# MORPHOMETRIC STUDY OF THE LUMBOSACRAL SPINE AND SOME OF ITS RELATED ANGLES IN LEBANESE ADULT FEMALES

BY

# El Sayed Soliman\*, Ibtissam Saab\*\* and Mohamed El Shishtawy\*\*\*

Departments of Anatomy and Embryology\*, Faculty of Medicine, Alexandria University, Physical Therapy\*\*, Faculty of Health sciences, Beirut Arab University, Lebanon; and Forensic Medicine& Clinical Toxicology\*\*\*, Faculty of Medicine, Benha University, Egypt.

#### **ABSTRACT**

The present study was undertaken to examine medicolegal importance of morphometric characteristics of lumbar vertebrae, lumbar intervertebral discs and some important related angles in adult Lebanese females. The subjects of this study included thirty Lebanese adult females aged between 18-22 years. The subjects were selected among students of the faculty of health sciences, Beirut Arab University. Two plain radiographic views for the lumbosacral spine were taken for each subject (An anteroposterior view and a lateral view). Measurements were made direct from the X-ray films using Vernier calliper and were recorded to the nearest tenth of a millimetre. The following measurements were taken for each Lumbar vertebra: The anterior height of the body, posterior height of the body, horizontal diameter of the pedicle, vertical diameter of the pedicle, interpedicular distance and the width (transverse diameter) of the body. Regarding intervertebral discs, the anterior height, posterior height and anteroposterior diameter of the disc (disc depth) were measured. In addition, the following angles were measured: the angle of lumbar lordosis, lumbosacral angle and angle of sacral inclination. The mean and standard deviation of the above mentioned parameters were calculated and recorded. It is concluded that measurements obtained in this study form a base line figures in normal Lebanese adult females in terms of morphometric measurements in healthy subjects as well as giving guidance to clinicians as being applicable for evaluation and management of subjects complaining of low back pain; not only do these age related normative values help in identifying the underlying cause, but they also direct physicians towards the proper line of treatment. Whether specific preventive modalities or rehabilitation protocols could be instituted to prevent low back pain in subjects with particular spinal alignment remains unclear and should be investigated in future studies. Moreover, these normal figures could also be of forensic importance because of the racial, ethnic and regional variations which have been observed in comparison with previous studies.

Key words: lumbar vertebrae, morphometric, medicolegal.

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# **INTRODUCTION**

Skeletal measurements have a great importance for the forensic medicine and forensic departments working with unknown variables. The aim of these measurements is to describe the remains in such terms so that one can achieve the goal of estimating age at the time of death, sex, ethnicity, stature, body weight/body built, details of individualizing characteristics i.e. amputations, fractures, ankyloses, deformities and bone pathologies and to some extent the cause of death if reflected in the remains/bones. The objective of skeletal measurements is to enable the law enforcement agencies to achieve the ultimate goal of personal identification (Kosa, 2000).

Lumbar lordosis angle is defined as the curvature assumed by the intact lumbar spine to compensate for the inclination of the sacrum, restore an upward spinal orientation, and consequently avoid forward inclination (Skaf et al., 2011).

The curvature of the lumbar spine (lumbar lordosis) and the role it plays in transmission of body weight had been studied extensively (Hellems and Keats, 1971; Pelker and Gage, 1982; Fernand and Fox, 1985). Evidences suggested that the interplay between the curvature and the ligaments that maintain it imparts a resilience that is important in protecting the vertebral column against compression forces and strains that may be encountered in various positions or during movements (Pelker and Gage, 1982). The shape of the lumbar curve varies in different individuals (Hellems and Keats, 1971); nevertheless, it has been noted that some cases of low back pain are attributable to abnormal posture or marked alteration of the curve (Pelker and Gage, 1982).

