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Normative values of trunk mobility in normal adults

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Abstract---Assessment of back function is limited due to lack of standard data set which may be used to accurately describe the range of motion of spine as there is wide disparity in the reference values for spine. The objective of present study was to establish reference values for trunk mobility in normal adults. In this cross sectional study, 137 subjects were assessed using Tape method and goniometry for trunk mobility in all planes (sagittal, frontal and transverse). The mean values by tape method and goniometry for flexion with stabilization were 6.95 ± 0.64 cm and $74.68 \pm 5.67^\circ$, (for flexion without stabilization 9.59 ± 0.73 cm and $99.33 \pm 5.53^\circ$), for extension 4.71 ± 0.51 cm and $26.03 \pm 3.29^\circ$, for Rt. Lateral flexion 17.28 ± 2.59 cm and $32.95 \pm 3.38^\circ$, for Lt. lateral flexion 17.06 ± 2.54 cm and $32.60 \pm 3.44^\circ$, for Rt. Rotation 5.49 ± 0.55 cm and $41.93 \pm 3.35^\circ$, for Lt. rotation 5.38 ± 0.55 cm and $41.65 \pm 3.39^\circ$ respectively. The study concluded that there was no statistically significant difference for all spinal movements among the genders, except in lateral flexion (p value 0.009 & 0.008) and rotation (p value 0.023 & 0.004) where females had greater mobility than males.

Keywords---trunk mobility, spine range motion, tape method, goniometry.

Introduction

Bending and twisting motion of spine is essential for activities of daily living.[1] Trunk kinematics is important in sustaining body equilibrium..[2]The core of physical therapy is to assess and evaluate the range of motion. The measurement of motion has the advantage of being more objective and quantifiable than the

assessment of subjective measures such as pain and its correct interpretation can have a significant role in the scientific basis of therapeutic interventions.[3,4]

The normative values of spinal range of motion are essential for apt diagnosis of spinal disabilities as well as for evaluation of interventional outcome. [5]The literature reveals wide disparity in the values of the ranges of movements in the lumbar region. As a result, there is no standard data set which may be used to accurately describe the range of motion in the different plane.[6] Most of the studies listed, evaluate the movement in the sagittal plane, some in the coronal plane, while very few have considered horizontal plane movement. It is also necessary to investigate motion in the coronal plane where regularity, symmetry and restraint parameters together constitute individual intervertebral motion phenotypes.[7]

The mobility measurements of all trunk motions, as well as the reliability of the measurement technique has not been discussed in any previous study.[8]Assessment of back function is limited due to lack of reference values and depending on the existing principle standard and also simultaneous in-vivo motion data of the whole spinal column are scarce.[9]Thus, there should be age and gender specific Spinal ROM values for every population.[5]

Studies have shown some validity and reliability for extremity ROM measurements, whereas measurement for trunk motion has proven to be more difficult. These include the use of visual estimation, radiographs, inclinometers, spondylometers, fingertip-to-floor methods, goniometers, plumb lines, and tape measures. Due to existence of a multitude of techniques for measurement of back motion, not one method has been developed fully (i.e., its reliability and validity demonstrated) for clinical use.[10,11] Attempts for accurate measurements of spinal motion are reported by many studies. Fitzgerald et al found high reliability for tape measure technique.[12] The goniometric method of measuring spinal mobility, though not most accurate, seems to be clinically accessible, objective and easy to use.[13,14]

In India, such studies are rare and so in present study an attempt has been made to establish reference values for trunk mobility in normal adults of Indian population. All movements including flexion with and without stabilization, extension, lateral flexion to both the sides and rotation to both the sides have been measured by measure tape and goniometer. A comparison between genders has been made.

Experimental, Materials and Methods

This cross sectional study was approved by SVIEC. Informed consent was obtained from normal healthy adults between the ages of 18-26 years of age who were willing to participate in the study. A total 137 subjects (66 males & 71 females) for the study were recruited from three colleges of Sumandeep Vidyapeeth campus. Subjects who were having history of trauma, thoracic pain, past medical history of a malignant tumour, structural deformity, prolonged use of corticosteroids, drug abuse, immunosuppressant, HIV, any systemic disease, unexplained weight loss, any neurological diseases, fever were

excluded. Demographic details were taken in all the subjects. All movements of the trunk were measured three times and an average of three was taken. For ROM measurement with tape, the following procedure was used.

