



## Three Dimensional Digital Modelling of Human Spine Anthropometrics and Kinematics from Meta-analysis. How Relevant is Existing Anatomical Research?

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For abbreviations see (1).

**Table S1. Normalised cervical vertebrae measurements** (modified from (2-8))

mm / (°)	C1	C2	C3	C4	C5	C6	C7
VRHa	16.0						
VRHp	10.4						
VRTa	6.9						
VRTp	8.3						
VRD	47.9						
FDD	33.5	25.1	17.5	16.2	16.1	16.1	16.0
FDW	32.1	21.1	24.6	25.6	26.5	26.9	26.4
LMa-VRa	5.4						
TP-LM	8.9						
C1Fac-D	21.8						
VBHa		20.5	14.2	13.5	12.8	13.1	14.7
VBHp		16.7	14.6	14.1	13.7	13.7	15.0
VBHpc			12.2	11.9	11.9	11.4	13.4
H		41.0					
DH		17.8					
DDD <sub>s</sub>		12.2					
DDDi		11.1					
DDW <sub>s</sub>		11.1					
DDWi		10.2					
ASH		16.0					
EPLH		4.2					
DI		13.4					
EPWi		19.7	20.8	21.7	22.8	25.2	29.5

<b>EPWs</b>							16.7
<b>EPDs</b>		12.7	15.0	15.6	15.6	16.2	16.7
<b>EPDi</b>		16.1	16.2	16.4	16.8	17.3	16.8
<b>SPL-pi</b>		36.8	30.8	30.6	29.9	35.8	46.7
<b>SPL-ps</b>		40.2	24.6	33.8	35.6	41.7	49.9
<b>SPL</b>		35.5	31.0	31.8	29.9	35.8	47.9
<b>TPW</b>	82.6	57.5	56.0	56.7	58.2	61.1	73.7
<b>EPI-ti (°)</b>		4.2	2.0	2.1	2.7	2.7	1.8
<b>EPI-ts (°)</b>			2.7	3.5	1.7	4.7	2.2
<b>SPI (°)</b>		19.8	22.0	20.0	20.0	13.9	14.3
<b>DBHa</b>		4.8	5.3	5.5	5.4	5.2	4.7
<b>DBHp</b>		4.2	3.3	3.0	3.0	3.3	3.5
<b>D-Gap</b>		1.7					
<b>V-ind</b>		1.0	0.8	0.8	0.8	0.9	0.8
<b>L</b>		53.6	46.5	46.7	49.3	55.9	63.3
<b>PDI (°)</b>			42.3	43.3	40.3	31.9	29.9
<b>UJI (°)</b>			43.0	43.9	39.8	45.0	53.6
<b>PDW</b>			5.9	5.7	5.9	6.2	6.9

**Table S2. Normalised thoracic vertebrae measurements** (modified from (9,10))

<b>Mm/ (°)</b>	<b>T1</b>	<b>T2</b>	<b>T3</b>	<b>T4</b>	<b>T5</b>	<b>T6</b>	<b>T7</b>	<b>T8</b>	<b>T9</b>	<b>T10</b>	<b>T11</b>	<b>T12</b>
<b>VBHa</b>	17.1	18.2	18.3	19.1	19.2	19.1	19.1	19.6	20.8	22.7	23.8	25.5
<b>VBHp</b>	17.5	18.2	19.2	20.0	20.6	20.9	21.6	22.0	22.6	24.1	26.5	28.2
<b>VBHpc</b>	14.8	16.3	16.5	17.0	17.0	18.2	19.1	19.6	20.2	21.2	22.3	23.8
<b>EPWi</b>	29.1	28.7	27.1	27.2	28.3	29.6	30.5	32.0	34.6	37.1	41.0	44.1
<b>EPWs</b>	25.7	26.1	25.8	25.7	26.1	27.5	29.1	30.9	32.1	33.4	36.6	40.9
<b>EPDi</b>	20.6	22.6	24.4	25.7	27.0	28.2	29.9	30.8	32.5	33.1	33.3	35.0
<b>EPDs</b>	19.4	20.5	23.8	24.4	25.5	27.2	28.7	29.2	30.7	32.0	33.4	34.4
<b>SPL</b>	52.5	54.6	54.2	53.6	54.6	56.4	52.9	55.3	53.8	51.7	47.8	49.7
<b>FDW</b>	22.8	20.4	19.2	17.8	17.9	18.1	18.1	18.6	18.8	19.1	20.3	23.3
<b>FDD</b>	17.2	16.0	16.7	17.0	17.1	17.3	16.9	16.7	16.5	16.2	16.8	19.1
<b>TPW</b>	78.9	72.7	63.7	59.6	64.0	64.2	63.3	62.8	62.1	61.2	54.7	49.2
<b>EPI-ti (°)</b>	3.9	1.9	2.1	2.3	2.0	1.8	2.2	2.3	1.2	1.2	2.2	1.8
<b>EPI-ts (°)</b>	1.8	1.7	2.4	1.5	2.1	2.1	1.6	1.3	0.9	0.5	2.3	2.2
<b>SPI (°)</b>	14.7	15.1	15.5	15.9	16.4	16.8	17.2	17.6	18.0	18.4	18.8	19.2
<b>DBHa</b>	3.5	3.3	2.6	2.9	2.8	3.3	3.9	4.2	4.5	5.3	6.6	5.1
<b>DBHp</b>	3.7	3.8	3.6	3.8	3.9	4.3	4.3	4.4	4.4	4.9	5.2	5.6
<b>V-ind</b>	1.0	1.1	1.2	1.3	1.4	1.4	1.5	1.5	1.6	1.7	1.7	1.8