Anterior access to the L1-L5 vertebrae and disc spaces can be technically challenging, frequently requiring special approach by the neurosurgeon for an adequate exposure. The technique is used for lesion excision, corpectomy, vertebral body reconstruction with cages, realignment, and/or plating or screwing. For a successful anterior approach and a suitable instrumental design via screw, adequate morphometric knowledge about body of lumbar vertebrae and disc spaces and standardized volumetric data are also required for neurosurgeons. Thus, morphometric and volumetric evaluation of lumbar bodies and discs are needed to contribute to a safe anterior approach during surgery(Gocmen et al., 2010).

The last decades have seen an increasing use of transpedicular screw instrumentation techniques as a means of spinal fixation (Stefee et al., 1986; Lorenz et al., 1993). The screw enables various devices (plates, rods or wires) to be applied to the

spine for the purpose of immobilization or fixation. The success of the technique depends upon the ability of the screw to obtain and maintain purchase within the vertebral body (Zindrick et al., 1986). This is determined among other factors, by the accuracy of choice of screw, size of the pedicle and the quality of the bone of the pedicle. The choice of the screw for the procedure is nevertheless, determined by the minimum (horizontal) diameter of the pedicle (Krag et al., 1986; Zindrick et al., 1987; Weinstein et al., 1992). Morphometric data on diameters of the pedicles are, therefore, useful in preoperative planning and in designing of pedicle screws.

The pioneering work of Elsberg and Dyke (1934) , Landmesser and Heublein (1953), Verbiest (1954, 1955), Simril and Thurston (1955), Schwarz (1956) and Hinck et al.(1966) have established the clinical value of measurements of interpedicular distance in diagnosis of narrowing of the spinal canal. Since then, the size of the spinal canal has attracted increasing interest. Various techniques including plain radiographs, myelography, epidural venography, computed tomography, and diagnostic ultrasound have been used to measure the size of lumbar spinal canal (Amonoo-Kuofi, 1982). Although each technique has its own limitation, Chynn et al. (1978) observed that plain radiographs are of great value in the diagnosis of lumbar spinal canal stenosis.

Many morphological studies on lumbar spines have been reported about age, sex and race (Hinck et al., 1966; Amonoo-Kufi, 1985 and Lee et al., 1995). To our knowledge, there has been no report in the English literature about morphometry of the lumbar spines in Lebanese people.The present study was undertaken to examine morphometric characteristics of lumbar vertebrae, lumbar intervertebral discs and the important related angles in normal Lebanese adult females to form a base line figures in healthy individuals which may be of forensic importance regarding racial, ethnic and regional variations.

# SUBJECTS AND METHODS

Subjects of this study included thirty Lebanese adult females aged between 18-22 years. They were selected among students of the faculty of health sciences, Beirut Arab University.

# The inclusion criteria included:

- 1. Age : 18-22 years.
- 2. No prior spine surgery.
- 3. No history of low back pain.
- 4. No history of pregnancy.

# The exclusion criteria included:

- 1. Diagnosed lumbar spinal pathology.
- 2. Spinal deformities from physical examination or x-ray.
- 3. Diagnosed diabetes, hypertension, rickets or osteoporosis.

Two plain radiographic views for the lumbosacral spine were taken for each subject:

a) Anteroposterior view.

b) Lateral view: in the lateral recumbent position with the hips and knees flexed 45°. This position was thought to be preferable in studies of the lumbar lordosis angles because the angle to which the knees and hips were flexed gave a balanced relaxation of the thigh and knee, thus producing a more or less normal lumbar curve (Amonoo-Kuofi, 1991).

All radiographs had been taken where the X –ray beam was centred on L3 with an anode film distance of 100 cm. The magnification resulting from the use of this technique was negligible (Amonoo-Kuofi, 1995). Measurements were made direct from the X-ray films using Vernier callipers and were recorded to the nearest tenth of a millimetre

# The following measurements were taken:

# A. Lumbar vertebrae :

The following measures were taken as shown in figures (1 & 2) according to Amonoo-kuofi (1991) & Amonoo-Kuofi (1982):

- 1. The anterior height of the body of each lumbar vertebra on the lateral view (figure 1).
- 2. The posterior height of the body of each lumbar vertebra on the lateral view (fig-

ure 1).

