and using a special sized translucent Goniometer, the angle formed at their point of intersection was measured as the lumbar lordotic angle. An Architectural set was used to construct and ensure that perpendiculars were at 90 degrees to the end plate extensions.

Fig. 1: Reference diagram of the Cobb 4- line method for angle of Lumbar lordosis(Derived from Yochum and and Rowe 2005)



RESULTS AND ANALYSIS

The 300 lateral lumbosacral X-rays, were grouped into age intervals of ten, stratified according to gender and analysed.

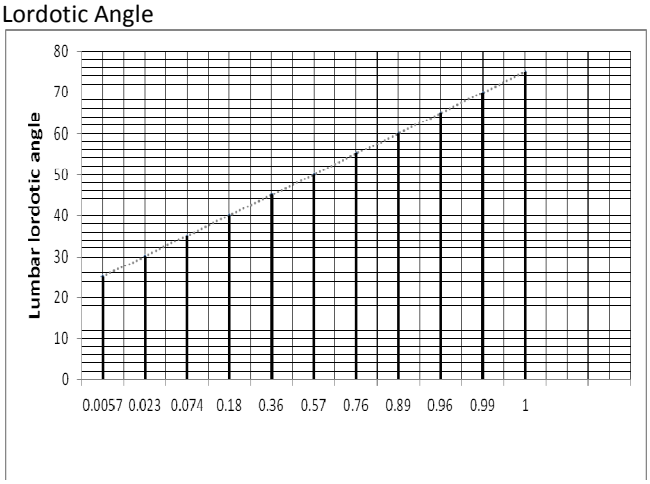
Results are presented as general distribution of sample population in tables 1 and 2, mean, standard deviation, standard error of the mean, variance, coefficient of variance, relative frequency, % probability, cumulative frequency, % cumulative frequency, normal deviate (z) expected cumulative frequency, and the probability density function curve (figure 2).

Table 1. Distribution of the sample population

Sex	Frequency	Gender Percentage
Males	144	48
Females	156	52
Total	300	100

From table 2 in the next page, it can be observed that individuals who have (LLA) lumbar lordotic angle lower than 23^0(hypolordosis),= 0% ,where as those with angle values 68^0 and greater (hyperlordosis)=(100-98)%=12%. From tables 2 and 3 below, It can be worked out that, 10% of the sample population have lumbar lordotic angle=37^0 or lower, 81% have lumbar lordotic angle=57^0 or lower, and individuals with lumbar lordotic angle greater than or equal to 48^0=(100-71)% =29%, and those with angle values greater than or equal to 38^0 =(100-10)%= 90%.

Figure 2: Probability Density Function [Pdf] Curve of Lumbar Lordotic Angle



Majority of the population in the current study can therefore be classified as having normal lumbar lordotic angles, despite being symptomatic and ordered to undergo radiologic investigation.

Mean lumbar lordosis angle (LLA)=48.45. Standard Deviation (SD)=9.28, Standard Error of the Mean (SEM)=0.54, 95% Confidence Interval $(\bar{X} \pm 1.96SE)$=47.39–49.51, Coefficient of variation $\left(SD/\bar{X} \times 100\right)$ = 19.15%.

Lumbar lordosis angle values within the age group, 48-57years showed lower Coefficient of variation (13.6%) compared with 18-27 years (23.9%).

A statistically significant association was found between age and Lumbar lordotic angle, particularly for age group 58-67and 68-77years (table 5).

Table 2. Frequency distribution of lumbar lordotic angle

LLA Range (^{0})	Mid point (x)	Frequeny (f)	Cumulative Frequeny	Relative frequency	% Probability	% Cumulative frequency	Normal Deviate (Z)	Z value (D table)	Cumulative Z value
23 – 27	25	4	4	0.013	1.3	1.3	-2.527	0.0057	0.0173
28 – 32	30	9	13	0.03	3	4.33	-1.988	0.023	0.051
33 – 37	35	16	29	0.053	5.3	9.67	-1.449	0.074	0.106
38 – 42	40	50	79	0.167	16.7	26.33	-0.910	0.18	0.18
43 – 47	45	61	140	0.203	20.3	46.67	-0.371	0.36	0.21
48 – 52	50	72	212	0.24	24	70.67	0.167	0.57	0.93
53 – 57	55	33	245	0.11	11	81.67	0.705	0.76	1.33
58 – 62	60	33	278	0.11	11	92.67	1.244	0.89	1.65
63 – 67	65	16	294	0.053	5.3	98	1.783	0.96	1.85
68 – 72	70	5	299	0.016	1.6	99.67	2.322	0.99	1.95
73 – 77	75	1	300	0.0033	0.33	100	2.860	1.00	1.99

