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QUANTITATIVE DIMENSIONAL ANALYSIS OF THE LUMBAR SPINE: A SEGMENTAL MORPHOMETRIC EVALUATION

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ABSTRACT

Spine injuries resulting from industrial accidents, tuberculosis of the spine, exposure to occupational hazard, sickle cell disease are increasingly being encountered. Clinical conditions from these injuries can manifest in many different forms, often characterized by pain of varying degrees and severity. Patients' misunderstanding of the patho-etiology of spine diseases, lack of faith in the availability of equipment and personnel in Nigerian hospitals to effectively provide affordable curative treatment and the consequent preferences for traditional bone setters are responsible in part for the high morbidity and mortality reported in resource limited countries. The aim of this study is to quantitatively evaluate the lumbar region of the vertebral column to estimate cadaver length, provide population specific data for Nigerians and to document presence or absence of anatomical variations with regards to race. A total of 37 (34 males and 3 females) cadavers were studied. A total of one hundred and eighty-five (185) lumbar vertebrae were harvested and prepared by soil and water maceration. General examination for obvious bone pathology was done before measuring the various parameters. Results showed significantly higher dimensions in males as compared to females. Detailed knowledge of the dimensions of the lumbar vertebrae and its findings will enhance positive contributions to the on-going efforts in scientific study and surgical operations. It will also improve current understanding of the anatomical basis of the spine with regards to physical therapy, rehabilitation and sports medicine.

KEYWORDS: Lumbar, injuries, Nigerian.

INTRODUCTION

The human vertebral column is a delicate complex structure. It is designed to bear the weight of the head, trunk and limbs as they perform various activities with the aid of the skeleton and muscles attached to them. The column also provides protection to the spinal cord. It extends from the occiput to the sacrum and comprises thirty-three bones of which twenty-four only are movable (articulating) while the remaining nine are fused. The last mobile vertebra, L5 rests at an angle on the first part of the immobile sacral bone to form the lumbosacral curve.[1] The strength and resilience of the vertebral column depends on the size, shape and orientation of the vertebrae.[2] A healthy adult spine has three curves, cervical lordotic, thoracic kyphosis and a lumbar lordotic curve. This sinusoidal arrangement of bones with the shock absorbing intervening intervertebral discs confers on it the mechanical properties of a spring equivalent to the square of the number of curves plus 1, with the capacity to bear weight and maintain craniospinopelvic balance.[1,3] Vertebral column length has been reported to estimate stature with relative ease and accuracy.[4,5,6,7,8] It has been reported that in both males and females, the cervico-thoraco-lumbar segments give more accurate estimation of stature.[5]

A study by Raxter et al.,[6] reported that the maximum vertebral body heights (anterior to the pedicles) best predicted the cadaveric statures from known samples. The lumbar region of the spine is bioengineered for bipedal locomotion and weight bearing. It also supports organs of abdomen and the pelvis. Spinal cord injuries mostly involve the thoracic and lumbar segments[9,10] yet, compared with other regions, lumbar spines of African descent have not received much attention; most of the available data, being those derived from populations in America, Asia and Europe.[11]

Ethical Clearance: Permission to carry out the study was sought from the Department of Human Anatomy, Faculty of Basic Medical Sciences, University of Port Harcourt, Department of Anatomy, Faculty of Basic Medical Sciences, PAMO University of Medical Sciences, Port Harcourt where the study took place and approval was obtained from the Research Ethics Committee of the University of Port Harcourt, **Ref: UPH/CEREMAD/REC/MM84/045.** Compliance with institutional rules with respect to human experimental research and ethics was strictly adhered to.

