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*Original Research Article*

# Normative Values of Modified - Modified Schober Test in Measuring Lumbar Flexion and Extension: A Cross- Sectional Study

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## ABSTRACT

**Background:** Low Back Pain is the most common musculoskeletal problem worldwide, but there is a lack of normative values based on specific population of LROM required during its evaluation. So, the purpose of this study was to find out the normative values of Modified - Modified Schober Test in measuring lumbar flexion and extension in Indian population. It is obvious that without knowing about normal values, it's difficult to find the abnormal values.
**Materials and Methods:** MMST flexion and extension were measured on 200 healthy adults of 21 to 40 years, out of which 100 were males and 100 were females. Then those were divided into two strata depending on age such that strata 1 (age 21-30yrs) had 100 volunteers and strata 2 (age 31- 40 yrs) had 100 volunteers.
**Results:** Normative values were found to be 6.85±1.18cm for MMST flexion and 2.42±0.74 cm for MMST extension. MMST extension was statistically higher in strata 1 than strata 2. MMST flexion was statistically higher in males than females with significance sensitivity set at <*.05*.
**Conclusion:** Lumbar extension was found to be decreased with increasing age. Lumbar flexion was more in males than females, whereas there is no difference in lumbar extension between the genders.

***Keywords:*** Modified - Modified Schober Test, Normative Values, Lumbar Flexion, Lumbar Extension, Cross Sectional Study, Measurement.

## INTRODUCTION

Spinal range of motion measurements are a standard part of the evaluation of patients with any form of back pain, with the most commonly assessed movement being flexion. [1] Low back pain (LBP) is most common clinical, social, economic, and public health problem with prevalence between 6.2% (in general population) to 92% (in construction workers) in Indian population. [2] The 1 year incidence of people who have a first-ever episode of low back pain ranged from 6.3% to 15.4%, and the 1 year incidence of people who have any episode of low back pain (i.e., first-ever or recurrent) ranged from 1.5% to 36%. [3] In patients with LBP, measurements of lumbar range of motion (LROM) is considered crucial for etiology, diagnosis, and treatment of spinal pathologies, determination of abnormal limitation and evaluation of permanent impairment in individuals with longstanding back problems. [1,4] It will only be possible to find any alteration in the range of motion of a joint if we have normative data to compare with.

Modified Modified Schober Test (MMST) is one of the renowned method for measuring lumbar range of motion because of its simplicity, its high co-relation with flexion measurements of lumbar spine obtained through radiograph. Along with these qualities, it gives accurate measurements, can be used everywhere and materials used are affordable and easily available. [1] This method is reliable, valid and convenient for both therapist and patient as it does not need any fixation and landmarks are easy to palpate. Unlike the radiographic technique which has health risks related to repeated exposure to x-ray radiation, it does not harm the patient. [5-7] Modified Modified Schober Test (MMST) is a modification of Modified Schober Test (MST) by Van Adrichen and Van der Korst (1973). It uses two marks one over the spine connecting two PSIS and other over 15 cm superior to first mark. It eliminates the errors in identification of lumbosacral junction and make sure that entire lumbar spine was included. [7-9]

A factor affecting lumbar range of motion includes age, gender and other physical attributes such as height, sitting-to-standing height ratio, time of day, occupation, lifestyle and disability. [8] Medical conditions, pelvic asymmetry, race and geographical distribution also determine the joint ROM. [10] For spinal flexibility measurements to be meaningful to clinicians or researchers, they must have normative values and understanding of how different variables affect range of motion. Many studies have been done in past to find out the normative values of spinal mobility using MST. But only one study by Van Adrichen et al (1973) on Nigerian population could be cited in previous literature for normative data of MMST flexion. [9] There is no study available for normative values of MMST extension on any population. So, the purpose of this cross-sectional study was to find out the normative value of MMST used to assess lumbar range of motion and to document the effect of age and gender on lumbar range of motion in Indian population.

## MATERIALS AND METHODS

**Subjects:** This prospective cross sectional study measured the values of MMST flexion and extension from the students, staff and relatives of patients coming to the NIOH, Kolkata, India between April, 2015 to December, 2015. Ethical approval was taken from Institute Ethical Committee (IEC) on 13th March, 2015. A stratified purposive sample design was used to select the volunteers.