- 3. The horizontal diameter of the pedicle of each lumbar vertebra on an anteroposterior view (figure 2).
- 4. The vertical diameter of the pedicle of each lumbar vertebra on an anteroposterior view (figure 2).
- 5. The interpedicular distance measured as the shortest distance between the medial borders of pedicles for each lumbar vertebra on an anteroposterior view (figure 2).
- 6. The width (transverse diameter) of the body of each lumbar vertebra. This was measured at the level of the narrowest part of the waist of the vertebra on an antero-posterior view (figure 2).
- The ratio of the inter-pedicular distance to the transverse diameter of the corresponding lumbar vertebra was calculated.

# **B.** Intervertebral discs:

The following measures were taken as shown in figure (1) according to Amonookuofi (1991).

- 1. The anterior height of the lumbar intervertebral discs lying between the vertebrae from the first lumbar to the first sacral vertebrae on the lateral view (figure 1).
- 2. The posterior height of the lumbar intervertebral discs lying between the vertebrae from the first lumbar to first sacral vertebrae on the lateral view (figure 1).

3. The antero-posterior diameter of the disc (disc depth) on the lateral view (figure 1). Disc depth =AB+CD/2 (Amonoo-kuofi, 1991).

# C. Angles:

The following angles were measured as shown in figure (3) according to Amonoo-kuofi (1992):

1. The angle of lumbar lordosis: the angle between the plane of the upper surface of the first lumbar vertebra and the upper surface of the sacrum.

- 2. The lumbosacral angle: the angle between the plane of the inferior surface of the fifth lumbar vertebra and the plane of the upper surface of the sacrum.
- 3. The angle of the sacral inclination: measured between the plane of the upper surface of the sacrum and the horizontal plane.



**Fig. (1)**: Diagram showing positioning of markers for measuring the intervertebral discs and bodies of lumbar vertebrae: Vertebra: CB: anterior height; DA: posterior height; Disc:BC: anterior height; AD: posterior height. Disc depth = AB+CD/2. After Amonoo-kuofi (1991).



**Fig.(2)** : Plain x-ray for the lumbar spines antero-posterior view showing; a-horizontal (C) and vertical (D) diameters of the pedicle, b-interpedicular distance (A) as well as the transverse diameter of the body (B) of the vertebra after Amonoo-Kuofi (1982).



**Fig.(3)** : Lateral view of the lumbar spine showing A: Angle of lumbar lordosis; B: Lumbosacral angle; C: Angle of sacral inclination after Amonoo-kuofi (1992).

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#### **Statistical analysis**

Statistical analysis was done by using SPSS version 16 (Statistical Package for social Sciences). Mean and standard deviation of the above mentioned parameters were calculated and recorded. Significance was considered when P value is less than 0.05.

# RESULTS

The present study was performed on 30 adult Lebanese females. Their ages ranged from 18-22 years with a mean of  $19.67\pm$  1.19 years. Their weight ranged from 50-73 kg with a mean of  $61.01\pm6.2$  kg. Their height ranged from 158-180 cm with a mean of  $163.1\pm4.9$  cm. Their body mass index ranged from 18.7-27.6 with a mean of 22.21\pm2.5 (table 1).

**Table (1) :** Age, weight, height and body mass indexof the studied subjects.

	Min.	Max.	Mean ± SD
Age (years)	18	22	19.67 ± 1.19
Weight (kg)	50	73	61.01 ± 6.2
Height (cm)	158	180	163.1 ± 4.9
BMI	18.7	27.6	22.21 ± 2.5

The results of the present study revealed that the mean anterior heights of the bodies of the lumbar vertebrae increased from L1 to L5 (table 2), while the mean posterior heights decreased from L2 to L5, with the exception of L1 which is lower than L2 (table 3).