MATERIALS AND METHOD

Cadavers for maceration were obtained from the Department of Human Anatomy of the University of Port Harcourt and PAMO University of Medical Sciences, Port Harcourt. Minimum sample size for this study was calculated using: n = Za2s2/ ε2

Where n is the desired sample size, s is the standard deviation from previous studies, ε is the error margin and zα is a value from the normal distribution related to and representing the confidence level (equal to 1.96 for 95% confidence) at 5% level of significance.[12,13] Thus a total of 185 lumber vertebrae consisting of 34 sets of males and three sets of females, were used in this study. Total body length was obtained from each of the cadaver before dissection of the vertebrae. The vertebral columns were disarticulated and separated from the body and measured to obtain their total length thereafter, the bones were prepared by soil and water maceration. There was no use of chemicals, bleaching and polishing so as to avoid loss of collagen and other micro tissues from the end plates and discs and to preserve the chemical integrity of the bones. After thorough maceration, investigations were carried out with general observations for; Normal vertebral formula; C2 T12 L5 S4 C4, Normal lumbar vertebral formula; L1 - L5, fusion abnormalities, added vertebrae, missing vertebrae and lumbarization. Bones with obvious pathological deformities were excluded.

Measurements on the vertebrae were taken using a digital vernier caliper calibrated to 0.1 mm. All measurements were done with the vertebra placed in the supine position in the axial plane by one member of the research team and in accordance with standard protocols.[14,15,16,17,18] Measurements were done three times and the average score was used for the analysis. This was to avoid inter-observer technical error of measurement.

Total spine length was calculated as the sum of all central vertebral body heights plus the intervertebral disc heights from C2 to L5.

The other parameters measured include

A. Vertebra body

i. The anterior vertebra body height (AVBH) - the distance in the sagittal plane between the central borders of the superior and inferior vertebral body anteriorly.

ii. The posterior vertebra body height (PVBH) - the distance in the sagittal plane posteriorly between the posterior borders of the superior and inferior vertebral body end plate.

iii. The superior vertebral body width (VBSUP) - the distance in the transverse plane between the left and right borders of the superior vertebra body.

iv. The middle vertebra body width (VBMID) **-** the distance in the transverse plane between the left and right borders of the middle vertebra body.

v. The inferior vertebra body width (VBINF) - the distance in the transverse plane between the left and right borders of the inferior vertebra body.

B. Lamina: Measurements were taken on both sides (left and right)

vi. The lamina height (LMNHT) - the transverse distance between the superior and inferior borders on the lamina.

vii. The lamina length (LMNLT) - the transverse distance between the spinous process and the lateral border of the superior articular process of the lamina.

viii. The **lamina thickness (**LMNTK) - the maximum measurable thickness of the lamina.

C. Spinous Process

ix. The spinous process length (SPLT) **-** the sagittal length from the anterior superior edge to the most posterior edge of the spinous process.

x. The spinous process height (SPHT) **-** the distance between the superior and inferior borders, measured at the edge of the Sagittal plane.

xi. The spinous process thickness (SPTK) - the maximum transverse distance between the central points of the lateral surfaces of spinous process.

Data Analysis: The mean, standard error of the mean, range and standard deviation were calculated. Unpaired T test was used to compare measured parameters between two variables. Pearman's correlation test was used to determine the relationship between the variables at $p<0.05$ level of significance. Simple regression equations at $y = bx + c$ was deduced, where 'c' is a constant, 'b' is the regression coefficient. Analysis was done using SPSS statistical package.

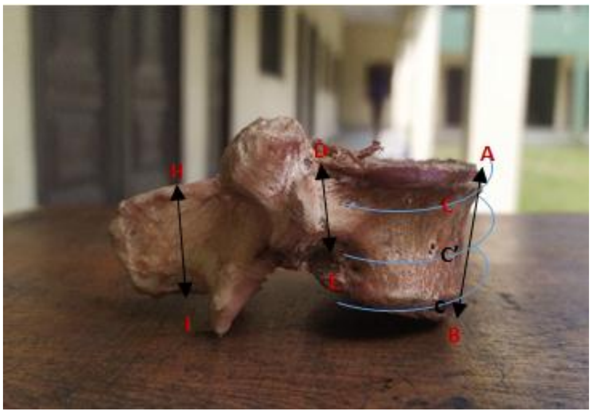

Fig. 1a: Lateral view of lumbar vertebra 4 (L4) showing its dimensions.