The volunteers included were the healthy males and females from 21yrs to 40yrs of age with Physical Component Summary (PCS) and Mental Component Summary (MCS) score of SF36 scale above 50 by using purposive sample design. [1,5,11 - 13] The volunteers excluded were the individuals with history of back surgery or hip surgery, trauma to back or lower extremity, low back pain within the last six months, hamstrings tightness, diagnosed cases of rheumatoid arthritis or osteoarthritis of the spine or hips, spinal deformity, neurological disease, any history of cardiovascular diseases such as hypertension, stroke, or other cardiac disorders, obesity (BMI $\geq$ 30 kg/m$^2$) and females with pregnancy. [5,10,13-16] Total 246 healthy individuals were approached with the proposal of study 29 individuals refused to participate. The individuals agreed to participate and signed the consent form were 217. Out of those 6 were obese subjects, 5 were having hamstring tightness, 6 had gone through the difficult period of low back pain in last 6 months. Data was collected from 200 healthy individuals.

**Procedure:** Volunteers were approached with proposal of the study. Aim and procedure of the study were explained in the most communicable language. All the information regarding body marks that were marked by body marker on lumbar region and warm up exercises before measurement was given to the volunteers. Informed consent form (which also includes permission to use their data and photograph for presentation and publication purpose) written in their preferred language (English/ Hindi/ Bengali) was taken from volunteers who agreed to participate. Demographic data including age, sex, height, weight, Body Mass Index (BMI) and occupation was collected and volunteers were stratified into two strata according to age: strata1(age 21 to 30 years) and strata2 (age 31 to 40 years). Short Form- 36 scale (SF-36) was filled by therapist by asking the questions from volunteers. [17] Hamstring tightness was checked through Active Knee Extension Test. [18] Prior to the test, the volunteers were asked to warm up with 10 repetition of back stretches in side flexion and rotation and a 5-minute walk at self-determined pace around the research venue. [7,10] Lumbar flexion and extension were avoided to prevent the practice effect. Measurements of lumbar flexion and extension were carried out with measuring tape using standardized method of Modified-Modified Schober Test based on guidelines provided in the American Medical Association (AMA) Guides (1993). [5,7,8,15]

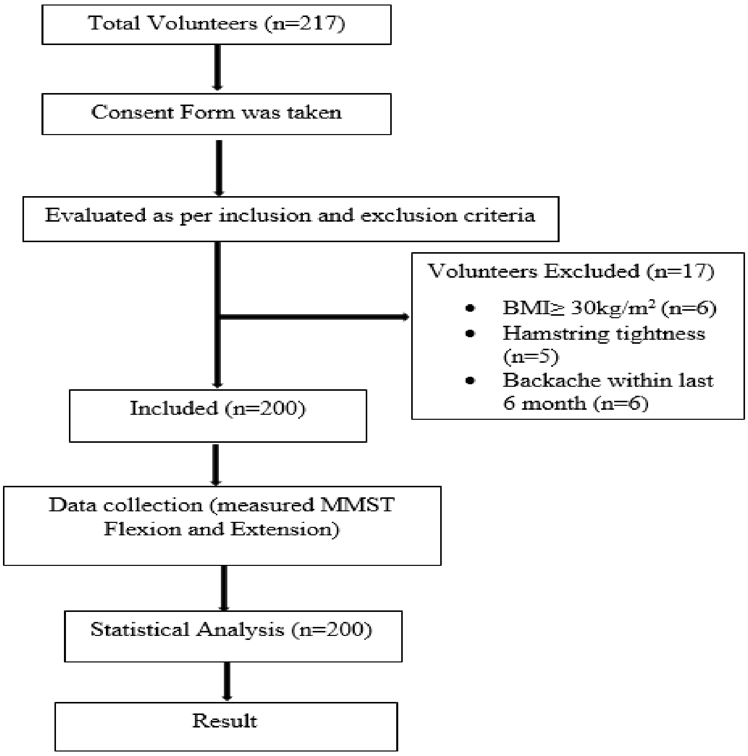


**Figure1: Flow Chart**

## Measurement of Lumbar Flexion

The volunteers were instructed to remove their shoes and disrobe, exposing their back from gluteal fold to mid-thoracic spine with left and right PSIS fully exposed. [5] The volunteers were asked to stand erect, with their eyes directed horizontally, arms at their sides, and feet placed on a paper footprint that was secured to the floor (the heels of the footprint was about 15 cm apart). [16] This position helped the volunteers to stabilize the pelvis, aided them in maintaining their balance and helped us to improve the consistency of measurements.