Thoracic and Lumbar Flexion and Extension:[15]

The subject was asked to stand erect with no lateral flexion and rotation at cervical, thoracic and lumbar spine. Marking of C7 and S1 spinous processes was done using skin marker. By aligning the tape, Distance between two marks was measured and recorded. The tape was held in place and the subject was asked to perform flexion and then extension (allowing the tape to accommodate the motion.). Hip and knee flexion was avoided. The distance was recorded once patient completes the motion. Discrepancy among the measurements indicated the amount of thoracic and lumbar flexion and extension.

Flexion with Stabilization

The subject was asked to stand erect with no lateral flexion and rotation at cervical, thoracic and lumbar spine. Subject's pelvis was stabilized by a belt which was attached with a wooden chair to prevent pelvic motion. Rest all Procedure was same as measuring flexion.

Thoracic and Lumbar Lateral Flexion:[15]

The subject was placed in standing position with the arms resting by the side and the distance between the tip of middle finger and the floor at the leg level was measured using tape. With both feet lying flat to the ground and knees in full extension, the subject was asked to arch sideways as much as possible. The distance was measured again and discrepancy was recorded. The same procedure was performed for the opposite side.

Thoracic and Lumbar Rotation:[8]

The subject was asked to be in sitting position keeping knees together and hip 90° flexed, arms placed across chest. For right rotation, Left posterior clavicular Prominence to right greater trochanter was marked and measuring tape was placed. The subject was asked to sit erect and then turn to right side as much as he can. Initial and final distances were recorded. The same procedure was performed for the left side. For ROM measurement with goniometer, the following procedure was used.[12]

Spinal Flexion and Extension: The subject was asked to be in erect standing position keeping feet shoulder width apart. The goniometer was aligned keeping the fulcrum at superior aspect of iliac crest while stationary arm and movable arm were placed perpendicular to the floor and parallel to midaxillary line respectively. The subject was then asked to bend forward and backward as far as possible for flexion and extension respectively keeping the knees extended. At the end of the maximum spinal motion attained by subject, the degrees of motion were recorded.

Flexion with Stabilization: The subject was standing erect with feet approximately shoulder-width apart. Subject's pelvis was stabilized by a belt which was attached with a wooden chair to prevent pelvic motion. Rest all procedure was same as measuring spinal flexion.

Lateral Flexion: Subject was positioned in erect standing keeping the feet shoulder-width apart, the fulcrum of goniometer was placed at the level of lumbosacral junction. The position of stationary arm was perpendicular to the floor while movable arm was positioned parallel to spine taking reference point of C7 spinous process. To keep the goniometer at eye level, the observer was sitting behind the subject. Then subject was asked to bend sideward as far as possible. The degrees of motion were recorded for both right and left side.

Thoracic and Lumbar Rotation: The subject was placed in sitting without back support, keeping the feet flat on the floor to stabilize the pelvis. The goniometer was aligned keeping the fulcrum over the center of cranial aspect of patient's head and the stationary arm was kept parallel to imaginary line joining both prominent tubercles of iliac crests. The movable arm was aligned parallel to line joining two acromion processes. Now the subject was asked to perform the motion. At the end of the rotation, the degrees of motion were recorded for both right and left side.

Result

The data were analyzed using SPSS software (version 14). The level of significance was kept at <0.05 .

Total participants	---137
The age range was	---18 to 26 years
Percentage of Males	--- 66(48%)
Percentage of Females	--- 71(52%)
Mean age of total participants 21.22) years	---20.42 \pm 2.32 (male-19.56, female-
Mean BMI of total participants 21.16) kg/m ²	--- 20.94 \pm 4.03 (male-20.71, female-

Figure 1 Measuring trunk movements by tape method



Figure2 Measuring trunk movements by goniometry



Table 1 Mean, Standard deviation for different movements using both methods

	Variables	Mean	Std. Deviation
Method			
Tape measurement	Flexion Stabilization (cm)	6.95	0.64
	Flexion (cm)	9.59	0.73
	Extension (cm)	4.71	0.51
	Rt Lateral Flexion (cm)	17.28	2.59
	Lt Lateral Flexion (cm)	17.06	2.54
	Rt. Rotation (cm)	5.49	0.55
	Lt. Rotation (cm)	5.38	0.55
Goniometry	Flexion Stabilization (degrees)	74.68	5.67
	Flexion (degrees)	99.33	5.53
	Extension (degrees)	26.03	3.29
	Rt Lateral Flexion (degrees)	32.95	3.38
	Lt Lateral Flexion (degrees)	32.60	3.44
	Rt. Rotation (degrees)	41.93	3.35
	Lt. Rotation (degrees)	41.65	3.39