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Vertebra	Anterior height				
	Min.	Max.	Mean ± SD		
L1	29	36.3	31.8 ± 1.8		
L2	29	36	32.7 ± 2.1		
L3	29.5	38.6	34.1 ± 2.2		
L4	29.9	39	34.2 ± 2.2		
L5	29.8	37.2	34.5 ± 1.8		

**Table (2) :** The anterior heights of the bodies of lumbar vertebrae (in mm).

<b>Fable (3) :</b>	The	posterior	heights	of	the	bodies	of
	lumb	oar vertebi	rae (in m	m).			

Vertebra	Posterior height			
	Min.	Max.	Mean ± SD	
L1	29	36	32.3 ± 1.9	
L2	29	37.6	33.2 ± 2.1	
L3	29	39.1	32.9 ± 2.2	
L4	27.7	35	32.2 ± 1.8	
L5	25	35.7	30.7 ± 3.0	

Regarding the intervertebral discs, the present study revealed that the mean anterior heights of the intervertebral discs showed gradual increase (table 4), while the mean posterior height showed no specific pattern of change. However, the narrowest posterior height was L5/S1 disc, while the widest posterior height was L4/ 5 disc (table 5).

Intervertebral	Anterior height			
disc	Min.	Max.	Mean ± SD	
L1/2	5.6	13.9	10.0 ± 2.2	
L2/3	5.6	17.4	12.4 ± 2.5	
L3/4	10.6	19.2	14.6 ± 2.2	
L4/5	11.7	21.1	16.5 ± 2.1	
L5/S1	11.8	21.6	16.8 ± 2.6	

**Table (4) :** The anterior heights of lumbar intervertebral discs (in mm)

Table (5) : The posterior heights of lumbar interver	-
tebral discs (in mm).	

Intervertebral	Posterior height			
disc	Min.	Max.	Mean ± SD	
L1/2	4.3	9.4	6.2 ± 1.4	
L2/3	3.5	8.7	6.0 ± 1.2	
L3/4	4.9	7	6.0 ± 0.5	
L4/5	4.9	10	6.6 ± 1.2	
L5/S1	2.9	7.5	5.3 ± 1.4	

Regarding the anteroposterior diameter of the disc (disc depth), the present results revealed nearly the same disc depth, i.e., constant disc depth starting from L1/2disc to L5/S1 disc (table 6).

Intervertebral	Anteroposterior diameter				
disc	( Disc Depth)				
	Min.	Max.	Mean ± SD		
L1/2	43.4	40.5	37.1 ± 1.8		
L2/3	35.3	41.6	38.2 ± 1.8		
L3/4	34.4	41.8	38.3 ± 2.2		
L4/5	36.3	41.4	38.6 ± 1.6		
L5/S1	34.6	41.2	37.2 ± 1.7		

**Table (6) :** The antero-posterior diameter of lumbarintervertebral discs (disc depth) .

Regarding the pedicles of the lumbar vertebrae, the results of the present study revealed that the mean horizontal diameter of the pedicle showed gradual increase from above downwards (table 7), while the mean vertical diameter of pedicle of the lumbar vertebrae from L1 to L5 was more or less constant (table 8). At all levels the vertical diameter was greater than the horizontal diameter. Also, it has been noted that the vertical diameter becomes more oblique with each successive inferior level, producing more inclination of the horizontal diameter as well (figures 4&5).

Vertebra	Horizontal diameter			
	Min.	Max.	Mean ± SD	
L1	5.2	11	6.4 ± 1.3	
L2	5.2	10	7.0 ± 1.1	
L3	5.8	12.2	8.5 ± 1.4	
L4	7.6	15	10.5 ± 1.9	
L5	10	17.5	13.1 ± 2.2	

Table (7) :	The horizontal diameters of the pedicles
	of the lumbar vertebrae (in mm).

Table (8) :	The vertical diameters of the pedicles o
	lumbar vertebrae (in mm).

Vertebra Vertical diameter

	Min.	Max.	Mean ± SD
L1	11	18	15 ± 1.4
L2	11.9	18	15.3 ± 1.4
L3	11.5	20.6	15.7 ± 2.1
L4	12	18.5	15.1 ± 1.6
L5	11.4	20.3	15.8 ± 2.6



Figure (4)Figure (5)Figures (4&5): Showing that the vertical diameter of the pedicle becomes more oblique with each successive inferior level.