Then, the therapist demonstrated the proper procedure of forward bending with the arm hanging in front and keeping knees straight. After showing the proper procedure, the therapist confirmed that volunteers were doing it correctly. [5] Then, the therapist kneeled behind the standing volunteers and identified both the PSIS with her thumb. Inferior margins of the volunteer’s PSIS were marked with body marker and a ruler was used to locate and mark a midline point on sacrum (inferior mark). Then the final mark (superior mark) was marked on the lumbar spine 15 cm above the midline sacral mark (inferior mark). [8] The therapist aligned the tape measure between two skin marks with zero at inferior mark and 15cm at superior skin mark. The measuring tape was kept firmly against the volunteer's skin while the volunteers were asked to bend forward with the instruction "Bend forward as far as you can while keeping the knee straight". [7] The measuring tape was maintained against the volunteer's back during the movement but was allowed to unwind to accommodate motion.

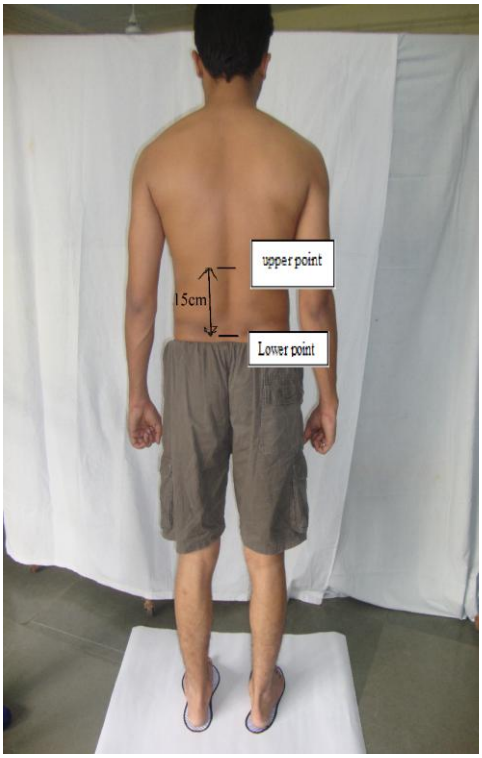


**Figure 2a: Comfortable standing position**

For each of the spinal motion measured, the end of the range of motion (ROM) was defined by instructing the volunteers to report that they cannot move any further. At the end of flexion ROM, the distance between the two marks was noted. The ROM was the difference between 15 cm and length measured at the end of motion. After each measurement, instruction given to volunteer was: "you can come back to a comfortable standing position".


**Figure 2b: Measurement of MMST flexion**

**Measurement of Lumbar Extension [7,8]**

The same landmarks and procedure described for the flexion technique were used for measuring lumbar extension. With the volunteers in the erect standing position, with their eyes directed horizontally, arms at their sides, and feet placed on paper footprint, the therapist lined up the measuring tape between the markings. While holding the tape measure placed firmly against the volunteer's skin, the therapist gave instruction: "Place the palms of your hands on your buttock and bend backward as far as you can". When the volunteers bent backward into full lumbar extension, the new distance between the superior and inferior skin markings was measured using the tape and the change in the distance between the marks was used to indicate the amount of ROM of lumbar extension. After measuring lumbar extension, instruction given to volunteers was: "You can come back to comfortable standing position". At the end of data collection, all skin marks were removed with spirit.


**Figure 2c: Measurement of MMST extension**

The mean of three consecutive measurements was used in the final analysis to determine LROM. Volunteers were allowed to rest for 1 minute in between three sets of measurement in their most comfortable position, so that they could be ready for next measurement.

