Original Research Article

RELATIONSHIP BETWEEN TRANSVERSUS ABDOMINIS STRENGTH AND LUMBAR LORDOSIS IN YOUNG ADULTS

ABSTRACT

Background: The researchers and clinicians are emphasizing on function of Transverse Abdominis (TrA) which is a deepest abdominal muscles because there is an evidence that TrA is recruited independently of the other abdominal muscles in many different tasks and plays an important role in lumbar stability.

Aim: The purpose of this study was to assess the relationship between TrA muscle strength and lumbar lordosis in young adults.

Method: Total 394 subjects were recruited from the constituent institutions of Sumandeep Vidyapeeth with the age range 18-35years. All the subjects, Lumbar lordosis angle and their TrA strength were measured with the Flexicurve and Pressure Biofeedback Unit respectively. Lumbar lordosis angle was calculated using established formula. Average of 03 trials was considered for TrA strength.

Results: Pearson correlation coefficient was -0.18 on correlating Lumbar lordosis angle with TrA strength, -0.09 for age with TrA strength and 0.11 for age with lumbar lordosis angle.

Conclusion: This study concludes that there is negative relationship between lumbar lordosis and TrA i.e. as the lumbar lordosis angle increases, the strength of TrA muscle decreases.

Keywords: Transversus Abdominis, Lumbar Lordosis, Flexiruler, Flexicurve, Pressure BiofeedbackUnit, Young Adults, Age, Lumbar Stability

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1. INTRODUCTION

The upper body is supported by the lumbar spine and it acts as a bridge to transmit the weight from the upper body to the pelvis and lower limbs. Lumbar spine is the first and foremost accountable for posture and stability.[1]Lumbar lordosis (LL) is the basic component of the posture in keeping the sagittal balance.[2] Lumbar lordosis and changes in lumbosacral angle not only affects the lumbar stability but also affects the lumbar muscle strength.[3]

Lumbar lordotic curve and pelvic inclination angles in a standing position as per theory should be affected by the lengths of lumbar erector spinae and abdominal muscles. Hence, in a normal standing posture, pelvic inclination angle is related to the lumbar curve, and these angles are related to the strength and length of the abdominal and back muscles.[4]

Recently the researchers and clinicians are emphasizing on function of TrA which is a deepest abdominal muscles because there is evidence that TrA is recruited independently of the other abdominal muscles in many different tasks including upper and lower limb movements as well as ambulation[5]and plays an important role in lumbar stability.

As the TrA is a digastrics muscle, contraction of it results in reduction of trunk circumference as well as it flattens the abdominal wall in the lumbar region. This leads to increase of intra-abdominal pressure, tensions in the thoracolumbar and anti fascias resulting in spinal stability.[5,6,7]So, there is significant evidence that TrA muscle plays a crucial role in spinal control.[5]A number of studies have reported the importance of the Transversus abdominis, which contributes significantly to lumbar stability and posture.[7,8]

Directly palpating TrA is not possible because Internal Oblique is superficial to TrA and limits tactile feedback.[6]So, clinical method to objectively measure the TrA muscle strength is by using pressure biofeedback.[9]A pressure biofeedback unit is a device to objectively assess abdominal muscle function, including TrA activation, during an abdominal drawing-in manoeuvre.[6]

Postural evaluation is used to identify spinal alterations or to track the progress of treatment at the various healthcare levels. Flexicurve or flexible ruler is a simple, inexpensive, non-invasive and safe to use devise, which can be moulded according to the contour of the thoracic and lumbar spine curves in the sagittal plane. This is very helpful in clinical and community based setting.[10,11,12,13]

However, the relationship between Transversus abdominis strength and lumbar lordosis had been studied, but such relationship studies have been insufficiently studied in young adults. Hence, we aim to assess the relationship between TrA muscle strength and lumbar lordosis in young adults.

2. METHOD

2.1 Ethical considerations

Following ethical approval by the Sumandeep Vidyapeeth Institutional Ethical Committee, subjects who fulfilled the inclusion criteria were recruited. These subjects gave their informed consent.

2.2 Participants

This is a cross-sectional study with 394 young adults. Subjects with the age group of 18-35 years without any history of low back pain were included in the study. Of these, 325 were Females and 69 were Males. Subjects with any spinal or abdominal congenital deformity, surgery, trauma, infection, neurological pathology and pregnant females were excluded from the study.

