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Analysis of Work Related Skeletal Changes in the Spine: A Comparative Radiographic Study of the Lumbosacral Angle in Nurses and Computer Operators.

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ABSTRACT

Increased degenerative changes in the lumbar spine have been linked to various occupations. These alterations have been documented to be associated with low back pain (LBP) amongst actively engaged workers. An experimental cross sectional study was done to determine the Lumbosacral angle of young adults currently engaged in primary seated occupation (Computer operators), and primary standing and walking occupation (Nurses) in Nigeria. Lateral radiographs of seventy-six (76) healthy working volunteers (34 males = 44.7% and 42 females = 55.3%) from three strata; 24 nurses, 29 computer operators and 25 undergraduate students represented by Group1, Group2 and Control respectively, were studied in three Medical centres located in the city of Port Harcourt, Nigeria. Subjects were within the age range 18 and 45 years with mean age of 27 years. Before commencement of data collection, each participant voluntarily signed an informed consent form. Each lateral radiograph was evaluated using Fergusons method for measurement of the normal LSA. Statistical analysis were done using the computer based SPSS Version 20 with level of statistical significance set at $p<0.05$ (providing 95% confidence interval). The Mean±S.D values for height, weight and BMI were 1.66±0.07m, and 66.43±11.46Kg and 24.11±4.41Kgm-2 respectively. Mean LSA for whole sample was 31.00±6.23°. Considering the three groups, mean LSA values were 32.53±6.04° for group 1, 32.05±4.30° for group 2, and 29.84±8.03° for the control group. Post-Hoc multiple comparison showed no significant difference ($P>0.05$) in the mean LSA for the three groups. However, differences in LSA was observed between workers in group 2 &group 1 for age 18-24years and between workers in group 2 &control for age 25-31years. Though mean LSA of this young population of subjects fell within normal range, the study demonstrates that the cumulative effect of certain professions over time may exceed the physiological weight bearing mechanisms of the spine and result in reversal or exaggeration of the normal curvatures of the lumbar spine. Sacral orientation determines global spinal configuration, hence the consequences may include moderate to severe work related musculoskeletal disorders involving all segments of the vertebral column.

Key words: LSA = Lumbosacral angle; Fergusons method; Occupation; Lumbar spine.

INTRODUCTION

Musculoskeletal structures exhibit flexibilities in response to impressed forces.In most activities of daily living and in those professions which involve manual handling of materials, the magnitude of the human lumbosacralangle changeswhen compressive and shear forces are brought to bear on the spine. The rest of the spine responds with corresponding changes in lordosis or kyphosis in order to maintain normal sagittal balance and avoid structural damage.[1][2][3] It has been argued that an increase in the LSA shifts weight bearing in the direction of the zygapophysial joints which are closely associated or related to diffuse distribution of neurovascular structures located anatomically in the region of the lumbosacral joint.[2][3]

Though Pain in the lower back is common inindividuals engaged in physically demanding activities, it most frequently occurs in populations, where tools are not designed according to ergonomic principles. It has been estimated that about 70 - 90% of individuals will experience lower back pain at some point in their lives.[4] Studies have demonstrated significant relationships between self-reported physical risk factors like prolonged sitting, prolonged standing, working in stooping and squatting positions for extended periods and the occurrence of musculoskeletal disorders at various body sites. As a result of availability and lower cost, most patients who require confirmatory investigations for low back problems have routine X-rays taken of the lumbosacral spine as part of their initial evaluation.[5][6][7] Rather than relying on diagnosis based on experience, Researchers and Therapists have observed that lateral radiographs of the lower back, can be traced easily for anthropometric analysis, to provide very reliable

additional diagnostic information. One of the parameters commonly employed in the objective assessment of spinal health is the Ferguson's Sacral Base Angle, also referred to as the lumbosacral angle.[8]

Recent reports indicate that the prevalence of low back pain in Nigeria is on the increase;[9][10] a situation that is likely to worsen as a result of non-automationof jobs for most of the citizens in addition to the very low awareness of ergonomics in this country. Though the debate on the relationship between intervertebral angles and low back pain remains unsettled, it is being increasingly realizedthat a low or high lumbosacralcurve is likely to be associated with low back pain.[11] It is our opinion that studieswhich involve subjects currently engaged in various physically demanding tasks will provide more insights into the anatomical mechanisms which underpin the adaptive mechanical behaviour of the spine in different conditions of weight bearing. To the best of our knowledge, only a handful of authors have provided quantitative data on the size of lumbarcurves of Nigerians and its relationship with specific occupations.