***Statistical analysis***

Data were analysed using SPSS version 16 software. Levene's Test was used to analyze equality of variances - height, weight and BMI between both strata and genders. Descriptive statistics were used to determine the mean and standard deviation (SD) of MMST flexion and extension. The independent *t-test* was used to compare the mean values of MMST flexion and extension according to age and gender. The Karl Pearson Correlation Co-efficient test was used to correlate the MMST flexion and extension values with age. The tests were applied at 95% confidence interval and *p values* were set at 0.05.

## RESULTS

The mean, standard deviation (SD) and value of significance for demographic variable of both the strata and gender are shown in table 1.

**Table 1: Demographic Summary (Values are Mean ± SD)**

| Variables | STRATA1 (n=100) | STRATA2 (n=100) | F-value | Sig-Value | Male (n=100) | Female (n=100) | F-value | Sig-value |
|---|---|---|---|---|---|---|---|---|
| Height (m) | 1.61±0.084 | 1.61±0.091 | .558 | .456 | 1.67±.06 | 1.55±0.06 | .363 | .548 |
| Weight(Kg) | 60.54±8.94 | 61.77±10.5 | 2.177 | .142 | 65.17±9.5 | 57.14±8.3 | .946 | .332 |
| BMI ($Kg/m^2$) | 23.23±2.54 | 23.70±3.3 | 6.744 | .010* | 23.25±2.8 | 23.67±3.1 | 1.160 | .283 |

*significant at *p<0.05, n = number of volunteers*

**Table 2: Normative values of MMST flexion and extension (Values for Mean ± SD)**

| | Total (n=200) | Strata1 (21-30 Yrs) ( n=100) | Strata2 (31-40 Yrs) (n=100) | Male (n=100) | Female (n=100) |
|---|---|---|---|---|---|
| MMST Flexion (cm) | 6.85±1.18 | 6.94±1.16 | 6.75±1.19 | 7.07±1.19 | 6.62±1.13 |
| MMST Extension(cm) | 2.42±0.74 | 2.68±0.78 | 2.16±0.61 | 2.40±0.83 | 2.44±0.65 |

*n=number of volunteers*

The normative values were found to be 6.85±1.18cm for MMST flexion and 2.42±0.74cm for MMST extension and presented in table 2.

On comparison, MMST flexion values showed no statistically significant difference between the strata, while MMST extension values were significantly higher in strata 1 than strata 2 which is represented through a bar graph as shown in figure 3. The correlation between MMST flexion and age group was found to be statistically non-significant, whereas MMST extension showed statistically significant negative correlation with age. This means that MMST extension decreases as the age increases. The scatter plot graph is used to show these correlations as seen in figure 4 and figure 5. The comparison of MMST flexion values between the genders showed that males had higher MMST flexion values than females of same age group. The *p-*

*value (0.006)* showed that the difference between them was statistically significant. Comparison of MMST extension showed no statistically significant difference between both genders. This comparison is also represented through a bar graph as shown in figure 5.

