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RELATIONSHIP BETWEEN TRUNK EXTENSOR ENDURANCE AND DYNAMIC BALANCE IN FEMALE PHYSIOTHERAPY STUDENTS

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Abstract

Aim-To study the relationship between Trunk Extensor Endurance and Dynamic Balance in Female Physiotherapy students.

Background-Poor Trunk Extensor endurance may induce strain on passive structure of Lumbar Spine,and therefore may lead to Low Back Pain. Sufficient Trunk Extensor Endurance has an essential role in balance, coordination as well as Sports specific tasks. Reduced Trunk Extensor endurance are likely pathway by which these pathophysiologic changes influences balance and mobility status. Establishing a relation between trunk extensor endurance and dynamic balance will provide a rationale to give core Strengthning for reducing balance deficit related injuries.

Method-70 healthy female Physiotherapy students (Age group-18-26 years)were selected for this study on the basis of Inclusion and Exclusion criteria. Their Trunk extensor endurance was assessed using Sorenson test. Dynamic Balance was assessed using Star Excursion Balance test. The Pearson's Product moment correlation statistics was applied for the Data Analysis. All the Statistical Analysis was performed using SPSS 28.0.0 Software.

Result-It was found that there exists a positive correlation between Trunk extensor endurance and Dynamic balance performance of Right Lower Limb(r=0.487, p=0.001) as well as Left Lower Limb(r=0.489, p=0.0018).

Conclusion-The study concluded that there exists a significant relationship between Trunk Extensor Endurance and Dynamic balance in female Physiotherapy students between the age group of 18-26 years.

***Keywords*-Trunk Extensor Endurance, Dynamic Balance, Star Excursion Balance test, Sorenson Test.**

INTRODUCTION

Skeletal elements of spine forms a column that contributes in transferring of the load to lower extremity for static and dynamic balance.[1]Balance is a key component of normal daily activities of an individual such as walking , running and climbing stairs. In the simplest terms," Balance is the ability to maintain the body's Centre of gravity within the Base of support ".[2]

According to a study, the core musculature which includes the muscles of trunk and pelvis are responsible for maintaining stability of spine and pelvis and plays a very important role in the transfer of energy from larger torso to smaller extremities during dynamic activities. Hence, in case if the extremities are strong but the core is weak, there is decrease in muscular summation through the core that would result in less force production leading to inefficient movement pattern.[3]

Major Trunk core Muscles-

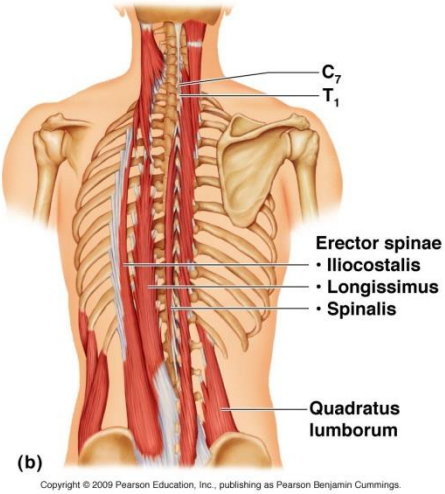


fig 1-core muscles

- Multifedus
- Transverses abdominis
- Rectus abdominis
- Internal obliques
- External oblique
- Quadratus lumborum
- Erector spinae
- Splenius

Minor Trunk Core Muscles-

- Lattissimus Dorsi
- Gluteus maximus
- Trapezius

Trunk extensor muscles helps in controlling movement , transfer of energy ,shift body weight and distribute stresses of weight bearing .Hence the functional movement and balance are highly dependent on trunk musculature and poor trunk muscle endurance may lead to severe injuries and low back pain. Hence,the core stability plays a key role in dynamic balance.[4]

Kibler et al defines core stability as the "Ability to control position and motion of trunk over the pelvis to allow optimum production ,transfer and control of force and motion to the terminal segments in dynamic activities.''[5]

Panjabi stated that ''Core stability is achieved by integration of active spinal stabilizers(core muscles) , passive stabilizer (spinal column) and neural control that act together to control Intervertebral joint Range of motion in order to allow for the performance of ADLs.[6,3]

Contribution of passive elements results from interaction of mechanical load on bony architecture and tissue compliance compared with active muscle component, the contribution to stability from the passive elements is quite small. For example, an invivo lumbar spine may experience compressive loads > 6000 N during activities of daily living and still maintain stability without postural sway. However, without active support, the lumbar spine becomes unstable under compressive loading of only 90 N. Therefore contribution of active muscular components of this system are critically important[7].