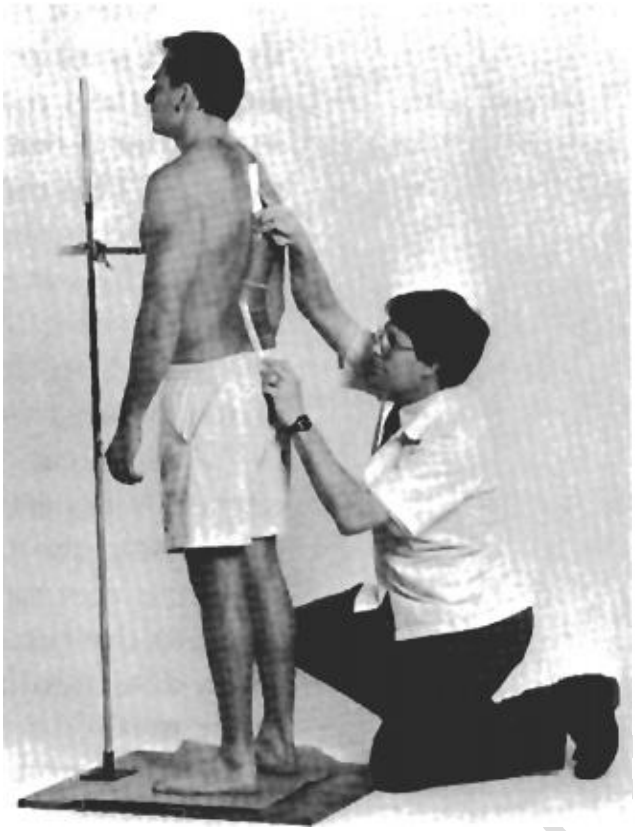
2.3 Procedure:

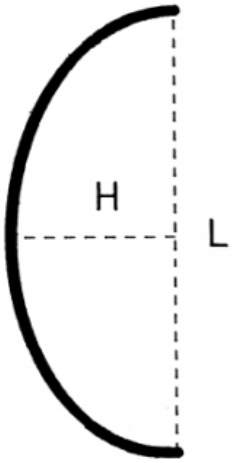
The data were collected using convenient sampling technique.

Lumbar curvature assessment procedure:

Subjects were escorted to the procedure room to maintain the privacy of the subject. Subject with barefoot was asked to assume a normal standing posture on a wooden board. His/her lower back was exposed and a dowel was extended mounted on an adjustable stand horizontally until it touches the subject's xiphisternum. This device aids in the control of postural sway while subsequent measurements were obtained. While the subject is standing, his/her ASIS and PSIS were palpated to confirm the pelvis symmetry and then the spinous processes of L_1 and L_5 was palpated. Then upper border of L_1 and lower border of L_5 were marked with the pen. The subject remained in the normal standing posture and the flexible curve (figure 1A) was pressed against the spinous processes of the lumbar spine. The points that intersect the pen marks were recorded. Then the flexible curve was lifted from the spine without changing the configuration of the curve. The convex side of the flexible curve was traced on the plain paper (figure 1C). The points that intersected L_1 and L_5 were marked, and a line was drawn between them. The length of this line (labelled L) was measured using a ruler. Another line (labelled H), representing the height of the curve, was drawn perpendicular from the midpoint of L to the curve and was measured. These two measurements were used to calculate Theta (θ) (figure 1B), an index of lordosis, using the following formula:

$$\theta = 4 \times [\text{Arctan } (2H/L)$$





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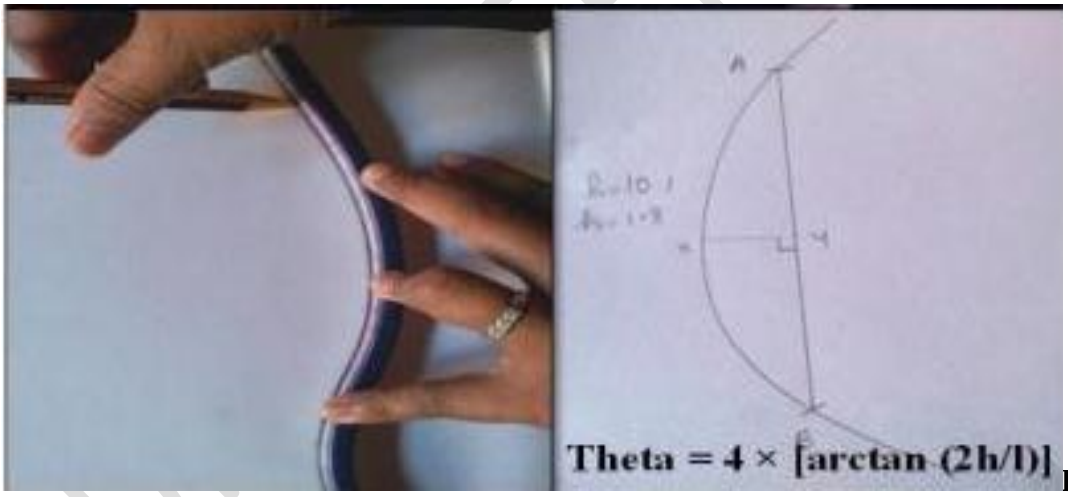