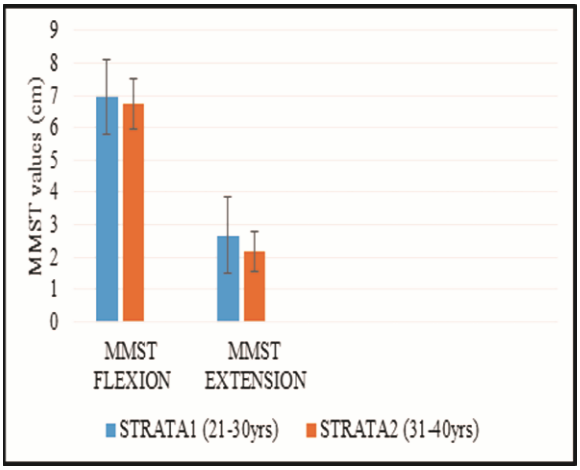


**Figure 2: Comparison of MMST flexion and extension value between strata**

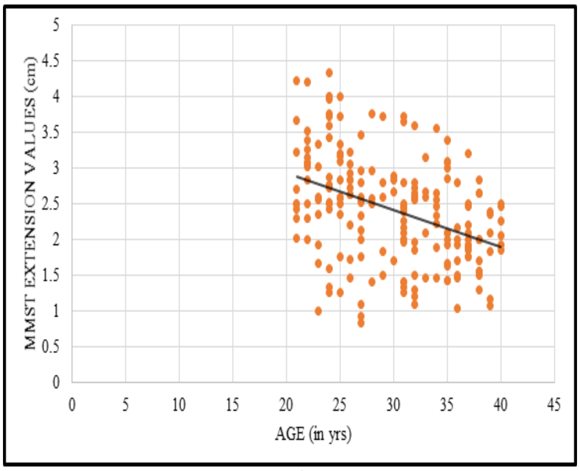


**Figure 3: Correlation of MMST Flexion with**

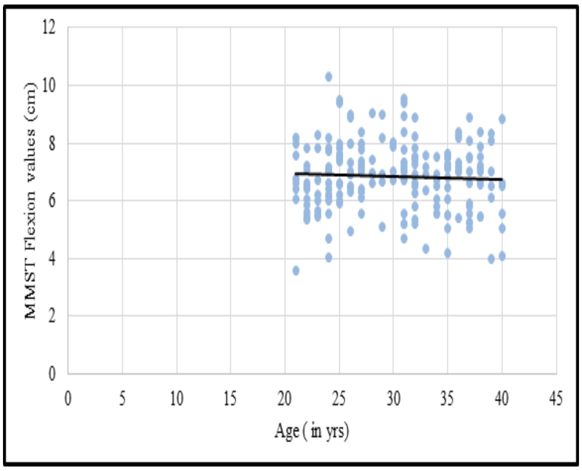


**Figure 4: Correlation of MMST extension with age**

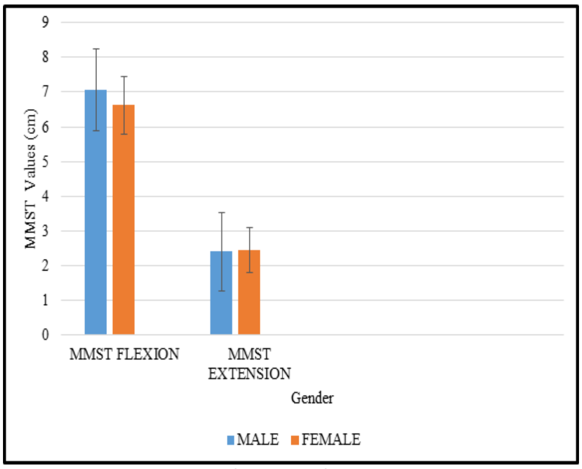


**Figure 5: Comparison of MMST flexion and extension value between genders**

## DISCUSSION

One of the most important step in a physical therapist's management of patients with low back pain is the comprehensive examination of strength and range of motion which requires objective findings. Any abnormal findings can only be judged on the basis of normal findings. So, the present study was conducted with a goal to find out the normative value of MMST used to measure the lumbar flexion and extension and to evaluate the effect of age and gender on LROM. The volunteers who participated in this study were healthy adults from 21 to 40 years of age. Previous studies have stated that a general decrease in spinal ROM occurs in aging adults. [1,5,10,13] So, the incidence of false negative values had been reduced by excluding volunteers above 40 years. The number of males and females and the volunteers in both strata were kept equal to avoid any kind of gender biasness. The analysis of demographic data (height, weight and BMI) showed the homogeneity between the strata and genders.

In this study normative values for 200 healthy adults were found to be 6.85 ±1.18 cm for MMST flexion and 2.42±0.74 cm for MMST extension. Several studies had been done by Macrae IF et al (1969), Moll JMH et al (1972) and Fitzgerald GK et al (1983) in past to find the normal values of lumbar flexion and extension, but all have used MST as a testing tool. [1,5,11,13,15,19] A study by Van Adrichen et al (1973) specified the normal values for MMST flexion as 6.7±1.0 cm in male subjects and 5.8±0.9 cm in female subjects from 15 to 18 years of age. [8,9] In this study, mean of MMST flexion for male volunteers of 21-40years was 7.07±1.19cm and for female volunteer was 6.62±1.13 for the same age group. Difference in the results of MMST flexion might be because of regional and racial variations as the study by Van Adrichen et al (1973) was conducted in Nigeria and the present study was conducted in India. [9] Jackson ET et al (2010) found the normative values of lumbar extension were greater for African-American women than for white women in their study. This showed the effect of race on LROM. Genetic influences as well as environmental and behavioral factors were proposed as the determinants of differences in lumbar ROM in their study. [20] The results of study by Egwu M.O.et al (2012) and Battie MC et al (1987) also stated that physical attributes like height, BMI, sitting to standing height ratio affects the LROM in healthy individuals. [1,10] The average height of males (165.3cm) and females (165.3cm) are higher in India than the average height of males (163.8cm) and females (157.8cm) in Nigeria. [21] Apart from this, that was a pilot study where researchers had included only 5 healthy men from age 20-25 years and other 248 subjects were the children and adolescents from the age of 6years to 18 years.

