

# ASSESSMENT OF THE SPINE IN A HEALTHY WORKING POPULATION: A RADIOGRAPHIC STUDY OF THE LUMBOSACRAL ANGLE IN RELATION TO OCCUPATION IN SOUTHERN NIGERIA

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## ABSTRACT

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*“Lumbar curves are designed to increase the resilience of the vertebral column. The lumbosacral configuration changes depending on the type of job and profession.”*

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**Objective:** This study was carried out to evaluate the effect of occupation on the Lumbosacral angle of the spine in a cohort of working adult Nigerians

**Method:** Lateral radiographs from two hundred and twenty healthy working adults within the age range 18 to 55 years comprising 136 males (61.82%) and 83 females (38.18%), with a mean age=29.14(7.45) years were studied. Participants at the time of investigation were engaged in different physically demanding occupations with a minimum of one year job experience. The sample included a control group made up of undergraduate students from the University of Port Harcourt. Prior to data collection, all participants read and signed informed consent forms. Each lateral radiograph was evaluated using Fergusons sacral base-horizontal 2-line method. Statistical analysis was done using the computer based SPSS Version 17, Chicago IL, and a confidence level of 0.05 was accepted as indicative of statistical significance.

**Results:** A statistically significant difference was found between the four groups in terms of age, gender and occupation. The lumbosacral angle of the groups engaged in physically demanding occupations were significantly higher than the control (undergraduate students).

**Conclusion:** The lumbar curves are designed to increase the resilience of the vertebral column. Over a time period, physically demanding jobs are likely to cause various degrees of significant alterations in the lumbosacral configuration

**Key words:** LSA=Lumbosacral angle, LLA lumbar lordotic angle, MSSD= Musculoskeletal Disorder.

## INTRODUCTION

At home and in many parts of the world, Nigerians, including children are employed in jobs which require them to handle various physically demanding tasks over long periods, and in unhealthy posture, because design requirements of workplace and tools are not based on ergonomic principles. Abnormal repetitive postural patterns as determined by specific occupations become ingrained and in turn lead to the development of low back syndrome.

Derangement of the spine can remain asymptomatic for years because African spines in relation to activities of daily living and work related musculoskeletal disorders have not been adequately studied. Recent reports indicate that the prevalence of low back pain in Nigeria is on the rise.<sup>1,2</sup>

According to<sup>3</sup>, low or high angulation of the sacral base is likely to be associated with low back pain. Many researchers have observed that jobs which require prolonged standing, stooping or squatting may result in excessive straightening or exaggeration of vertebral column curvature and have been found to be associated with low back syndrome.<sup>4,5,6</sup> To the best of our knowledge, no studies have provided data concerning the behavior of the Nigerian spine under these conditions, as a result of which patients who develops lower back problems finds difficult to participate actively in the management of their conditions. Beyond that lack of adequate data to back interventions, instigate physicians to focus more on experience rather than evidence based practice.

Some authors<sup>7,6</sup> relying on data derived mainly from across Europe, America and Asia assert that a low lumbosacral angle may be associated with pains in the lower back, in contrast, other groups<sup>4,5</sup> argue that in many cases, low back pain occurs commonly in association with exaggerated LSA. It has also been argued that the behaviour of the lower spine underweight bearing conditions involves internal and external mechanisms which ensure stability of the spine.<sup>4,8</sup> Their research study suggested that exploring these mechanisms would unravel the submerged aetiological factors associated with many back conditions. For Africans and Nigerians, progress in spine related surgical procedures has been slow due to poor understanding of these mechanisms, forcing Physicians

to use data from Caucasian studies.

In developing countries where resources are limited, physicians routinely request radiographic imaging in preference to other more expensive and invasive methods in the management of work related disorders of the back. As a result various measurement methods have been developed, and the lumbosacral angle referred to in some texts as the sacral base angle or sacral base-horizontal angle is one such measurement.

We therefore aim to determine the degree of lumbosacral angulation in relation to the physical demands of different professions.

**Objectives:** To determine reference normal values of LSA in a population of healthy Nigerian workers, grouped according to commonly assumed occupational postures, and to find if significant differences exist between the different groups in terms of the observed measurement values.

**Hypothesis:**

- i.) LSA of workers in the 3 groups arranged according to occupationally defined postures would be higher compared to controls.
- ii.) LSA of female workers is predicted to be higher when compared to males.