B

Fig1:A: Curve representing the tracing obtained through the use of the flexible ruler. **B**: The index of lordosis (*θ*) is obtained by the formula shown where L = the length of the curve and H = the height of the curve and Graphing of the lumbar curve.

MeasuringTransverse Abdominis strength

Patient was positioned in prone lying with arms 90/90, head turned to one side and feet hanging off the end of the table. The pressure biofeedback (figure 2) unit was placed horizontally under the abdomen (navel at the centre of the unit) with the lower edge just below the ASIS. The cuff was inflated to 70 mm Hg by the examiner and instructed the patient to perform the drawing-in maneuver while fully relaxing the abdomen and maintaining relaxed breathing without moving the spine or pelvis. If done properly, the pressure dropped by 6 to 10 mm Hg. The therapist had kept a note that the participant can maintain the pressure drop for up to 10 seconds. A 20 sec break was given between each contraction (10sec hold). Muscle endurance (holding or tonic capacity) of the Transversus Abdominis (TrA) was measured by the number of 10 second holds (up to count of 10). Total 03 trials were given to the subjects and the readings were recorded.

Fig 2: Pressure Biofeedback

3. STATISTICAL ANALYSIS

The data were analysed using statistical software and were normally distributed. Descriptive statistics including Mean, Standard Deviation & Standard Error Mean were calculated. ANOVA test was applied to calculate the statistical significant mean difference between the groups with statistical significance kept as 0.005.Post hoc test (Bonferroni correction test) was applied for multiple comparisons between the groups with statistical significance kept as 0.005.

4. RESULTS AND DISCUSSION

4.1 RESULTS

As per the sample size calculations, total 394 participants were included in this study. Mean Age was 20.38 ± 2.54 years. Pearson correlation coefficient was -0.18 on correlating Lumbar lordosis angle with TrA strength, -0.09 for age with TrA strength and 0.11 for age with lumbar lordosis angle.

Table 1: Comparison of Lumbar Lordosis angle and Transverse Muscle strength.

Lumbar Lordosis	N	TrA Mean	SD	p value
Hypo LL	111	63.22	2.75	**0.0001**
Normal LL	275	60.87	3.13	
Hyper LL	8	62.73	4.82	
Total	**394**	**61.57**	**3.24**	

Table 2: Comparison of Gender with Lumbar Lordosis angle and Transverse abominis muscle strength.

Gender	Lumbar Lordosis	N	Mean	SD	p value
FEMALE	Hypo LL	101	63.35	2.72	**0.0001**
	Normal LL	221	60.96	3.15	
	Hyper LL	3	66.87	1.40	
	Total	**325**	**61.76**	**3.25**	
MALE	Hypo LL	10	61.83	2.81	0.4530
	Normal LL	54	60.52	3.05	
	Hyper LL	5	60.24	4.36	
	Total	**69**	**60.69**	**3.10**	