Table 3. Mean, S.D, SEM and C.O.V of the sample population according to age

Age groups	Mean LLA	Standard Deviation	Standard Error of the mean (SEM)	Coefficient of variation
18 – 27	44.08	10.50	1.47	23.82%
28 – 37	47.1	10.14	1.31	21.53%
38 – 47	50.18	8.60	1.10	17.14%
48 – 57	50.02	6.84	0.93	13.67%
58 – 67	49.19	7.94	1.02	16.14%
68 – 77	56.23	8.87	2.46	15.77%

Table 4. Mean, S.D, Sem And C.O.V Of The Sample Population According To Gender

Gender	Mean LLA	Standard Deviation	Standard Error of the Mean	Coefficient of variation
Males	47.33	8.61	0.72	18.19%
Females	49.69	9.64	0.77	19.40%

Table 5. Statistical analysis according to age and gender

	T cal	T tab	P value	Inference	Null Hypothesis
Age Groups					
18-27 and 28 37	1.55	1.98	p>0.05	Not Significant	Accepted
28 -37 and 38 47	1.80	1.98	p>0.05	Not Significant	Accepted
38 -47 and 48 - 57	0.11	1.98	p>0.05	Not Significant	Accepted
48 -57 and 58 - 67	0.6	1.98	p>0.05	Not Significant	Accepted
Gender					
Males and Females	2.24	1.96	P<0.05	Significant	Rejected

Lumbar lordotic angle was significantly higher in females p<0.5.

Comment; Para spinal muscles, ligament and the skeletal structures to which they attach are usually larger and stronger in males. This enhances efficiency and the tendency of these structures to hold adjacent structures in normal sagittal alignment. In addition, majority of African women were carried on the backs of their mothers and as mothers bear their own children on their backs. Equally true is the fact that compared with males of the same age, African women are less mobile.

By way of single variable calculus, and using table 3 and figure 2, a probability density function curve derived by plotting the cumulative sum of the frequency of a given angle, summed progressively over successive angles and then multiplying by 100/N(300) was constructed(figure3), using the equation;

$$Percentage\ (P = \frac{100}{\sqrt{2\pi}}\int_{-\infty}^{1} e^{\frac{-x^2}{2}} dx)$$

, From table 2 and figure 2, approximately 95% of the population studied had lumbar lordotic angle within the range 30^0-65^0

From the graph (figure 2), the probability of having an individual with lumbar lordotic angle of 30^0 =0.023(<0.5), and of 65^0=0.96,(>0.5.close to 1). Therefore a male or female Nigerian African, aged 18-76 years is not likely to have lumbar lordotic angle of above 80^0 or below 20^0 without manifest symptoms.

DISCUSSION

This study consisted mainly of young adults, middle age and the old adults. The mean age of the sample population was 43.59yrs ± 15.14, and that of the male and female were 42.17 ± (15.68) and 44.90 ± (14.56) respectively.

Few studies exist on the, angle of lumbar lordosis of Africans and Nigerians. Fairly consistent values have been reported by several authors (41^0) [10](48.2^0)[11], ($64^{0)}$ [12].The most frequent measurement values are in the range 34^0-70^0 for these non-Nigerian studies. Previous studies [13, 14-17] had suggested that racial factors influenced the magnitude of lumbar lordosis angles in humans. Patrick [14], in his study of 105 Nigerians, using a flexi curve, found an increase in the thoraco lumbar curvature of more than 20% in Nigerians compared to Caucasians. To the contrary,[17,18] contend that the greater curvature seen in African Americans is due to greater buttock size, whereas [15] reported lumbar lordosis angle of 61^0 in whites compared to 42^0 for black males. Stagnara [16] did not find any statistically significant difference in lumbar lordosis between African, American and European Americans. The conflicting reports inlfuenced [19], to conclude that the relationship between lumbar lordotic angle and race needed further investigation. We found in this study lumbar lordotic angle within the range of normal of literature reported values, but slightly lower than those obtained from non-whites. The difference could have arisen from possible musculoskeletal adaptation accessioned by centuries of bearing the weight of young ones on the back with cloth belts, as opposed to the use of hand driven wheeled baby carrier used by Caucasians.