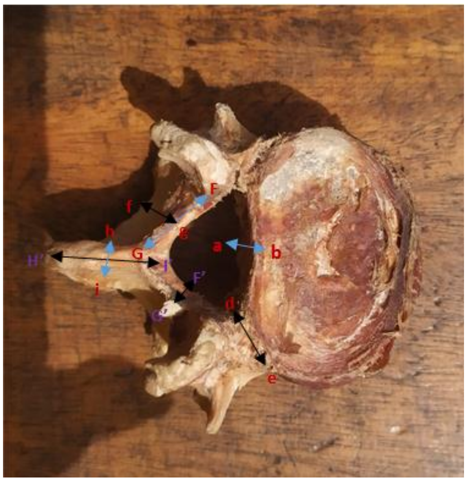

Fig. 1b: Superior view of lumbar vertebra 4 (L4) showing its dimensions.

Anterior vertebral body height (AVBH): AB, Posterior vertebral body height (PVBH): ab, Superior vertebral body width (VBSUP): C, Middle vertebral body width (VBMID): C', Inferior vertebral body width (VBINF): c, Lamina length (LMNLT): FG, Lamina thickness (LMNTK): F'G', Lamina height (LMNHT): fg, Pedicle height (PDTH): DE, Pedicle width (PDWD): de, Spinous process length (SPLT): H'I', Spinous process height (SPHT): HI, Spinous process thickness (SPTK): hi.

RESULTS AND DISCUSSION

Table 1: Descriptive Statistics and Univariate analysis of Full body height, Total vertebra length and Lumber length (mm).

Parameters	N	Minimum	Maximum	Mean ± SD.	Std. Error	C	MEAN ± SD	B	P-value
FBH	37	54.00	72.24	62.97 ± 4.26	0.81	-	-	-	-
TVL	37	21.40	29.00	24.19 ± 1.73	0.33	-	-	-	-
LL	37	6.80	8.00	7.31 ± 0.30	0.06	15.75	62.97 ± 1.93	6.46	0.02

N = number of samples, Std. = Standard, Dev. = Deviation, C = Constant, SD = Standard deviation, B = regression coefficient, P-value ≤0.05.

Table 2: Descriptive Statistics and Univariate Analysis of Lumber length and all measured lumber segment parameters (mm).

Parameters	N	Minimum	Maximum	Mean ± SD	Std. Error	C	Mean ± SD	B	P-value
LL	37	6.80	8.00	7.31 ± 0.30	0.06	-	-	-	-
AVBH	37	15.42	24.46	19.28 ± 2.16	0.44	-	-	-	-
PVBH	37	15.30	28.51	19.80 ± 2.95	0.60	-	-	-	-
VBSUP	37	25.44	45.38	31.88 ± 5.65	1.15	-	-	-	-
VBMID	37	24.85	41.27	30.36 ± 5.00	1.02	-	-	-	-
VBINF	37	28.95	48.65	35.96 ± 6.15	1.26	-	-	-	-
PDHTL	37	7.34	18.44	13.50 ± 2.64	0.54	-	-	-	-
PDHTR	37	10.64	18.58	13.71 ± 2.40	0.49	-	-	-	-
PDWDL	37	5.17	12.19	7.52 ± 1.57	0.32	-	-	-	-
PDWDR	37	4.24	11.42	7.39 ± 1. 89	0.39	-	-	-	-
PDTKL	37	5.10	11.29	6.98 ± 1.47	0.30	-	-	-	-
PDTKR	37	4.82	10.24	6.80 ± 1.36	0.28	-	-	-	-
LMNHTL	37	15.42	28.57	20.61 ± 3.20	0.65	-	-	-	-
LMNHTR	37	17.46	25.40	21.37 ± 2.38	0.49	-	-	-	-
LMNLTL	37	4.85	12.93	8.47 ± 2.50	0.51	-	-	-	-
LMNLTR	37	5.05	14.30	8.76 ± 2.82	0.58	-	-	-	-
LMNTKL	37	4.08	10.73	7.47 ± 1.60	0.33	-	-	-	-
LMNTKR	37	4.20	9.41	7.00 ± 1.35	0.28	6.64	7.31 ± 0.13	0.10	0.03
SPLT	37	9.47	32.01	24.79 ± 5.15	1.05	-	-	-	-
SPHT	37	8.36	24.40	12.80 ± 2.98	0.60	-	-	-	-
SPTK	37	3.04	7.60	4.94 ± 1.30	0.27	-	-	-	-

N = number of samples, Std. = Standard, Dev. = Deviation, C = Constant, SD = Standard deviation, B = regression coefficient, P-value ≤0.05.