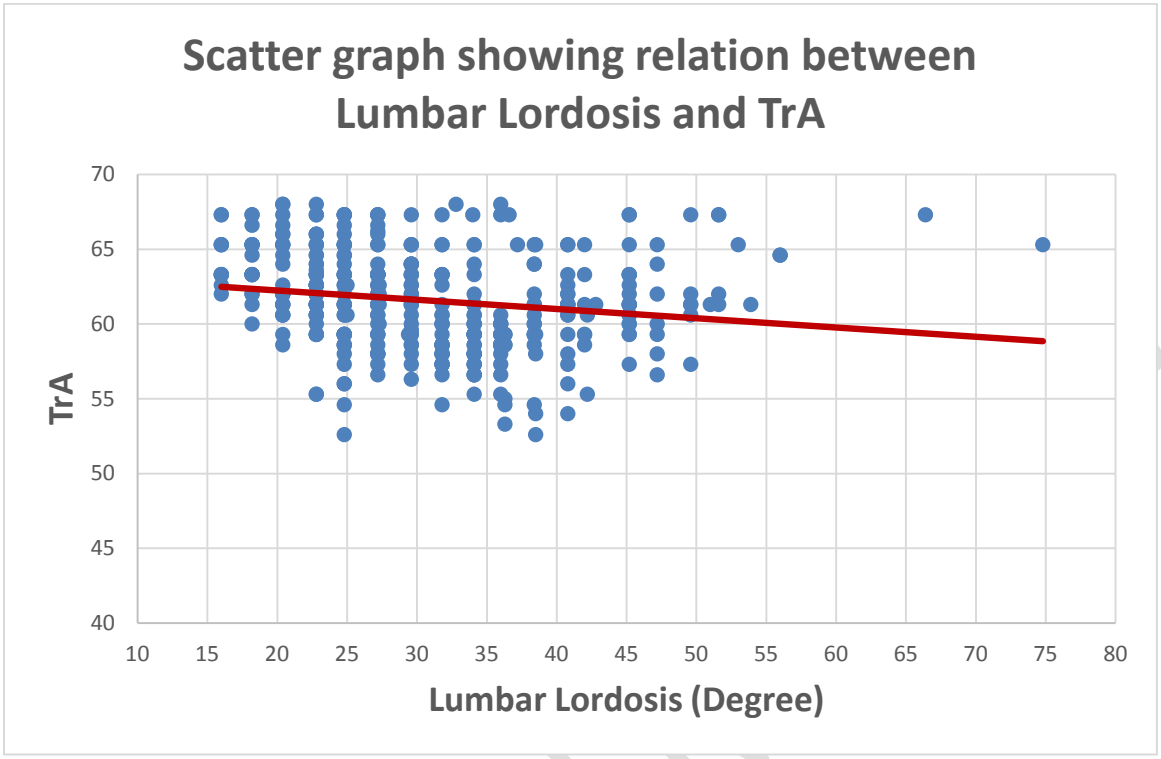

Figure 3: Scatter graph showing relation between Lumbar lordosis and TrA

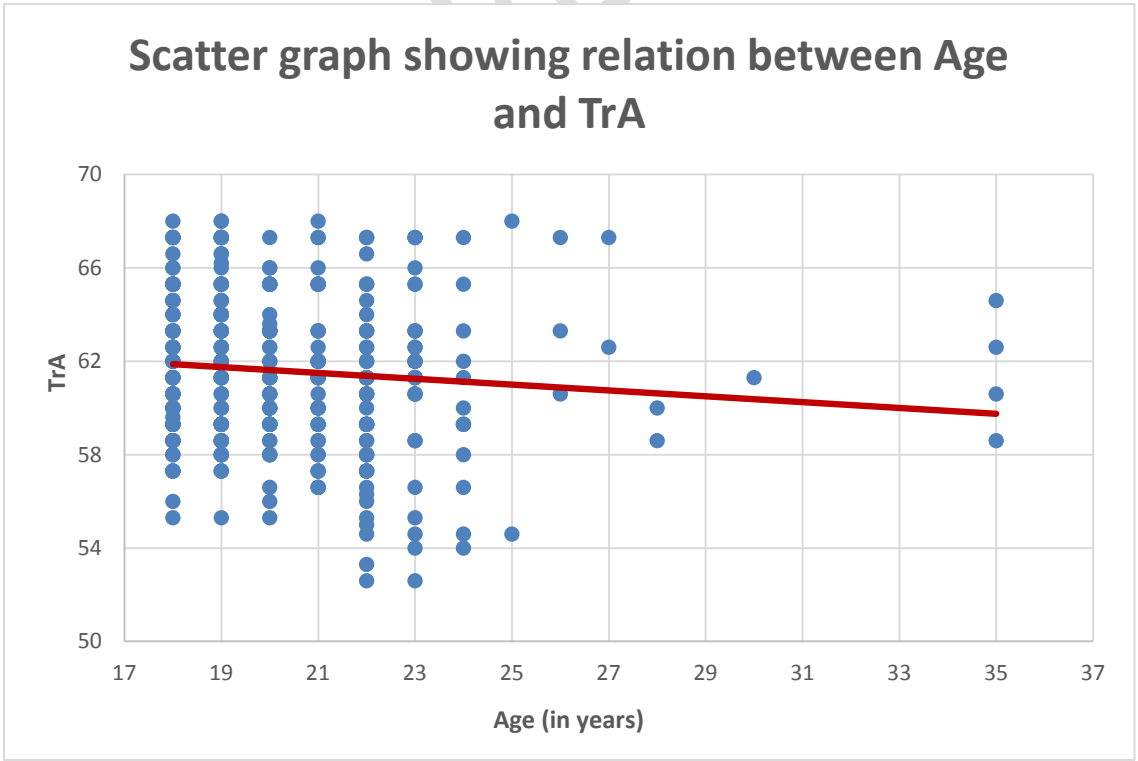

Figure 4: Scatter graph showing relation between Age and TrA

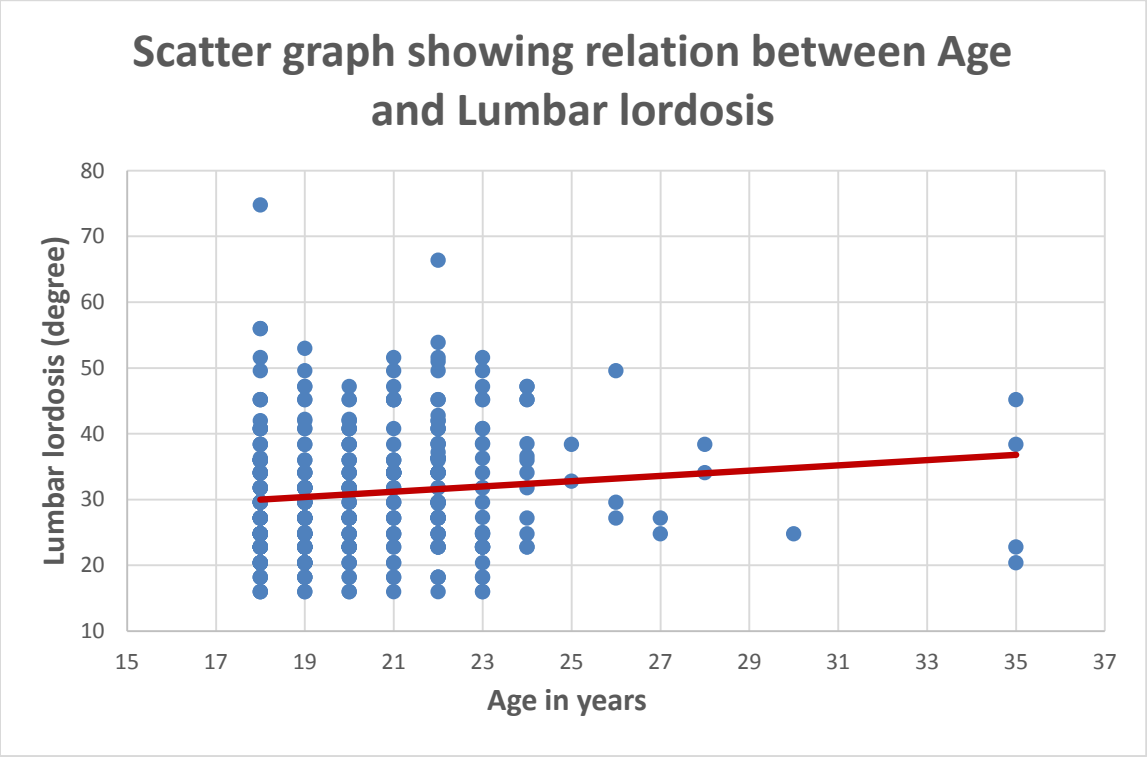

Figure 5: Scatter graph showing relation between Age and Lumbar lordosis

4.2 DISCUSSION

However all the abdominal muscles play an important role in spinal and pelvis control, Transverse Abdominis muscle has proven its independent role than the other trunk muscles in controlling the spine and its activation is related with the postural demands.[7]This fact is also supported by the study [14] which suggested that Transverse abdominis muscle is to be exercised to increase its muscle mass in order to improve lumbar stability and balance.

To measure the curvature of the lumbar spine and strength of the Transversus abdominis muscle, Flexicurve and Pressure biofeedback unit were used respectively. Nourbakhs et al.,[15] determined from their study that lumbar lordosis angle of females ranged between $42^0 \pm 15^0$ and males' lumbar lordosis angle ranged between $32^0 \pm 10^0$ indicating that females had greater lumbar lordosis angle than males which was in agreement with many other studies.[2, 16, 17,18] So, keeping these values as reference values in the study for the males and females lumbar lordosis angle, we segregated the values of the lumbar lordosis (LL) angle into Normal lumbar lordosis angle, Hypo lumbar lordosis angle, and Hyper lumbar lordosis angle. So, according to the lumbar lordosis angle, total 275 subjects had Normal LL, 111 subjects had Hypo LL and 08 had into Hyper LL.