The present study revealed that the mean interpedicular distance increased gradually from L1 to L5 (table 9). At the same time, the mean transverse diameter of bodies of the lumbar vertebrae showed

also a gradual increase from L1 to L5 (table 10) keeping the ratio of the interpedicular distance to the transverse diameter of the body more or less constant about 0.6 (table 11).

Vertebra	Interpedicular distance			
	Min.	Max.	Mean ± SD	
L1	19	27.5	23.5 ± 2.3	
L2	21	29	25.1 ± 1.9	
L3	23.1	30	26.1 ± 1.9	
L4	23	30.9	27.4 ± 1.9	
L5	28	37.1	32.4 ± 2.5	

**Table (9) :** The interpedicular distance for each lumbar vertebra (in mm).

Table (10) : The transverse diameter of the	e body of
each lumbar vertebra (in mm).	2

Vertebra	Transverse diameter			
	Min.	Max.	Mean ± SD	
L1	33.6	45	38.9 ± 3	
L2	35.3	47.2	41.0± 3.1	
L3	38.1	49.9	44.0 ± 3.3	
L4	41.8	54.9	48.0 ± 2.9	
L5	50	66.9	57.1 ± 4.2	

**Table (11) :** The ratio of the interpedicular distanceto the transverse diameter for each lumbar vertebra

Vertebra	Interpedicular	Transverse	Ratio
Vertebra	merpedicular	mansverse	natio
	distance	diameter	
L1	23.5	38.9	0.60
L2	25.1	41.0	0.61
L3	26.1	44.0	0.59
L4	27.4	48.0	0.57
L5	32.4	57.1	0.57

The present study revealed that in adult Lebanese females the lumbar lordosis angle ranged from 55° to 99° with a mean of  $71.8^{\circ} \pm 12.8^{\circ}$ , the lumbosacral angle ranged

from 7° to 33° with a mean of  $15.9^{\circ} \pm 5.7^{\circ}$ ; while the sacral inclination angle ranged from 24° to 65° with a mean 45.4°  $\pm$  10.7° (table 12 and figures 6 & 7).

**Table (12) :** The angles of lumbar lordosis, lumbosa-<br/>cral angle and the angle of sacral inclina-<br/>tion in degrees

Angle	Min.	Max.	Mean ± SD
Lumbar lordosis	55°	99°	71.8°±12.8°
Lumbosacral	7°	33°	15.9°±5.7°
Sacral inclination	24°	65°	45.4°±10.7°





# **DISCUSSION**

Determination of race through morphological measurements of bones is not so simple. Inspite of several multivariate statistical studies of specific measurements of the skull and a few long bones, this is still one of the most problematic areas in skeletal identification (Giles and Elliot, 1962).The present study is just a trial to solve this problem through comparing the results on Lebanese adult healthy females with those of other published literatures to reach a clue.

The results of the present study revealed that the anterior heights of the bodies of the lumbar vertebrae increased from L1 to L5, while the posterior heights decreased from L2 to L5, with the exception of L1 which is lower than L2. At the same time, the anterior heights of the intervertebral discs showed gradual increase, while the posterior height showed no specific pattern of change. However, the narrowest posterior height was L5/S1 disc, while the widest posterior height was L4/5 disc.

In comparison, Gocmen et al. (2010) on Anatolians recorded smaller values regarding the anterior height of the bodies of lumbar vertebrae as well as the anterior heights of lumbar intervertebral discs than those obtained in the present study. However, their results showed a gradual cephalocaudal increase which is of the same pattern to the changes obtained in the present study. Ablyazov (2012) on Uzbekistani recorded results which are nearly equal to those obtained in the present study regarding the anterior and posterior heights of vertebral bodies; however, he recorded smaller values for the anterior and posterior heights of the intervertebral discs. These parameters can be helpful to evaluate lumbar vertebral anatomy in terms of morphometric measurements in healthy subjects as well as giving guidance to the surgeons during anterior approach. Moreover, knowing the normal distance of the lumbar intervertebral space can be helpful in predicting the appropriate size of the devices inserted in the intervertebral space so as to decrease the incidence of postoperative complications (Hong et al., 2010) where restoration of the appropriate intervertebral disc space is highly recommended.