Table 3: Descriptive statistics of Male and Female Vertebra Body Dimensions (mm).

Vertebrae level	Parameter	N	Range	Minimum	Maximum	Mean ± SD.	Std. Error
L1 M	AVBH	34	9.78	18.47	28.25	24.33 ± 2.26	0.39
F	AVBH	3	0.88	21.30	22.18	21.86 ± 0.49	0.28
M	PVBH	34	12.69	15.75	28.44	23.34 ± 3.16	0.54
F	PVBH	3	1.66	19.64	21.30	20.71 ± 0.93	0.54
L2 M	AVBH	34	11.87	19.33	31.20	24.72 ± 2.90	0.50
F	AVBH	3	2.75	21.45	24.20	22.75 ± 1.38	0.80
M	PVBH	34	13.17	17.39	30.56	24.09 ± 3.36	0.58
F	PVBH	3	2.46	20.44	22.90	21.30 ± 1.39	0.80
L3 M	AVBH	34	14.55	19.35	33.90	25.97 ± 3.24	0.56
F	AVBH	3	3.27	22.66	25.93	24.00 ± 1.72	1.00
M	PVBH	34	13.72	17.37	31.09	24.55 ± 3.51	0.60
F	PVBH	3	2.49	21.50	23.99	22.37 ± 1.40	0.81
L4 M	AVBH	34	17.48	16.03	33.51	25.77 ± 3.118	0.55
F	AVBH	3	4.05	22.75	26.80	25.00 ± 2.06	1.19
M	PVBH	34	15.53	15.37	30.90	24.51 ± 3.79	0.65
F	PVBH	3	5.15	20.55	25.70	22.92 ± 2.60	1.50
L5 M	AVBH	34	17.65	17.07	34.72	27.11 ± 3.50	0.60
F	AVBH	3	3.18	24.80	27.98	26.89 ± 1.81	1.04
M	PVBH	34	17.06	16.04	33.10	25.30 ± 3.48	0.60
F	PVBH	3	4.75	21.65	26.40	23.90 ± 2.38	1.38
L1 M	VBSUP	34	15.55	31.12	46.67	41.82 ± 3.27	0.56
F	VBSUP	3	0.28	41.02	41.30	41.17 ± 0.14	0.08
M	VBMID	34	23.73	26.16	49.89	37.88 ± 3.94	0.68
F	VBMID	3	1.30	38.35	39.65	38.85 ± 0.70	0.41
M	VBINF	34	18.58	32.44	51.02	43.85 ± 3.93	0.67
F	VBINF	3	0.54	42.39	42.93	42.72 ± 0.29	0.17
L2 M	VBSUP	34	20.45	30.41	50.86	44.19 ± 4.16	0.71
F	VBSUP	3	0.89	45.99	46.88	46.58 ± 0.51	0.30
M	VBMID	34	16.76	27.80	44.56	39.91 ± 4.08	0.70
F	VBMID	3	0.49	44.21	44.70	44.52 ± 0.27	0.15
M	VBINF	34	21.76	31.55	53.31	46.44 ± 4.40	0.75
F	VBINF	3	0.26	48.05	48.31	48.16 ± 0.13	0.08
L3 M	VBSUP	34	18.25	34.25	52.50	46.12 ± 4.43	0.76
F	VBSUP	3	1.04	47.40	48.44	48.01 ± 0.55	0.31
M	VBMID	34	12.60	36.20	48.80	42.77 ± 3.43	0.59
F	VBMID	3	0.56	46.13	46.69	46.42 ± 0.28	0.16
M	VBINF	34	20.16	37.48	57.64	49.65 ± 4.60	0.79
F	VBINF	3	1.97	50.34	52.31	51.59 ± 1.09	0.63
L4 M	VBSUP	34	15.15	41.90	57.05	50.19 ± 3.58	0.61
F	VBSUP	3	0.90	53.57	54.47	54.06 ± 0.46	0.26
M	VBMID	34	14.88	38.10	52.98	45.38 ± 3.71	0.64
F	VBMID	3	0.21	52.46	52.67	52.59 ±0.11	0.07
M	VBINF	34	16.36	42.70	59.06	52.23 ± 3.63	0.62
F	VBINF	3	1.58	55.15	56.73	56.08 ± 0.83	0.48
L5 M	VBSUP	34	40.92	19.02	59.94	52.41 ± 6.73	1.16
F	VBSUP	3	1.72	55.08	56.80	56.23 ± 0.99	0.57
M	VBMID	34	18.78	36.01	54.79	46.91 ± 4.66	0.80
F	VBMID	3	0.48	54.52	55.00	54.77 ± 0.24	0.14
M	VBINF	34	22.10	36.12	58.22	50.90 ± 5.01	0.869
F	VBINF	3	1.64	57.26	58.90	58.08 ± 0.82	0.47