Balance is the ability to maintain centre of gravity (COG) of body within base of support (BOS) with minimal postural sway[4.]
It can be described as Static or Dynamic.
Static balance involves maintaining a stable base of support while minimizing movement of bodily segments and Centre of mass[8].
Dynamic balance involves the completion of a functional task with purposeful and efficient movements without compromising an established base of support[8].Dynamic balance is the active movement of centre of pressure occurring during standing, walking or execution of sports skill.[4] Dynamic activities are described as those that cause Centre of gravity (COG) to move in response to muscular activity within the base of support[9]

Maintaining balance is basically coordinated by three systems. Vestibular system gives the first input. Second balance coordinator is from the proprioceptive system that originates from somatosensory receptors in muscle tendons and joint for kinesthetic sense, body posture and spatial awareness. The final input is from the visual system that sends visual signals about body position. Interaction of nervous and musculoskeletal system are important for postural control/balance[4].
Impaired postural control, often inferred by increased postural sway, is found to be repeatedly associated with an increasing falling risk. Localized muscle fatigue is one of the factor that contributes to hamper postural control[10.]
According to a study, trunk inputs may play a more important role in triggering correction of balance , and recent evidence highlights that lumbar extensor fatigue may compromise postural control[10,11]
Hodges and Richardson examined the sequence of muscle activation during whole bodily movement and found that some of the core stabilizers (Multifedus , Tranversus abdominis) were activated before any limb movement occurs .These findings support the theory that development of movement control and stability occurs in a core to extremity (proximal to distal)progression[12] . Hence, maintaining optimum Trunk extensor endurance is quite important in providing and maintaining Dynamic stabilization[13.]
Endurance can be mechanically defined as" either the point of isometric fatigue, where the contraction can no longer be maintained at a certain level, or as the point of dynamic fatigue, when repetitive work can no longer be sustained at a certain force level"[14]. After the onset of fatigue there is decreased ability of paraspinal muscles to support the trunk that maybe a contributing factor, leading to diminished spine stiffness in attenuating ground reaction forces[18]. In fatigue condition, the muscle is unable to sustain the required force or power output.[19] It is considered that by improving a person's Trunk extensor endurance, the ability to perform dynamic activities increases efficiently[15.]
Hence , the present study was undertaken to find relationship between trunk extensor endurance and dynamic balance in female students of Physiotherapy.

MATERIALS AND METHODOLOGY

➢ MATERIALS:

- Pen
- Paper
- Measuring tape
- Timer
- Straps
- Couch
- Athletic Tape

➢ METHODOLOGY:

1) **Sample size** :70
2) **Study design**- Correlational study.
3) **Method of sampling**– Convenient sampling.
4) **Place of study**- Dr. Ulhas Patil College of Physiotherapy, Jalgaon
5) **Study Duration**- 6 months
6) **Selection Criteria**-

1. **Inclusion criteria**-

- Subjects with informed consent.
- Young healthy female students of Physiotherapy with age group 18-26 year old.

2. **Exclusion criteria-**

Subjects with -

- Any ankle trauma
- History of any dizziness
- Neurological condition(Traumatic/congenital)
- Vestibular impairments
- Uncorrected visual problems
- Suffering from acute severe low back pain
- Any congenital/acquired orthopedic deformities of spine and lower limb.
- Post Covid(less than 2 months)
- Limb length discrepancy.

PROCEDURE

To conduct the following study permission was taken from Dr.Ulhas patil college of Physiotherapy, Jalgaon. Ethical clearance was obtained from Institutional Ethical committee. Subjects were screened according to the Inclusion and Exclusion criteria. The informed consent was obtained from selected participants and procedure was explained. Initially, the demographic data that is Name , Age of the subject was assessed. In the first phase, Dynamic balance was assessed using Star excursion Balance test(SEBT) . Then, Trunk Extensor Endurance was assessed using the Sorensen test of Trunk Extensor Endurance.