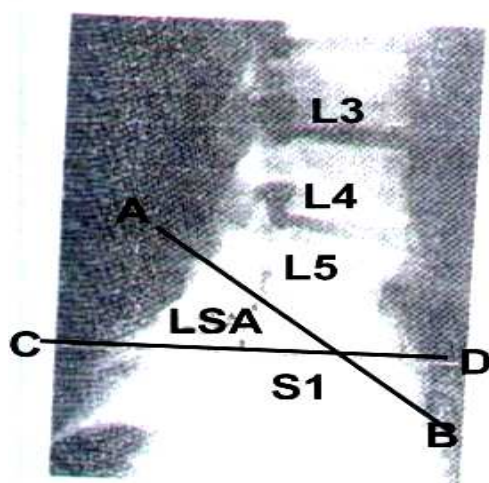
## MATERIALS AND METHODS

This study was a cross sectional survey which was conducted over a period of nine months from February till September 2013. Approval for the study was obtained from the Research Ethics Committee of the College of Health Sciences, of the University of Port Harcourt. All subjects fulfilling the study conditions were included in the study. Inclusion criteria were properly and adequately informed about the nature, risks, benefits and confidentiality of the study, after which they voluntarily signed the informed consent forms.

**Inclusion criteria:** Nigerians, aged 18-55 year, and willingness to provide written informed consent.

**Exclusion criteria:** Medical history of X-ray imaging study done in the past one month, physical and radiographic evidence of bone disease, sickle cell disease or tuberculosis, Obstetric history of pregnancy. Presence of leg length inequality >20mm and Body mass index (BMI)  $\geq 30$ .

**Subject recruitment** was done through personal communication by telephone calls and text messages. Posters were also placed around hospitals and other public places. Commonly assumed job postures were used to arrange subjects into three groups; 1 prolonged standing, 2 prolonged Sitting, 3 prolonged stooping, squatting and bending. An additional group comprising students who had not been exposed to occupationally defined postures of standing, sitting, stooping and squatting for extended period of time was included to serve as control.



LINE AB = SEP OF S1  
CD = HORIZONTAL

Figure1. Reference diagram for Ferguson's method (adapted from 4, 7)

**Technique** ---line AB was drawn parallel to and through the superior end plate of the sacral base. A second line CD was drawn horizontally across the body of the S1 vertebra. The angle of intersection measured at the posterior aspect is the lumbosacral angle(LSA)

For statistical analysis, the student's t -test and ANOVA statistic were then used to compare mean differences across the groups including the control. Where required, Turkey HSD and Dunnet T-tests were, employed to determine where exactly groups differed. The Man Whitney U/Wilcoxon non parametric statistic

## RESULTS

We determined the Mean, Range, SD SEM ,and CI for each parameter measured. The Kolmogorov Smirnov

tests for Normality showed LSA was not normally distribute Analysis of covariance (ANCOVA)statistics showed gender as covariant as opposed to age. There was a weak correlation and  $r^2=0.20$ , indicating that 20% of the lumbosacral angle can be explained by the age. We therefore included the Man Whitney U statistic in our analysis.

Majority (97.7%) of the population studied were below 50yoa. Males were slightly older, mean age was 30.16 (7.75) years, compared to 27.49 (6.67) years for females. Female workers had slightly higher body proportion but male subjects were heavier. *Table 5* Mean LSA for the whole sample was  $33.90^\circ$ . Males in the sample had higher LSA (Males)= $34.14^\circ$ ;(Females) = $33.50^\circ$ (*Table 4*) .Male subjects showed higher LSA than the females, but this was not significantly significant ( $P>0.05$ ).

About half (52.3%) of population studied had LSA within the range  $30-40^\circ$  compared with 30% who had LSA less than  $30^\circ$

Eighty two point three percent of the subjects had LSA within the range  $30-45^\circ$ .

Table1. Percent distribution of subjects by age

Age Group	N	Percentage
18-24	68	30.9%
25-31	76	34.6%
32-38	54	24.5%
39-45	15	6.8%
46-52	3	1.4%
53-59	4	1.8%
<b>Total</b>	<b>220</b>	<b>100.00%</b>

Table 2. Percent distribution of subjects by gender

Sex	N	Percentage
<b>Males</b>	<b>137</b>	<b>62.3%</b>
<b>Females</b>	<b>83</b>	<b>37.7%</b>
<b>Total</b>	<b>220</b>	<b>100%</b>

The Mann-Whitney Test was applied to check if within (age group 25-31) LSA differed significantly among occupations within subjects aged 25-31, the U statistic shows there was no statistically significant difference in lumbosacral angle between the three groups and control ( $P>0.05$ ).