This study was therefore conducted to determine the LSA valuesfor a population of young adults actively engaged in primary seated occupation (Computer operators), primary standing and walking occupation (Nurses) with the involvement of a group that do not participate in any of these forms of worked related postures (undergraduate students). An additional purpose was to also compare the measurement values in other to establish the existence of age-related difference in LSA across the various occupations.

MATERIALS AND METHODS

We examined fifty-eight healthy subjects drawn from two different occupations (24 Nurses and 29 Computer Operators), and 25 undergraduate students who served as control in this study. Subjects were mainly young to middle aged adults in the age range 19-45years with mean age of 27 years.

This study was carried out in the city of Port Harcourt, Nigeria. Approval was obtained from the Research Ethics Committee of the College of Health Sciences, of the University of Port Harcourt. Subjects were recruited through personal communication by telephone calls, text messages and posters. All subjects were properly and adequately informed about the nature, risks, benefits and confidentiality of the study, after which they voluntarily signed the consent form.

Inclusion criteria: These required that subjects be Nigerians aged 18-45 years of age who were ready and able to voluntarily provide written informed consent.

Exclusion criteria: These included medical history of X-ray imaging study done in the one month preceding commencement of the study, physical and radiographic evidence of bone disease, sickle cell disease or tuberculosis, ,Obstetric history of pregnancy, presence of leg length inequality greater than 20mm and Body Mass Index (BMI) greater than or equal to 30.

Technique and Landmarks: Ferguson's method was employed in this study; two lines, one drawn parallel to and through the superior end plate of the sacral base (XY), and a second line made to run horizontally across the body of the S1 vertebra (AB) were extended until an intersection was obtained. The angle of intersection ø was measured using a special sized transparent Goniometer as the lumbosacral angle (LSA).

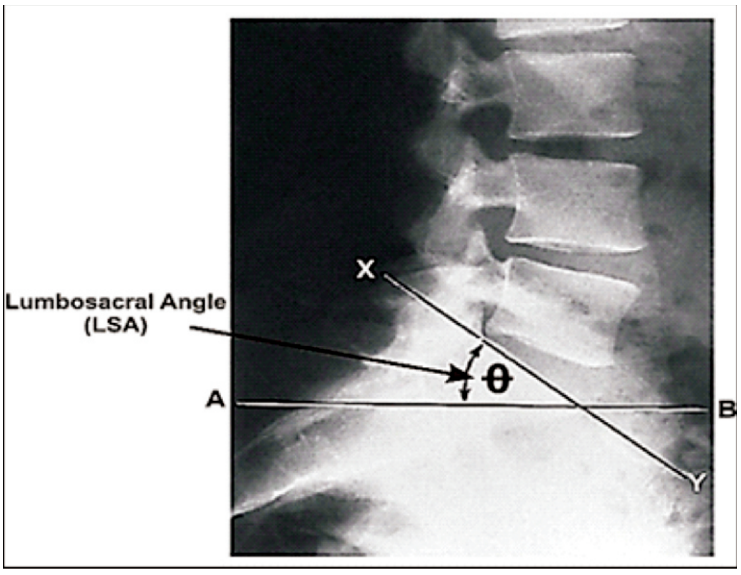

Figure 1: Reference measurement of the normal lumbosacral angle adapted from Cailliet[12]

RESULTS

About 51.32% of the study population had LSA less than 30°, 42.11% had LSA within the range of 30-40° while 6.58% had LSA greater than 40° but less than 46° (Table 1). As shown in table 2,the lowest value of LSA was recorded for subjects in the control group (29.84°) compared to groups 1 and 2 (32.53° and 32.05° respectively).Table 3 shows that the observed differences were not statistically significantly (P>0.05),though the mean LSA of the control group was lower than those of the group 1 and 2,

Age related LSA differences

A linear increase in LSA in direct proportionality with age was observed in subjects aged 18-38 years; this was followed by a decrease in angle values between 39-45years (Table 4 and Figure 2). From Table 5, the highest mean LSA (36.00°) was observed for the subjects in the occupational groups between ages 32-38 years while ages 18-24years of the control had the lowest mean value of 27.36°. From the Post Hoc multiple comparison test in Table 6 and 7, significant differences in LSA among subjects of the same age groups engaged in different occupations was observed; age group (18-24years) showed significant differences in LSA between the two occupational groups (P=0.043). On the other hand, within the age group 25-31years, statistically significant difference in LSA were observed between subjects in Group2 and Control (P=0.003). While other age groups of the various occupations showed no statistically significant difference in the LSA.