➢ **Star excursion balance test(SEBT)- (ICC-0.87)**

Star excursion balance test (SEBT) is one of the reliable and feasible method used to assess the dynamic balance as it challenges a person's ability to maintain a stable BOS simultaneously performing reach movements.[13]

- The star excursion test layout consisted of 4 lines applied to the floor with athletic tape; two forming vertical and horizontal lines and two positioned perpendicular to each other and at 45° with respect to the vertical and horizontal lines.(fig2)
- A rectangle representing the starting position of the feet was placed at the center point.
- This box was large enough to fit the subjects feet.
- The subject was asked to reach along the lines marked, with one leg while standing on the other leg.
- The distance reached in each direction was recorded separately by measuring through tape from center point to the point the subject has reached using the distal part of foot.

fig 2- star excursion balance test

➢ **Sorenson Trunk Extensor Endurance Test (Fig3) (ICC-0.88)**

- The subject was asked to lye on examining table in prone position with upper edge of iliac crests aligned with edge of table.
- The lower body was supported on the table by three straps; located around pelvis, knees and ankles respectively.

- The arms were folded across the chest and the subject was asked to maintain upper body in horizontal position parallel to the ground.
- The time during which the subject keeps the upper body straight and horizontal was recorded.

fig 3-sorenson test

fig 4-stopping criteria

- Criteria for stopping(Fig 4)- Until the patient felt exhausted or discomfort or when the trunk started downsloping by more than 5-10^{o}.
- In subjects who experienced no difficulty in holding the position ,the test was stopped after 240 seconds(4minutes).

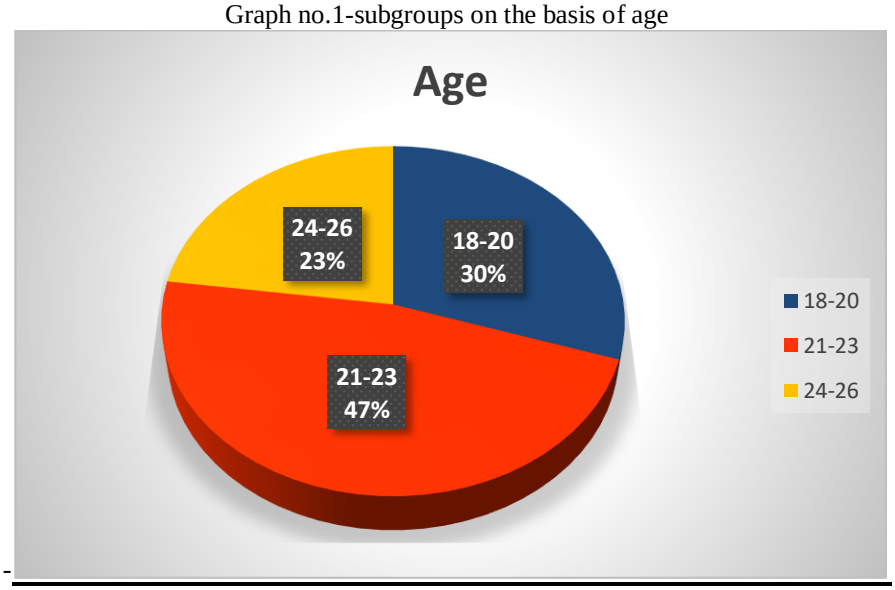
DATA ANALYSIS:

- The collected Data i.e. Trunk Extensor Endurance and Dynamic Balance are quantitative in nature.
- Hence , Pearson's product moment correlation statistics was applied to the test to find whether the Trunk Extensor Endurance significantly correlated with Dynamic balance.
- All the Statistical Analysis was performed using the Statistical Software SPSS(Statistical Package for the Social Sciences) 28.0.0
- All the tests were performed considering 95% Confidence interval and the Level of significance at 0.05 .

Table no.1 subgroups on the basis of age-

Variable	Range	Frequency
	18-20	21 (30%)
AGE	21-23	33 (47%)
	24-26	16 (23%)