Study by Murrie V. et al., [19] indicating that women had greater lumbar lordosis angle reasoning that such variations between the males and females must be genetically studied and it may be due to differences in the pelvis shape and size.

Comparison of lumbar lordosis angle and Transverse abdominis muscle strength, we found that those subjects who were having good Transverse Abdominis (TrA) muscle strength (mean TrA strength 60.87 mmHg) had normal LL angle i.e. females ranged in $42^0 \pm 15^0$ and males ranged in $32^0 \pm 10^0$. While those whose TrA muscle strength was reduced showed decreased or increased lumbar lordosis angle. Our study was in agreement with the study by Jobalia A. et al.,[7]who suggested that as the Transverse Abdominis muscle is a tonic, inter-segmental deep muscle, it is expected that its endurance helps in maintaining the spinal stability and hence concluded that Transverse Abdominis muscle strength had a significant role in controlling lumbar stability during postural control. Also according to Kisner et al.,[9] the tonic activity of TrA gives the adequate spinal stability. (Table 1)

Comparison of lumbar lordosis angle and Transverse abdominis muscle with the genders, it was noticed that those females who had good TrA muscle strength (mean: 60.96 mmHg, $p<0.0001$) fell in normal lumbar lordosis angle range 27^0-57^0 i.e.$42^0 \pm 15^0$, while those females who had hyper lordosis or hypo lordosis of lumbar spine had reduced TrA muscle strength. This indicated that TrA muscle strength plays an important role in maintaining spinal stability.[7] (Table 2)

In the present study we applied Pearson correlation coefficient (r) to find the correlation of 1. Lumbar lordosis angle with Transverse Abdominis muscle strength, 2. Age with Transverse Abdominis muscle strength, 3. Age with Lumbar lordosis angle. None of the correlation moved independently of each other, they were correlated to each other either positively or negatively.

Lumbar lordosis angle with Transverse Abdominis muscle strength analysed (r) which was -0.18 indicating that there was a weak negative correlation of lumbar lordosis with TrA muscle strength. So, as the lumbar lordosis angle increases, the strength of TrA muscle decreases. Our finding was supported by a study done by Pinto R. et al[20] which concluded that TrA muscle thickness improves with neutral lumbar postures indicating that muscle strength gets affected when the lumbar spine loses its neutral posture. (Figure 3)

Age with Transverse Abdominis muscle strength indicated weak negative correlation (-0.09). i.e. as the age increases, TrA muscle strength decreases. A study done by Davies P. et al., [20] proved that there is age-related decrease in the performance of the TrA muscle. (Figure 4)

Age with Lumbar lordosis angle, we found the correlation of age with lumbar lordosis as 0.11. It showed positive but weak correlation of age with lumbar lordosis. i.e. as the age increases lumbar lordosis also increases. This study's result was in agreement with study done by Tuzun C. et al., [21] who claimed that lumbar lordosis increases with age.(Figure 5)

So, in this study Pearson correlation coefficient suggested that as the age increases, lumbar lordosis increases and increase in lumbar lordosis results in decrease in TrA performance with the age.

5. LIMITATIONS

1. We targeted small age range, so we were unable to comment on actual changes in lumbar lordosis angle with age, if any.
2. We did not calculate the BMI of the subjects, as BMI plays a significant role in determining the effect of obesity on TrA muscle strength and lumbar lordosis.
3. All the subjects were assessed only once, so data about reliability and responsiveness were not reported in this study.

However, the relatively large sample size and the use of an objective and non-invasive device such as flexicurve and Pressure biofeedback were notable strengths.

6. RECOMMENDATIONS

Reasons for changes in lumbar lordosis angle should be recognized which would be important for clinical application. These reasons will provide platform for future studies.

7. CONCLUSION

Deep muscles are particularly important for the lumbar stability. Transverse Abdominis muscle has proven its independent role in controlling the spine. The results of this study have shown negative relationship between Transverse Abdominis muscle strength and Lumbar lordosis in young adults. Our findings may help health care professionals to better understand the relationships between Transverse Abdominis muscle strength and Lumbar lordosis in young adults.

8. REFERENCES

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