Table1: Percentage of LSA in overall sample

LSA (Degree)	N	Minimum	Maximum	% of Total N
< 30	39	22	46	51.32%
30 – 40	32	32	40	42.11%
40 – 45	5	27	43	6.58%
Total	**76**	**22**	**46**	**100.00%**

Table 2: Mean LSA of Occupations and Control

Studied Population	N	Min.	Max.	Mean	S.D	S.E.M	% of Total N
Occupations	51	22	46	32.26	5.07	0.81	67.11%
Control	25	22	44	29.84	8.03	1.84	32.89%
Total	**76**	**22**	**46**	**31.47**	**6.23**	**0.82**	**100.00%**

Table 3: Test of mean difference in the LSA of the occupations

PARAMETERS	GROUPS	POST HOC MULTIPLE COMPARISON Mean Diff.	Std. Error Diff.	t-value	P-value	ANOVA (Betw. Groups) df	F-value	Inference
LSA (DEGREES)								ANOVA (Not Sig)
	Group 1 Vs Control	2.69	2.39	1.12	0.27			G1 vs CONTROL; Not Sig
	Group 2 vs Control	2.06	2.20	1.07	0.29	0.989	0.379	G2 vs CONTROL; Not Sig
	Group 1 vs Group 2	0.48	1.66	0.29	0.77			G1 vs G2; Not Sig

Table 4: Descriptive characteristics of LSA by age groups

AGE GROUPS	N	Mean Age (Years)	Min. LSA	Max. LSA	Mean LSA	S.D	S.E.M
18 – 24	28	21.91	23	46	28.86	5.62	1.23
25 – 31	29	26.92	22	46	32.40	6.85	1.37
32 – 38	14	34.00	32	40	36.00	4.00	1.79
39 – 45	5	40.75	27	33	29.75	2.50	1.25
Total	**76**	**27.29**	**22**	**46**	**31.47**	**6.23**	**0.82**

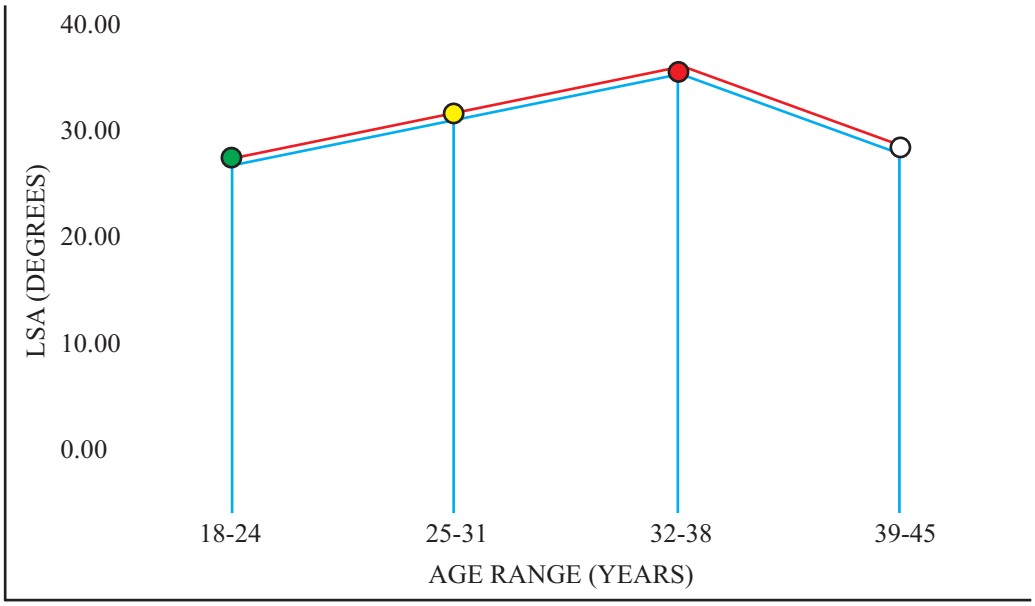

Figure 2: Mean LSA of overall sample with respect to age group LSA increases with age up to about the age of 38years, followed by a sudden fall up to age 45.