Graph no.1-subgroups on the basis of age



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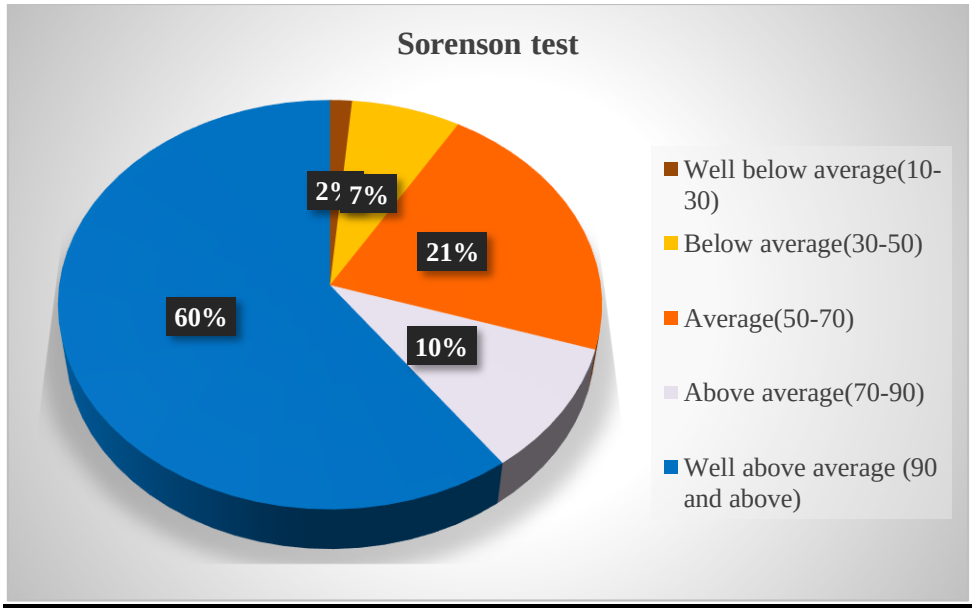
Inference- The pie diagram shows age wise distribution .In our study, out of 70 young females ,21 subjects were between the age group 18-20, 33 subjects were between 21-23 whereas 16 subjects were between 23-26 years of age.

Table no.2-evaluation of trunk extensor endurance among young female physiotherapy students using sorenson test-

Percentile	Grades	Frequency
10-30	Well below Average	1
30-50	Below average	5
60-70	Average	15
70-90	Above Average	7
90 and >90	Well above average	42

Graph 2-evaluation of trunk extensor endurance among young female physiotherapy students using sorenson test-

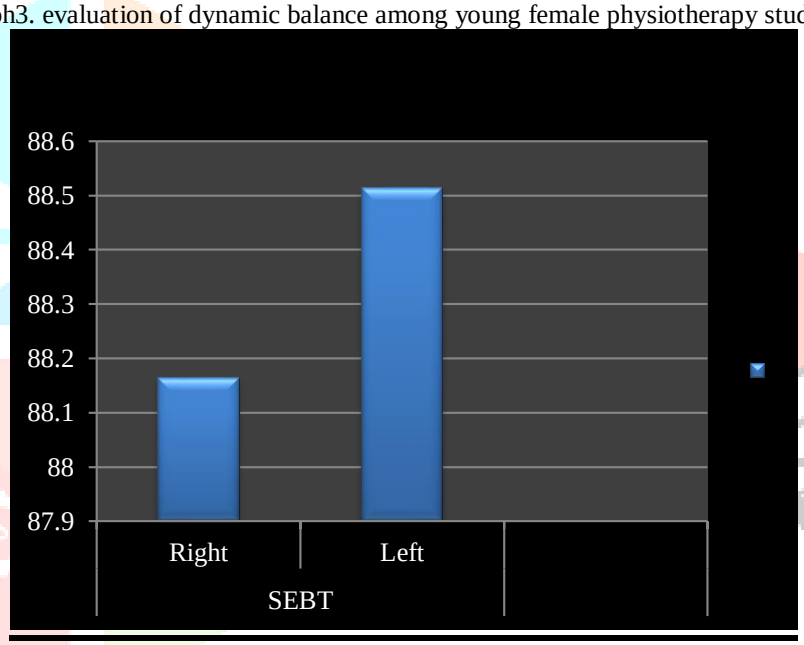


Inference- The pie Diagram shows distribution of the subjects according to the Endurance grading system. 2% subjects were categorized as “Well below average”,7% were ” Below Average” , 21% were “Average”,10% performed “Above average”, whereas 60% were “Well above average”.

Table no.3-evaluation of dynamic balance among young female physiotherapy students.