The lumbar flexion and extension movement occurs at zygapophyseal joint. [22] According to Tailor R.J. (1985), the pattern of postnatal growth in lumbar zygapophyseal joints leads to a changes in their shape and influences their functions and reaction to stress in the adolescent and adult. In fetal and infant stage lumbar zygapophyseal joint are oriented in coronal planes. During childhood, the facets in lumbar spine increases dramatically in size. [23] Orientation of zygapophyseal joint plays an important role in determining the motion at lumbar spine. Sagittal plane orientation allows a great range of flexion and extension ROM. [22] Racial differences, higher average height of Indian population than Nigerian population and sagittal plane orientation of zygapophyseal joint in adults compared to children or adolescents might be a possible reason for higher normative values of MMST from the previous study by Van Adrichen and Korst. To the best of our knowledge this study might be the first study to give the normative values of MMST extension. The normative values for MMST extension were almost similar for both male and female i.e. 2.40±0.83cm for male and 2.44±0.65cm for females in Indian population. Normative values of MMST flexion and extension was found to be 6.94±1.16cm and 2.68±0.78cm respectively for the 3rd decade of life and 6.75±1.19cm and 2.16±0.61cm respectively for 4th decade of life.

The age based comparison of mean values of MMST flexion between the strata-1 (21 to 30 years) and strata-2 (31 to 40 years) did not show any significant difference in this study. A study by Einkauf DK et al (1987) showed that anterior flexion decreases with age with significant difference between group of age 20-29years and 30-39years. They specified that the values obtained by them from obese subjects for anterior flexion by MST might be less reliable because it was difficult to accurately locate the bony landmarks due to excessive amount of subcutaneous fat and skin tissue in obese subjects. BMI of subjects was not controlled and only female subjects were included in their study. [13] The study by Fitzgerald et al (1983) demonstrated a different trend that the amount of lumbar flexion and extension decreased in 20-year intervals. The subjects included in their study were predominantly males, only 4 females were included. [11] The BMI was controlled in the present study and equal number of male and female had been included. Saidu I A et al (2011) concluded that the amount of range decreased in 18 years interval especially in anterior trunk flexion and right lateral trunk flexion in both sexes. [5]

Correlation of MMST flexion values with age was also found to be non-significant. As mentioned in the study by Fitzgerald et al (1983) that variations in spinal ROM occurs after an interval of 20 years. [11] This present study divided the age from 21 to 40 years in only two strata that too at an interval of 10- years. This could be one of the possible reasons for not getting the desired correlation. The inclusion of volunteers above 40years might have given us the same results that there is decrease in LROM during flexion and extension with age. Though the *p-value* does not show significant difference, but the mean values of strata1 were higher than strata2, showing decrease in LROM with age. The literature provides us the facts that there is decrease in strength of trunk muscles, cartilage, bone and ligaments with aging. [24] Aging also leads to the changes in intervertebral disk that includes loss of amount of proteoglycans and changes in specific type of proteoglycans, with resultant loss of water content. This leads to overall decrease in disk height. As discussed before, mobility of lumbar spine is also determined by the orientation of zygapophyseal joint. The orientation zygapophyseal joint also demonstrates changes with aging. [22,23] All these changes might be a probable explanation for decrease in LROM with increasing age.