Are the intervertebral disc heights related to the interspinous heights? Previous investigators reported that lumbar interspinous implants, although not a new concept (Whitesides, 2003), is such an alternative for use in degenerative conditions such as spinal canal and foraminal stenosis (Zucherman et al., 2005, Kondrashov et al., 2006, Siddiqui et al., 2007,).Although, Albietz et al. (2012) reported no correlation between the interspinous height with anterior disc or posterior disc heights, they stated that knowledge of anterior and posterior disc heights could assist in preoperative planning for implanting an interspinous device as these dimensions can be more easily retrieved from a standard lateral projection radiograph than can be the dimensions of the interspinous space.

Regarding the anteroposterior diameter of the disc (disc depth), the present study results revealed nearly the same disc depth, i.e., constant disc depth starting from L1/2disc to L5/S1 disc. The same results with the same figures were reported by Amonoo-Kuofi (1991) in Saudi Arabia.

More accurate knowledge of pedicle morphology and accurate measurements of the pedicle dimension in patient undergoing pedicle screw instrumentation is crucial (Sugisaki et al., 2009). Comparative studies reported by Zindrick et al. (1986 & 1987), Weinstein et al. (1992) and Errico & Palmer (1993) established that measurements obtained directly from plain films correlated well with values measured from computerized tomograms and from anatomical specimens.

The results of the present study revealed that the horizontal diameter of the pedicle of the lumbar vertebrae showed gradual increase from L1 to L5, while the vertical diameter was more or less constant. Also, at all levels the vertical diameter was greater than the horizontal diameter. At the same time, it has been noted that the vertical diameter becomes more oblique with each successive inferior level, producing more inclination of the horizontal diameter as well.

In comparison with previous studies, Olsewki et al. (1990) on cadaveric American specimen, Amonoo-Kuofi (1995) in Saudi Arabia and Sugisaki et al. (2009) on American people reported gradual cephalocaudal (from L1 to L5) increase in the horizontal as well as in the vertical diameter. On the other hand, Zindrick et al (1987) on Indian poeple, Kadioglu et al (2003) on Anatolian people and Lien et al (2007) on Taiwanese people reported a gradual cephalocaudal increase in the horizontal diameter, while the vertical diameter showed a gradual decrease. Thus, there is a general agreement regarding the cephalocaudal pattern of change in the horizontal diameter of the pedicle, while conflicting results (increase, decrease or constant) were recorded regarding the pattern of change in the vertical diameter. These latter variations may be attributed to racial, ethnic or regional variations.

Consistent with the present findings, Robertson et al. (2000), Seranan et al. (2002) and Sugisaki et al. (2009)reported that the pedicle cross-sectional morphology can be assumed to be elliptical and it becomes more oblique to the vertical plane with each successive inferior level. Also, Sugisaki et al. (2009) reported that the vertical diameters were greater than the horizontal diameters at all levels, which is again in agreement with the results of the present study.

Amonoo-Kuofi (1982) reported that pedicles produce visible landmarks on plain anteropostrerior radiographs and therefore, the interpedicular distances can be measured accurately. The lumbar part of the neural canal houses the caudaequina, and narrowing of the bony ring of the canal, which may be developmental or acquired, may lead to compression of the nerve root and cause low back pain (Verbiest, 1954 & 1955). Measurement of the width of the lumbar spinal canal is, therefore, a useful aid in the diagnosis of lumbar spinal stenosis syndrome.

The present study revealed that the interpedicular distance increased gradually from L1 to L5. At the same time, the transverse diameter of bodies of the lumbar vertebrae showed also a gradual increase from L1 to L5 keeping the ratio of the interpedicular distance to the transverse diameter of the body more or less constant about 0.6.