Table 5: Mean LSA according to age groups for the various occupations

Occ. Groups	Age Groups (Years)	N	Min.	Max.	Mean	S.D	S.E.M
Group1 (Nurses)	**18-24**	8	23	37	30.83	5.64	2.30
	25-31	8	22	44	32.50	6.97	2.46
	32-38	6	32	40	36.00	4.00	2.31
Group2 (Computer Operators)	**18-24**	7	28	34	30.00	2.83	1.41
	25-31	9	26	39	31.56	4.59	1.53
	32-38	8	32	40	36.00	5.66	4.00
	39-45	5	27	33	29.75	2.50	1.25
Control (Students)	**18-24**	13	24	46	27.36	6.28	1.89
	25-31	12	22	46	33.25	9.30	3.29
Total		**76**	**22**	**46**	**31.47**	**6.23**	**0.82**

Table 6: Test of mean difference in LSA for the various occupations of same age group (18-24) years

18 – 24 (Years)		N	Mean	S.D	S.E.M	P-value	Inference
Group1		8	30.83	5.64	2.30	0.552	Not Significant
	Control	13	27.36	6.28	1.89		
Group2		7	30.00	2.83	1.41	0.58	Not Significant
	Control	13	27.36	6.28	1.89		
Group2		7	30.00	2.83	1.41	**0.043**	**Significant**
	Group1	8	30.83	5.64	2.30		

Table 7: Test of mean difference in LSA for the various occupations of same age group (25-31) years

25 – 31 (Years)		N	Mean	S.D	S.E.M	P-value	Inference
Group 1		8	32.50	6.97	2.46	0.123	Not Significant
	Control	12	33.25	9.30	3.29		
Group 2		9	31.56	4.59	1.53	**0.003**	**Significant**
	Control	12	33.25	9.30	3.29		
Group 2		9	31.56	4.59	1.53	0.253	Not Significant
	Group 1	8	32.50	6.97	2.46		

DISCUSSION

Several large scale studies support the position that the temporal effect of occupation on the lumbar spine may be responsible for most of the pathological conditions encountered.[12-20] Data from most of these studies suggest that low or high angulations of the sacral base is likely to be associated with low back pain.

Our study showed that on the average the LSA in the sample studied increased in direct proportion with increasing age up to 38years.Thereafter, a pattern of increase decrease was observed. Previous authors [1-3][21-23] reported similar findings. Results from this study also confirm earlier observations that there is a significant relationship between occupation and LSA, consistent with reports.[3][18][24]

In contradistinction with the studies;[25-27] a linear increase in LSA in direct proportionality with age was observed in subjects aged 18-38 years. This was followed by a decrease in angle values between 39-45years. This is in agreement with earlier reports.[1-3] Our study also revealed significant differences in LSA among subjects of the same age groups engaged in different occupations. Thus, time dependent adaptation of the spine to occupation could be the major reason for these observed differences in lumbosacral angulation.

In an earlier report,[28] examined thirteen (13) subjects for about 2 hours of their normal office work with the purpose to evaluate lumbar posture and muscular activity while sitting during office work. They concluded that due to very low activation of lumbar muscles while sitting, the load is transmitted by passive structures like ligaments and IVD as a result of these, the lumbar spine may incline into de-conditioning. This may be a reason for low back pain. Similarly,[29] demonstrated that sitting with reduced lumbar support resulted in reduced sitting load on the lumbar spine and reduced lumbar muscular activity, which may potentially reduce sitting-related low back pain.

Also and consistent with previous observations,[30][31 the current study revealed that individuals whose occupation require primary standing postures are likely to have wider lumbosacral angulation. We found in this study, comparatively lower values of LSA in occupations which require sustained primary stooping and squatting postures as is commonly associated with individuals engaged as commercial computer operators in Nigeria. Results of this study are therefore in agreement with previous reports, that professions which involve prolonged standing, sitting, stooping and squatting postures are likely to result insignificant alteration of the normal lumbosacral angle as a form of adaptive mechanism to their occupation compared with those which involve alternating these postures within short periods.[21]

CONCLUSION

Our study showed evidence of occupation and age-associated LSA difference with respect to posture during active work. Individuals whose occupation require primary standing postures are likely to have wider lumbosacral angulation

Results of this study support our hypothesis that as part of the adaptive response to the weight bearing conditions imposed by different occupations, the lumboscaral angle depending on age becomes more obtuse or acute.

SUGGESTIONS

Activities of daily living including the postural demands of different occupations have a profound effect on sacral orientation as determined by the size of LSA.When dealing with issues concerning lower back pain and design of surgical and medical interventions of spine related disorders, subject specific variables such as the occupation of an individual should be taken into consideration.

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