**Table S3. Normalised lumbar vertebrae measurements** (modified from (7,11-13))

<b>mm / (°)</b>	<b>L1</b>	<b>L2</b>	<b>L3</b>	<b>L4</b>	<b>L5</b>
<b>VBHa</b>	25.6	27.4	28.1	27.6	28.5
<b>VBHp</b>	27.1	28.0	27.8	26.9	25.5
<b>VBHc</b>	24.9	25.5	24.9	25.3	24.0
<b>EPWi</b>	45.4	47.7	50.3	51.9	51.8
<b>EPWs</b>	43.2	44.6	46.2	48.8	49.6
<b>EPDi</b>	34.5	35.0	34.9	35.1	34.2
<b>EPDs</b>	33.8	34.7	35.0	34.7	34.5
<b>SPL-ps</b>	53.0	56.2	57.1	55.2	51.7
<b>SPL-pi</b>	47.3	50.3	50.9	48.7	44.2
<b>SPL</b>	70.9	75.1	75.1	73.5	71.6
<b>FDW</b>	24.8	24.9	25.5	26.6	28.4
<b>FDD</b>	19.9	19.1	18.3	19.5	20.6
<b>TPW</b>	74.6	79.8	89.8	83.2	96.9
<b>EPI-ti (°)</b>	4.0	2.1	2.7	2.7	1.8
<b>EPI-ts (°)</b>	2.7	3.5	1.7	4.7	2.2
<b>SPI (°)</b>	19.6	19.8	20.1	20.9	21.3
<b>DBHa</b>	7.6	9.0	10.4	12.1	14.2
<b>DBHp</b>	6.6	9.0	10.4	12.1	14.2
<b>V-ind</b>	1.7	1.8	1.7	1.8	1.7
<b>L</b>	81.4	85.1	85.7	83.8	77.9

**Table S4 Minimum full ROM angular values of the entire spine (°)**

<b>Region</b>	<b>C0-C2</b>	<b>C3-T1</b>	<b>C0-T1</b>	<b>T1-T12</b>	<b>T12-S1</b>
<b>Flexion (Rx)</b>	14.7	30.8	45.5	27.6	15.1
<b>Extension (-Rx)</b>	-15.6	-32.9	-48.5	-12.4	-38.5
<b>Lateral bending (<math>\pm</math>Ry)</b>	$\pm$ 6.3	$\pm$ 18.2	$\pm$ 24.5	$\pm$ 52.0	$\pm$ 13.65
<b>Axial rotation (<math>\pm</math>Rz)</b>	$\pm$ 32.8	$\pm$ 25.2	$\pm$ 58.0	$\pm$ 49.0	$\pm$ 6.65

**Table S5 Average full ROM angular values of the entire spine (°)**

<b>Region</b>	<b>C0-C2</b>	<b>C3-T1</b>	<b>C0-T1</b>	<b>T1-T12</b>	<b>T12-S1</b>
<b>Flexion (Rx)</b>	20.3	42.6	42.9	52.4	22.4
<b>Extension (-Rx)</b>	-21.6	-45.5	-67.1	-23.6	-57.0
<b>Lateral bending (<math>\pm</math>Ry)</b>	$\pm$ 10.9	$\pm$ 31.3	$\pm$ 42.2	$\pm$ 76.0	$\pm$ 26.5
<b>Axial rotation (<math>\pm</math>Rz)</b>	$\pm$ 42.6	$\pm$ 32.7	$\pm$ 75.3	$\pm$ 71.0	$\pm$ 18.85

**Table S6 Cervical spine inter-vertebral motion percentage calculations (%)**

	<b>C0-C1</b>	<b>C1-C2</b>	<b>C2-C3</b>	<b>C3-C4</b>	<b>C4-C5</b>	<b>C5-C6</b>	<b>C6-C7</b>	<b>C7-T1</b>
<b>Rx</b>	19.1	13.2	7.9	11.7	12.2	13.3	11.4	11.4
<b>Ry</b>	11.6	14.3	13.6	14.0	12.8	11.9	10.9	10.9
<b>Rz</b>	4.7	51.9	7.7	8.6	7.7	7.7	6.8	5.8

**Table S7 Thoracic spine inter-vertebral motion percentage calculations (%)**

	T1- 2	T2- 3	T3- 4	T4- 5	T5- 6	T6- 7	T7- 8	T8- 9	T9- 10	T10- 11	T11- 12
<b>Rx</b>	6.0	6.0	6.0	6.0	6.0	8.0	8.0	9.0	9.0	15.0	21.0
<b>Ry</b>	6.0	9.0	9.0	7.0	7.0	7.0	10.0	9.0	9.0	12.0	15.0
<b>Rz</b>	15.0	12.0	11.0	11.0	11.0	11.0	11.0	7.0	5.0	3.0	3.0

**Table S8 Lumbar spine inter-vertebral motion percentage calculations (%)**

	T12-L1	L1-L2	L2-L3	L3-L4	L4-L5	L5-S1
<b>Rx</b>	9.1	13.0	15.8	18.2	21.6	22.3
<b>Ry</b>	11.6	16.5	19.9	24.6	16.3	11.0
<b>Rz</b>	11.6	16.6	19.5	22.0	18.9	11.4

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