These results are consistent with those of Hinck et al. (1966) on White Americans as well as Amonoo-Kuofi (1982), on Nigerians; both reported a steady increase in interpedicular distance from L1 to L5 in all age groups. In the same study, Amonoo-Kuofi reported that the width of the canal increases proportionately with the size of the vertebrae, always maintaining a canal to body ratio of 0.6, which is the same as the results of the present study. Recently, Gocmen et al. (2010) reported larger transverse diameter of the bodies of lumbar vertebrae from L1 to L4 except L5. Ablyazov (2012) in Uzebkistani reported results the interpedicular distance regarding which are nearly the same as those obtained in the present study.

Abnormal sagittal spinal alignment may cause persistent low back pain. It is estimated that at one time, 80% of the population will be afflicted with low back pain (Kelsey & White, 1980). Disc herniation, and degeneration which were found to increase with age (Amonoo-Kuofi, 1992 and Dammers & Koehler, 2002) were reported to be significant factors in the genesis of it; hence the importance to examine young individuals. This was supported by Paajanen et al. (1989), who found that the frequency of disc degeneration in individuals 20 years of age with low back pain to be 57%. Salminen et al. (1999) reported the presence of degenerative disc in at least one level in individuals 15 and 18 years of age to be 31% and 42% respectively. Cheung et al. (2009) detected, in Southern Chinese Society, the frequency of degenerative disc in individuals aged 18-29 years to be 42%. Several studies have shown the importance of sagittal spino-pelvic alignment in maintaining a balanced posture in normal population. However, the influence of sagittal spino-pelvic alignment on low back pain is still poorly understood. Previous investigators reported conflicting results suggesting either decreased (Rajnics et al., 2002 and Barrey et al., 2007), increased (Ergun et al., 2010) or normal (George et al., 2003) lumbar lordosis in patients with low back pain. Thus, it can be postulated that whether specific patterns

of sagittal spino-pelvic alignment are more prevalent in patients with low back pain is still unclear.

The present study revealed that in adult Lebanese females the lumbar lordosis angle ranged from 55° to 99° with a mean of  $71.8^{\circ} \pm 12.8^{\circ}$ , the lumbosacral angle ranged from 7° to 33° with a mean of  $15.9^{\circ} \pm 5.7^{\circ}$ ; while the sacral inclination angle ranged from 24° to 65° with a mean 45.4°  $\pm$ 10.7°. These angles are different from those of Egyptians, (Soliman and El-Nemr, 1996) where the lumbar lordosis angle ranged from 31° to 55° with a mean 43.6°  $\pm$  8,02°; the lumbosacral angle ranged from 7° to 15° with a mean of 10.25° ± 2.31°; whereas the sacral inclination angle ranged from 19° to 47° with a mean 33.1°± 8.69°. The three angles were higher in Lebanese than Egyptians. Kenji Endo et al. (2010) reported that the lumbar lordosis angle in Japanese was 49°±10° in normal control group while lumbar lordosis angle was 36.7°± 14.5° in cases of lumbar disc herniation; six month after surgery, the malalignment recovered to almost the same level (44.8° $\pm$  10.8°) of the control group. Rajnics et al. (2002) and Barrey et al. (2007) detected decrease in lumbar lordosis and sacral slope in patients with disc degeneration and disc herniation when compared to normal individuals. This was supported by Kenji Endo et al. (2010) who reported that the degree of intervertebral disc degeneration increased parallel to the decreased in sacral kyphosis and lumbar lordosis angles and to increase in sacral table angle. On the other hand, Ergun et al. (2010) reported that lumbosacral structure with a more vertical orientation causes a tendency to develop disc degeneration and disc herniation, which was observed frequently in MRI findings of young adult woman.