Table 4: Descriptive statistics of Male and Female Lamina Dimensions (mm).

Vertebrae level	Parameter	N	Range	Minimum	Maximum	Mean ± SD	Std. Error
L1 Males	LMNHTL	34	12.74	17.40	30.14	26.07 ± 3.07	0.53
	LMNHTR	34	14.60	18.62	33.22	25.32 ± 2.96	0.52
Females	LMNHTL	3	0.15	23.13	23.28	23.19 ±0.08	0.045
	LMNHTR	3	1.56	21.70	23.26	22.24 ± 0.88	0.51
Males	LMNLTL	34	8.37	6.09	14.46	10.43 ± 1.97	0.35
	LMNLTR	34	9.27	6.02	15.29	10.34 ± 2.13	0.37
Females	LMNLTL	3	0.09	8.07	8.16	8.12 ± 0.05	0.03
	LMNLTR	3	0.55	7.15	7.70	7.50 ± 0.30	0.17
Males	LMNTKL	34	5.85	4.00	9.85	6.69 ± 1.43	0.25
	LMNTKR	34	5.98	3.36	9.34	6.70 ± 1.27	0.22
Females	LMNTKL	3	0.47	5.30	5.77	5.47 ± 0.26	0.15
	LMNTKR	3	0.70	6.12	6.82	6.36 ± 0.40	0.23
L2 Males	LMNHTL	34	10.14	22.16	32.30	26.82 ± 3.24	0.56
	LMNHTR	34	9.44	21.19	30.63	25.94 ± 2.51	0.44
Females	LMNHTL	3	0.43	22.18	22.61	22.45 ± 0.24	0.14
	LMNHTR	3	0.06	23.65	23.71	23.67 ± 0.04	0.02
Males	LMNLTL	34	8.76	7.59	16.35	11.55 ± 1.84	0.32
	LMNLTR	34	8.24	7.64	15.88	11.55 ± 1.73	0.30
Females	LMNLTL	3	0.37	11.26	11.63	11.51 ± 0.21	0.12
	LMNLTR	3	0.08	12.00	12.08	12.04 ± 0.04	0.02
Males	LMNTKL	34	5.45	4.64	10.09	7.06 ± 1.36	0.24
	LMNTKR	34	7.22	3.50	10.72	7.10 ± 1.56	0.27
Females	LMNTKL	3	0.13	8.50	8.63	8.56 ± 0.07	0.04
	LMNTKR	3	0.02	7.11	7.13	7.12 ± 0.01	0.01
L3 Males	LMNHTL	34	11.98	20.00	31.98	25.92 ± 2.81	0.49
	LMNHTR	34	15.07	16.80	31.87	25.19 ± 3.27	0.57
Females	LMNHTL	3	4.16	22.42	26.58	25.01 ± 2.26	1.31