Table3. Percentage distribution of subjects by groups

Occupation	Sex	N	Percentage
Control	Males	40	18.2%
	Females	30	13.6%
Group 1	Males	16	7.3%
	Females	23	10.5%
Group 2	Males	41	18.6%
	Females	23	10.5%
Group 3	Males	40	18.2%
	Females	7	3.2%
Total		220	100.00%

Table4. Mean LSA &amp; its C.I according to gender

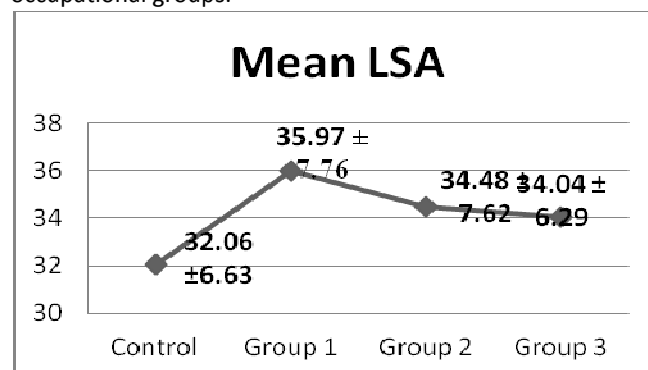
Sex	Mean LSA	SD	SEM	95% C.I	
				Lower	Upper
Males	34.13	7.41	0.63	32.88	35.38
Females	33.47	6.75	0.74	32.00	34.94
Total	33.88	7.16	0.48	32.93	34.83

ANOVA statistics, Mean LSA of occupations in group 1 were significantly higher than the control ( $F(3,216) = 2.857, p < 0.05$ ), Turkey HSD, Bonferroni and Dunnett showed statistically significant difference between the control and Group 1 only.

Among male subjects, mean LSA in group 1 was significantly higher than the control group, ( $p < 0.001$ ). Mean LSA in Groups 1, 2 and 3 were higher than the control but only group 1 (prolonged standing) attained statistical significance. Measurement values of the LSA for female subjects on the average was higher in Groups 2 and 3 compared group 1 and control. Statistical analysis however showed that this association was not statistically significant.

**For female subjects**, the LSA of female workers whose jobs require sitting for prolonged periods (group 2) had mean LSA significantly higher than control (undergrad students)  $P < 0.05$ . Also, among the female workers studied, a non significant relationship was found between LSA of control and group 1. Group 1 (employed in prolonged standing occupations) had reduced LSA as opposed to groups 2 (prolonged sitting) and 3 (workers who continually bend to stoop, squat or work in awkward positions).

Figure 2: Graphical representation of mean (SD) LSA in various occupational groups.



## DISCUSSION

Remarkable differences in the values of lumbosacral angle reported in published data have been observed. Investigators<sup>4,5,7,6,9</sup> reported values in the range 26-57° for Caucasians. Previous studies done on African and Indian populations showed, LSA values which were comparatively lower but within the range (35-50)°. However these findings were inconclusive, because they were restricted in design either to one gender as in<sup>10</sup> (female subjects only),<sup>11, 12</sup> (male subjects only) or was retrospective.<sup>13, 14</sup>

We observed in this study mean LSA of 33.9 degrees with a range of (28.17-47.00)°. Lumbosacral angles obtained from this study are within accepted normal range 26-57 degrees as reported by<sup>7</sup>, and consistent with the observation observed that the spines of Africans tend to have smaller lumbosacral curves, compared with Caucasians<sup>13</sup>, and Asians<sup>15</sup>. Further studies are necessary to see if this is in agreement with equally reported lower prevalence of low back pain in Africans compared to white populations. Considering the study by<sup>10</sup>, the subjects, comprised Indian women with age range 18-40 years. The predominance of females within the reproductive years of life could be responsible for the higher value of lumbosacral angle reported in her study. In agreement with this study, lower values of LSA have also been reported by authors using population of young adults who are not Africans (35.4°)<sup>4</sup>, (31.7°)<sup>16</sup>. However, using the reference normal

TABLE 5: General Distribution of variable according to sex

SEX		AGE	HEIGHT	WEIGHT	BMI	LSA
Females (N= 84)	Minimum	18	1.30	45	16.7062	21
	Maximum	54	1.79	110	37.8698	54
	Mean	27.49	1.6273	68.16	25.779	33.50
	Std. Deviation	6.665	.08046	13.048	4.717	6.717
	Std. Error of Mean	.727	.00878	1.424	.5146828	.733
Males (N= 136)	Minimum	18	1.50	40	16.4776	20
	Maximum	55	1.83	105	41.7778	60
	Mean	30.16	1.6871	70.09	24.69715	34.14
	Std. Deviation	7.748	.07223	12.396	4.62905	7.434
	Std. Error of Mean	.664	.00619	1.063	.3969381	.637
Total (N=220)	Minimum	18	1.30	40	16.4776	20
	Maximum	55	1.83	110	41.7778	60
	Mean	29.14	1.6642	69.35	25.11023	33.90
	Std. Deviation	7.452	.08073	12.655	4.681865	7.160
	Std. Error of Mean	.502	.00544	.853	.3156513	.483