Table 2 Comparison of mean values between the genders using tape method & goniometry by student's t-test

Variables	Gender	Mean (SD)	P value	Mean (SD)	P value
		Tape method		Goniometry	
Flexion with stabilization	Males	6.89±0.62	0.310	74.90±5.59	0.670
	Females	7.01±0.67		74.48±5.78	
Flexion	Males	9.69±0.69	0.155	100.05±5.42	0.143
	Females	9.51±0.75		98.66±5.59	
Extension	Males	4.79±0.46	0.097	26.44±2.85	0.166
	Females	4.65±0.57		25.66±3.65	
Rt. Lateral flexion	Males	16.73±2.28	0.009	33.11±2.96	0.613
	Females	17.87±2.79		32.82±3.75	
Lt. lateral flexion	Males	16.51±2.29	0.008	32.76±2.98	0.621
	Females	17.65±2.68		32.46±3.85	
Rt. Rotation	Males	5.47±0.53	0.754	41.26±3.06	0.023
	Females	5.51±0.59		42.55±3.51	
Lt. Rotation	Males	5.33±0.53	0.28	40.80±3.21	0.004
	Females	5.43±0.59		42.44±3.37	

Discussion

The purpose of present study was to establish normative values for trunk mobility in normal healthy individuals and to compare between genders. Total 137 participants were recruited for the study, which included 66 males & 71 females. The mean values of all movements along with standard deviation measured by tape method as well as with goniometry have been given in the table 1. The mean BMI for the total population in the present study was 20.94 kg/m² which falls under normal range. The difference between genders was not statistically significant for BMI in the present study (P value 0.510). Luca Vismara Et al found that thoracic ROM was reduced in obese people during forward flexion and reasoned that obesity affects normal posture and due to that stiffness can occur.[16] As the mean value of the present study falls under normal range, the effect of BMI is possibly eliminated.

In the present study, tape method and goniometer were used to measure trunk movements in all planes (sagittal, frontal and transverse). Mayerson and Milano tested the reliability of goniometer in their study on lumbar spine and they found goniometric measurements as doubtful and reasoned that the spine has multiple joint axes with positions that change during the movement so measurement of movement of the lumbar spine is a challenge.[17,18] In the present study, each movement was measured three times and an average of three was taken. Devra K Einkauf et al suggest performing only once to eliminate the possibility of a "practice effect" that might increase their ROM progressively with each trial and by allowing the subjects only one attempt to reach their Maximum range for each movement can give an accurate result.[13] However, Margaret Frost suggested that taking an average of successive repetitions improve the reliability of all measurements.[8]

Sagittal plane movements

Flexion was measured with and without pelvic stabilization to observe the changes that occur due to movement of pelvis as it helps to increase the consistency of measurements.[13] The difference was not statistically significant between genders for flexion movement. This matches with the results of Egwu et al.[5] In a study by J. M. H. Moll, the average spinal extension values were also similar.[19] He found extension to be more in males than females but the study consisted of participants in 15-24 years of age group with predominantly males. In the present study, the difference was not statistically significant between males and females. However, the ranges were lesser when compared to the normative values given by Kapandji and Batch.[12] Their age range was greater than this study.

Frontal plane movements

The mean value of lateral flexion in a study which was done only on females was higher than the present study.[13] Several studies have shown that lateral flexion is more in females compared to males. In the current study, the difference was statistically significant in lateral flexion between males and females by tape method which could be due to, an artefactual effect arising from morphological differences, like a narrower waist and broader pelvis in the female.[19,20]

Transverse plane movements

Average rotation of 5.35 can occur at trunk which has been given by Margaret Frost et al which matches with present study.[8] Their method of measuring trunk rotation in sitting was similar to this study to measure rotation. However, Veronica et al assessed spinal rotation in three different positions and suggested that position can not affect the rotation.[21,22]

Conclusion

This study established a set of normal values for trunk mobility in healthy individuals. The difference between genders was not statistically significant for all movements except lateral flexion and rotation where females were found to have a significantly higher lateral flexion and rotation range of motion than males.

Conflict of interest

Authors declare no conflict of interest

Source of funding

NIL

Authors' contribution

Purvi Patel: concept, data collection, manuscript writing
Lata Parmar: analysis of data, Manuscript editing

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