	LMNHTR	3	0.14	21.74	21.88	21.81 ± 0.07	0.04
Males	LMNLTL	34	7.65	7.10	14.75	11.61 ± 1.75	0.31
	LMNLTR	34	7.31	7.59	14.90	12.06 ± 1.83	0.32
Females	LMNLTL	3	0.04	11.03	11.07	11.05 ± 0.02	0.01
	LMNLTR	3	0.20	12.13	12.33	12.26 ± 0.11	0.07
Males	LMNTKL	34	6.45	3.08	9.53	6.73 ± 1.83	0.32
	LMNTKR	34	6.05	3.67	9.72	6.90 ± 1.76	0.31
Females	LMNTKL	3	0.01	8.46	8.47	8.46 ± 0.01	0.00
	LMNTKR	3	0.13	7.77	7.90	7.83 ± 0.07	0.04
L4 Males	LMNHTL	34	10.13	20.70	30.83	24.56 ± 2.38	0.41
	LMNHTR	34	11.91	18.23	30.14	24.28 ± 2.74	0.48
Females	LMNHTL	3	0.20	24.48	24.68	24.60 ± 0.10	0.06
	LMNHTR	3	0.18	22.51	22.69	22.59 ± 0.09	0.05
Males	LMNLTL	34	10.77	5.87	16.64	12.32 ± 1.87	0.33
	LMNLTR	34	8.58	6.86	15.44	12.65 ± 1.85	0.32
Females	LMNLTL	3	0.20	12.12	12.32	12.23 ± 0.10	0.06
	LMNLTR	3	0.31	12.37	12.68	12.51 ± 0.16	0.09
Males	LMNTKL	34	7.31	2.89	10.20	6.24 ± 1.66	0.29
	LMNTKR	34	7.77	2.63	10.40	6.73 ± 2.00	0.35
Females	LMNTKL	3	0.38	7.15	7.53	7.39 ± 0.21	0.12
	LMNTKR	3	0.50	7.43	7.93	7.75 ± 0.28	0.16
L5 Males	LMNHTL	34	16.15	13.85	30.00	21.66 ± 3.47	0.61
	LMNHTR	34	16.98	12.42	29.40	21.65 ± 3.65	0.65
Females	LMNHTL	3	4.85	19.63	24.48	21.56 ± 2.57	1.48
	LMNHTR	3	3.27	19.30	22.57	20.81 ± 1.65	0.95
Males	LMNLTL	34	15.75	10.42	26.17	14.25 ± 2.72	0.48
	LMNLTR	34	13.59	10.16	23.75	14.17 ± 2.47	0.44
Females	LMNLTL	3	0.50	12.93	13.43	13.25 ± 0.28	0.16
	LMNLTR	3	1.18	12.47	13.65	13.09 ± 0.59	0.34