Table 6. Distribution of LSA of subjects by groups

Occupation	Mean LSA	SD	SE	Confidence interval	
				Lower	Upper
Control	32.06	6.63	0.793	30.48	33.64
Group 1	35.97	7.76	1.242	33.46	38.49
Group 2	34.48	7.62	0.952	32.58	36.39
Group 3	34.04	6.29	0.917	32.20	35.89
Total	33.88	7.159	0.483	32.93	34.83

Table 7. Distribution of LSA according to occupational group and sex

Occupation	Sex	Mean LSA	SD	SE	95% Confidence interval	
					Lower	Upper
Control	Males	32.33	7.39	1.167	29.9622	34.6878
	Females	31.70	5.57	1.02	29.6218	33.7782
Group 1	Males	41.19	6.80	1.70	37.5618	44.8132
	Females	32.35	6.23	1.30	29.6517	35.0440
Group 2	Males	33.44	7.20	1.12	31.1662	35.7119
	Females	36.35	8.13	1.30	32.8308	39.8648
Group 3	Males	33.83	6.43	1.02	31.7677	35.8823
	Females	35.29	5.68	2.15	30.0346	40.5369

Mean LSA highest in Group1 (35.97<sup>0</sup>) followed by Group2 (34.53<sup>0</sup>). Group3 showed 34.04<sup>0</sup>. LSA is lowest in Control (32.06<sup>0</sup>).



range of LSA = 30-40° as suggested by<sup>17,18,19</sup>, only about half (52.3%) of our population studied had LSA between 30° - 40°. Among other factors, occupation as a factor could be responsible for the rest of the study population (47.7%) whose LSA fell outside this range.

The current study showed that LSA increased in direct proportion with prolonged standing, a condition of weight bearing. Several research findings also<sup>8,4,20,8</sup> reported that standing is associated with increase in LSA, and also with weight bearing.<sup>11</sup> It has been observed that occupational hazards resulting in injuries to the spine are most likely to occur if the lower back is held in flexion more than 30degrees for more than 4hrs or bent more than 45degrs for more than 2 hrs.<sup>18</sup> From our result, the LSA was lower in subjects who routinely assume the sitting postures. Similar observations have been documented<sup>21</sup>. Together these findings support conclusions reached earlier;<sup>4,22-24</sup> that adaptive skeletal changes in response to the physical demands of occupation may occur over a wide range of physiological normal values, but can also progress to disorders of the back.

The current study confirmed, higher LSA values for male subjects compared with female but the difference only became statistically significant when the effect of occupation (prolonged standing) was considered. On the other hand, only female subjects whose professions involved working for longer period of time in sitting posture, out of the three groups, exhibited significantly higher LSA compared with the control.

It has been argued that unlike results obtained in older women, younger women tend to have lower lumbar curves compared with males from the same region.<sup>13,25</sup> Previous studies<sup>5,26,27</sup> using population of young adults below 50 observed LSA higher in males which were found not statistically significant. These studies did not analyze the differences with respect to occupation.

Specifically, males engaged in occupations which require prolonged standing are more likely to have elevated LSA, which when persistent can reach a point obtuse enough to cause shear and compressive forces

leading to spondylolisthesis or microfracture. On the other hand, females who are engaged in prolonged sitting jobs are more likely than those who are not similarly predisposed, to have reduced or low LSA.

## CONCLUSION

Results from this study indicate that there is a significant relationship between occupation and LSA. In line with<sup>28,20</sup> and<sup>8</sup> this study supports our hypothesis that professions which involve prolonged standing, sitting, stooping and squatting postures are likely to result in significant exaggeration of the normal lumbosacral angle as a form of adaptive mechanism to their occupation compared with those which involve sitting. For the first time, we have generated data from a population of working Nigerians capable of improving knowledge base of spine therapists. Results of this study will certainly be helpful baseline data for further research and clinical assessment procedures.

### Recommendation:

We propose that when dealing with work related low back conditions, a multi disciplinary approach is more likely to provide opportunities for clinical enquiries to proceed beyond sex, and age, and this will ensure that spine related disorders are evaluated on a continuum between analysis of the relationship of posture, and occupation. Work postures should be alternated in short periods less than 3 hours between workers.

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