The results of comparison of mean values of MMST extension between the strata1 (21years to 30years) and strata2 (31years to 40years) revealed that there was a statistically significant difference between the strata and the values were higher in strata-1. Previous studies by Einkauf D.K.et al (1987) and Saidu I.A. et al (2011) found the same results that extension range decreases sharply between the 20- to 29-year and 30- to 39-year age groups. [5,13] The possible explanation for this could be that there is decrease in activities of daily living that requires extension with age especially the extreme of extension range, which causes the lumbar spine to undergo adaptive degenerative changes. These findings are supported by McKenzie's clinical observation where he stated "from my own observations it appears that few adults reach thirty years of age and maintain normal extension movements". [25] Another reason that limited the extension in older individuals could probably be the weakness of abdominal and back muscle. [5,13] These above mentioned reasons also explain the results of inverse correlation of MMST extension with age i.e. decrease in extension with increase in age.

Apart from age, gender is another factor which affects the MMST flexion and extension values. Macrae I. A. and Wright V. (1969) found that the difference of MST flexion values between the sexes was highly significant, where males have higher values than females. [15] Moran HM et al (1979) did a study on adolescents from the ages of 10-15 years had the same findings that boys were more flexible than girls in anterior flexion for each age group. [8] Saidu I.A. et al (2011) found that LROM in females were slightly higher than males, but difference was not statistically significant. [5] The use of different instruments like tape measure, goniometer, inclinometer, plumb line method by the investigators had made it difficult to compare among the studies. The results of this study for comparison of MMST flexion with gender showed that lumbar flexion range of motion were higher in males of age 21-40 years than the females of same age. The *p-value (0.006)* showed that the difference was statistically significant. The role of vertebral height and intervertebral disc height is difficult to ignore here, because literature says that it is the ratio between disc thickness and vertebral body height that determines the available motion. The greater the ratio, greater the mobility. Apart from this greatest mobility of the spine occurs between L4 to S1. [22] According to Frobin et al (1997), height of lumbar vertebrae is larger in females than in males, but height of lumbar discs is larger in males than in females and the highest disc height was found at L4-L5 and L5-S1. [26] So the ratio of intervertebral disc thickness to vertebral body height is more in males. This signifies that males are more liable to have higher lumbar flexion range of motion.

The comparison of MMST extension did not showed any statistically significant difference between the genders in this study. Egwu et al (2012) also found that extension and right lateral flexion were higher in females than their counterpart males. According to them, females generally have been reported to have longer trunk and shorter legs than men and these differences can significantly impact on variables such as spine loading and mechanical efficiency in physical performance assessments. [10] The results of this study showed similar values of MMST extension in both the genders because the zygapophyseal joints are in closed pack position during spinal extension movement. [22] The nucleus is pushed anteriorly stretching the anterior fibres of annulus and anterior longitudinal ligament. Meanwhile the articular processes of lower and upper vertebrae become more tightly interlocked and the spinous processes touch one another. [27] Hence extension is limited by the bony structures of vertebral arch and tension in anterior longitudinal ligament. Maheshwri Y et al (2004) explained in their study that facet joint orientation is independent of the gender. [28] Ran B et al (2015) found that the spinous processes of females were shorter and thinner but the difference was not statistically significant. [29] In his another study with Cai B. et al, it was explained that the difference in size of the lumbar spinous processes between males and females probably reflects the difference in average physical size between the genders. [30] This could be a probable reason for getting similar LROM in extension in both genders.

Limitations of the study: The normative values of MMST flexion and extension established in this study may not be generalized to all Indian population. In this study, lumbar rotation and lateral flexion were not measured, which are also necessary measurements of spinal flexibility. Sample size was small and data was collected from a single center.

In future studies, large sample size with individuals from different regions across the country could have been included to form a standard Indian normative data of MMST flexion and extension. Further studies are needed to determine a reliable and objective method with normative values for measuring lumbar side flexion and rotation. To find out the confounding factor for LROM, further studies are recommended to take into account the effect of height, weight, BMI, hamstrings tightness, standing-to sitting height ratio (trunk height), and body built, occupation.

## CONCLUSION

In conclusion, this study provides the normative values for MMST flexion and extension used for measuring LROM as 6.85±1.18 cm and 2.42±0.74 cm respectively. Although these values were different for different age strata and genders, MMST extension values showed an inverse correlation with age and were found to be decreased significantly with increasing age. MMST flexion values were significantly higher in male as compared to females. Therefore, it is recommended that physical therapists and clinicians should assess their patients lumbar ROM with respect to above mentioned normative values, taking into account the effects of age and individual variability.

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