Males	LMNTKL	34	13.06	2.57	15.63	6.50 ± 2.32	0.41
	LMNTKR	34	14.16	2.20	16.36	7.01 ± 2.60	0.46
Females	LMNTKL	3	0.40	7.05	7.45	7.18 ± 0.23	0.13
	LMNTKR	3	0.71	7.99	8.70	8.44 ± 0.39	0.23

Table 5: Descriptive statistics of Male and Female Spinous Process Dimensions (mm).

Vertebrae level	Parameter	N	Range	Minimum	Maximum	Mean ± SD	Std. Error
L1 M	SPLT	34	14.56	12.39	26.95	19.98 ± 3.43	0.60
F	SPLT	3	0.37	19.28	19.65	19.46 ± 0.19	0.11
M	SPHT	34	22.00	13.24	35.24	20.57 ± 4.16	0.72
F	SPHT	3	0.56	21.00	21.56	21.24 ± 0.29	0.17
M	SPTK	34	7.26	3.98	11.24	7.26 ± 1.62	0.28
F	SPTK	3	0.19	8.56	8.75	8.68 ± 0.10	0.06
L2 M	SPLT	34	16.87	13.59	30.46	21.98 ± 4.02	1.00
F	SPLT	3	1.64	17.04	18.68	17.61 ± 0.93	0.54
M	SPHT	34	16.58	16.05	32.63	21.92 ± 3.89	0.68
F	SPHT	3	1.88	19.40	21.28	20.11 ± 1.02	0.59
M	SPTK	34	6.15	4.64	10.79	8.05 ± 1.60	0.28
F	SPTK	3	0.66	7.20	7.86	7.54 ± 0.33	0.19
L3 M	SPLT	34	17.92	17.48	35.40	23.19 ± 3.86	0.67
F	SPLT	3	0.08	19.15	19.23	19.19 ± 0.04	0.02
M	SPHT	34	18.04	11.30	29.34	21.38 ± 3.32	0.58
F	SPHT	3	6.11	16.34	22.45	20.35 ± 3.47	2.01
M	SPTK	34	6.16	5.82	11.98	8.38 ± 1.46	0.25
F	SPTK	3	0.71	8.28	8.99	8.73 ± 0.39	0.23
L4 M	SPLT	34	18.21	17.76	35.97	23.58 ± 4.11	0.72
F	SPLT	3	1.11	22.54	23.65	22.95 ± 0.61	0.35
M	SPHT	34	18.48	14.25	32.73	20.29 ± 3.54	0.62
F	SPHT	3	0.27	15.26	15.53	15.42 ± 0.14	0.08
M	SPTK	34	7.84	5.96	13.80	9.47 ± 1.74	0.30
F	SPTK	3	0.90	9.09	9.99	9.68 ± 0.51	0.30
L5 M	SPLT	34	19.44	12.89	32.33	19.83 ± 4.04	0.71
F	SPLT	3	2.54	21.07	23.61	22.76 ± 1.46	0.85
M	SPHT	34	19.75	10.20	29.95	16.69 ± 3.98	0.70
F	SPHT	3	5.81	16.01	21.82	17.97 ± 3.33	1.93
M	SPTK	34	13.34	4.64	17.98	8.99 ± 2.78	0.49
F	SPTK	3	1.04	9.00	10.04	9.61 ± 0.55	0.31

This study was designed to estimate the cadaveric body length from parameters measured within the vertebrae using regression equations as well as characterize the lumber segment of the vertebrae towards proffering lasting solution in preclinical evaluation of implants and other prosthetic supports in the management of lumber spinal pathologic cases in the Nigerian population. We observed that there was statistical significant correlation between the lumber length (LL) and the full body length at $p<0.05$, hence regression equation was derived to predict the cadaveric length (Table 1). This was in agreement with the work of Raxter et al., [6] who reported that the maximum vertebral body heights (anterior to the pedicles) best predicted the cadaveric statures from known samples. In estimating the lumber length from its parameters, measurement values of right lamina thickness (LMNTKR) were observed to show statistically significant correlation with the lumber length and could predict the lumber length with regression equation (Table 2). Males were generally observed to have higher mean values for all measured parameter compared to their female counterpart. There was a gradual increase in mean for the anterior vertebrae body (AVBH) dimension from L1 (24.33 ± 2.26) to L5 (27.11 ± 3.50) in males and L1 (21.86 ± 0.49) to L5 (26.89 ± 1.81) for females. The other vertebral body dimensions showed gradual increase as they progressed from L1 to L5 but with females showing greater values compared to their male counterparts (Table 3). This is in line with the studies of Egwu et. al., [18] and Singh et.al., [22] who reported similar trends of gradual increases in their studies

Lamina dimensions reduced from L1 (26.07 ± 3.07 left; 25.32 ± 2.96 right) for males, (23.19 ± 0.08 left; 22.24 ± 0.88 right) for females to L5 (21.66 ± 3.47 left, 21.65 ± 3.65 right for males, 21.56 ± 2.57 left, 20.81 ± 1.65 right) for females (Table 4).

Spinous process dimensions also decreased from L1, reached a maximum at L4, then decreased slightly to L5. This pattern was recorded for spinous process length and thickness (Table 5). Spinous process height showed marked degrease at L4 with females having higher values than the males.

CONCLUSION

Data from this study provided normative values of the lumbar vertebrae body, lamina and spinous process. These data are new and could be used for the construction of learning models as well as surgical replacement procedures.

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