In the light of those previous studies as well as the present one, it seems reasonable to hypothesize that individuals with abnormal sagittal spino-pelvic alignment have a greater risk of developing disc herniation than those with normal lumbosacral slope. As Ergun et al. (2010) reported that individuals with a straighter vertebral column have a greater risk of low back pain complaints and more severe symptoms throughout their lives than those with normal sacral slope, it is of some interest to speculate that since adult Lebanese females present more vertical orientation of the lumbosacral structures, hence they have a tendency to develop disc degeneration or herniation.

It is concluded that measurements obtained in this study form a base line figures in normal Lebanese adult females in terms of morphometric measurements in healthy cases. These normal figures could be of forensic importance because of the observed racial, ethnic and regional variations and could give guidance to clinicians as being applicable for evaluation and management of subjects complaining of low back pain. Not only do these age related normative values help in identifying the underlying cause, but they also direct physicians towards the proper line of treatment. Whether specific preventive modalities or rehabilitation protocols could be instituted to prevent low back pain in subjects with particular spinal alignment remains unclear and should be investigated in future studies.

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# دراسة مورفولوجية للفقرات العجزية وبعض الزواياذات الصلة فى الإناث اللبنانيات البالغات

المشتركون في البحث

أ.م.د. السيد سليمان
 أ.م.د. إبتسام ساب\*
 أ.م.د. محمد الشيشتاوى\*\*
 من أقسام التشريح والأجنة – كلية الطب – جامعة الأسكندرية
 \*العلاج الطبيعى – كلية العلوم الطبيعية – جامعة بيروت العربية – لبنان
 \*\*الطب الشرعى والسموم الإكلينيكية – كلية الطب – جامعة بنها

أجريت هذه الدراسة بغرض معرفة الخصائص المورفولوجية للفقرات القطنية والأقراص الغضروفية بين الفقرات القطنية وبعض الزوايا المهمة ذات الصلة وذلك في الإناث اللبنانيات البالغات. شملت عينة الدراسة ثلاثون فتاة تتراوح أعمارهن بين ١٨-٢٢سنة. وقد تم اختيارهن من بين الطالبات بكلية العلوم الصحية بجامعة بيروت العربية و لقد تم عمل صور اشعة عادية على الفقرات القطنية والعجزية من العمود الفقري (صورتان لكل فتاة إحداهما أمامية – خلفية والأخرى جانبية). ثم أجريت قياسات مباشرة من صور الأشعة باستخدام مسطرة فيرنيير لأقرب جزء من العشرة من المليمتر.

وتم أخذ القياسات التالية لكل فقرة قطنية: الارتفاع الأمامي لجسم الفقرة، والارتفاع الخلفي لجسم الفقرة والقطر العرضي لجسم الفقرة وكذلك المسافة بين العنيقين وقياس القطر الأفقي والقطر العمودي للعنيق. أما فيما يتعلق بالأقراص الفقرية، فقد تم قياس الارتفاع الأمامي والخلفي وكذلك الارتفاع الأمامي الخلفي من القرص (عمق القرص). وبالإضافة إلى ذلك، تم قياس الزوايا التالية، زاوية القعس القطني والزاوية القطنية العجزية و زاوية الميل العصعصي. ثم تم حساب المتوسط والانحراف المعياري لكل من القياسات المذكورة أعلاه وتسجيلها.

وخلصت هذه الدراسة إلى أن القياسات التي تم الحصول عليها تشكل قاعدة خط الأرقام التي قد تكون مناسبة لتقييم الأشخاص الذين يشكون من آلام أسفل الظهر، ليس فقط لأنها تساعد في تحديد السبب الكامن وراء ذلك، لكنها أيضا توجه الأطباء مباشرة نحو الخط السليم للعلاج. وعما إذا كان بالامكان استخدام هذه القياسات لوضع بروتوكولات لإعادة تأهيل هؤلاء الذين يعانون من آلام اسفل الظهرفإن ذلك يستوجب الكثير من الدراسات التي يجب أخذها في الاعتبار في المستقبل. وعلاوة على ذلك، يكن أيضا أن تكون هذه الأرقام ذل الظهرفان ذلك

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