An increase in lumbar lordotic angle was observed from 18 years, to 37 years, with a plateau about age 47 to 67 years. The current investigation also demonstrated significant age related differences in lumba lordosis angle, which were observed between different age groups particularly 58—77 years (Table3). Similar flexibilities in the degree of lordosis in relation to age were noted by [20- 23.] Their studies showed a gradual increase in lumbar lordotic angle up to middle age followed by a decrease. This result is also similar to the works of [21, 12, and 23], who found a statistically significant variation in the lumbar lordosis angle of different age groups, with older individuals showing higher values. Authors using relatively younger subjects; [24, 5] observed gradual but significant increases in lumbar lordotic angle with age. However,[11,20,25-27] failed to demonstrate any significant association between lumbar lordosis and age. The higher standing of the Coefficient of variation in the younger age group and the significant association between anterior lumbar curvature and old age, is remodeling through the mechanism of osteoclasts and osteoblasts, as opposed to degenerative changes in the older age group, with greater involvement

of osteoclasts. In addition, levels of proteoglycans; in particular, the sulphated moieties of chondroitin and heparan, decrease with increasing age. Cancellation of bone is also believed to occur more in the older age group and at a faster rate in the axial skeleton compared with the appendicular [2,4].

This is also consistent with the work of [30], who reported higher incidence of low back pain in men within the age range of 40-47 years.

Our results showed significantly higher values of lumbar lordotic angles in females, compared with males (Table 5 and 6) $P<0.05$. This is in concordance with published data on sexual dimorphism with respect to lumbar lordotic angle; Gelb[13] reported Lumbar lordotic angle of $43.25^{0)}$, for men and 47.19^{0} for women. Other authors[21, 28, 23] have reported similar findings of sex related differences. 0ur findings however contradict those by [5,10,12,25,27,29,30] who found no significant differences between male and female subjects with respect to angle of lumbar lordosis.

Fernand and Fox [13], proposed that Lumbar lordotic angle in excess of 68 degrees constitutes hyperlordosis and angle values below 23 degrees, hypolordosis. Using this as an attempt at classification, in conjunction with table 2 and figure 2, only about 12% of our sample population would be classified as hyperlordotic and none of them in the hypolordotic group. That percentage from public heath point of view may be considered significant, being responsible for the symptomatology that made the individuals go to hospital though subsequently found to be free of skeletal pathology. The probability density function curve derived from (Table 2 & Figure 2), provides a practical mathematical selection tool for estimating the magnitude of deviation from normal, given an individual's race, age, gender and estimated angle of lumbar lordosis. Authors using relatively younger subjects.....However,[11,20, 25- 27], failed to demonstrate any significant association between lumbar lordosis and age.

This may partially account for the lower prevalence of low back pain in populations of Nigerian Africans compared with Europeans [30,31]

We constructed a probability density function curve(pdfc) from table 2,using single variable calculus –with it and for any Nigerian presenting with problems of the lower spine and for whom information on age, gender and estimated angle of lumbar lordosis is available, the probability density function curve provides a quick diagnostic mathematical aid for the quantitative estimation of the magnitude of deviation from normal.

CONCLUSION

Data from our study suggest that the magnitude of angulations in the lumbosacral segments of normal spines in particular, the lumbar lordotic angle is significantly associated with age.

For the first time, we have also provided sufficient evidence to establish a strong position for anthropometric relevance of the Lumbar lordotic angles of Nigerians, with regards to gender

In this study, we observed lower measurement values of Lumbar lordotic angles compared with literature reported values for Caucasians. This is in agreement with the report of lower prevalence of low back symptoms in Africans. Thus racial factors may indeed be relevant in the size of the lumbar lordotic angle and in other related anatomical dimensions of the lower back in humans.

To our knowledge this is the first group specific study of its kind to propose a way of finding out whether or not a patient's Lumbar lordotic angle and by extension, other measurable linear and angular parameters of the human spine , fall within accepted range with respect to race, age and gender.

It is hoped that spinal health physicians and professionals in related fields will find group specific quantitative studies like this beneficial in their areas of practice.

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