SIDE(Lower Limb)	SEBT (Mean)
Right	88.165
Left	88.514

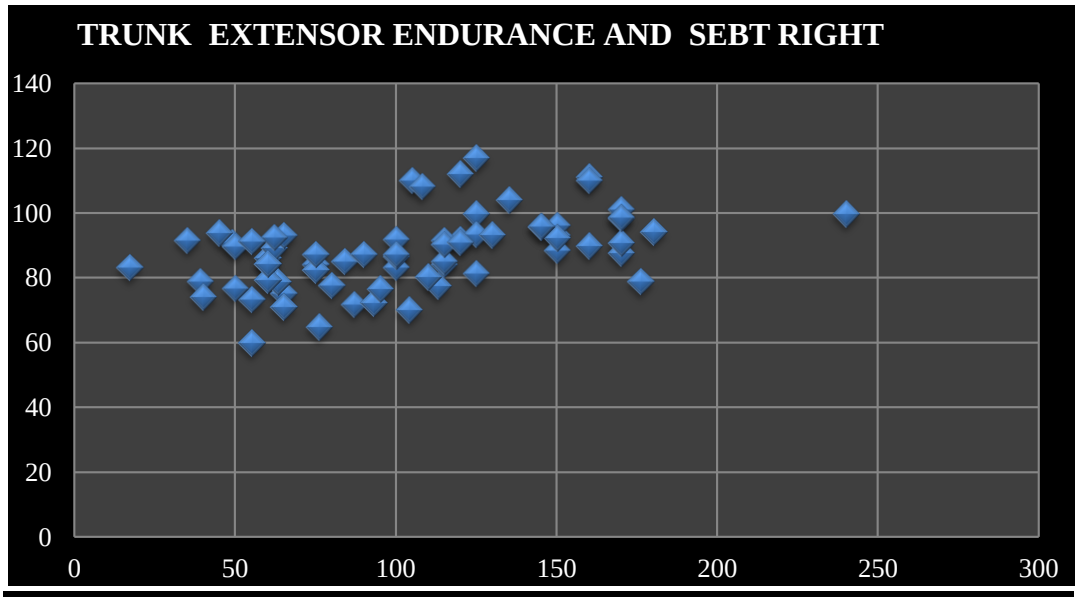
Graph3. evaluation of dynamic balance among young female physiotherapy students.



Inference-The Bar graph shows the Dynamic balance among female physiotherapy students .It reflects that the dynamic balance of right side is more as compared to that of the left side.

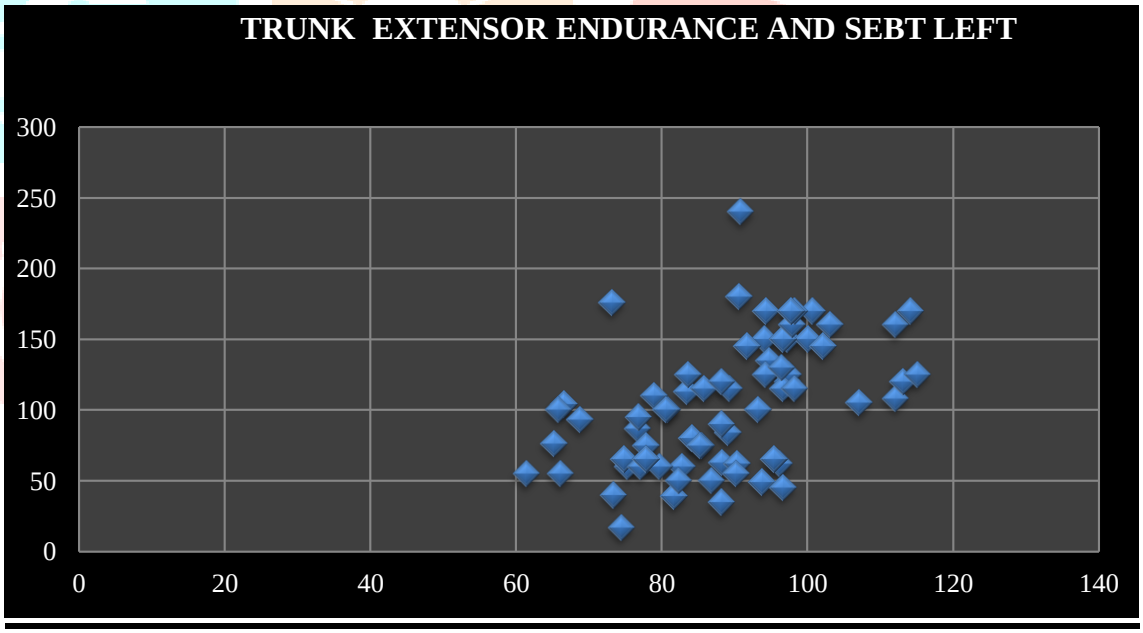
RESULT-

SORENSON TEST	SEBT(RIGHT)	r value	p value
104.04 ±45.04	88.165±45.91	0.487	0.001



The scatter diagram shows there exists a positive correlation between the Trunk extensor endurance and dynamic balance of Left lower limb.

SORENSON TEST	SEBT(LEFT)	r value	p value
104.04±45	88.514 ±41.62	0.489	0.0018



The scatter diagram reflects that there is a positive correlation between The trunk Extensor endurance and dynamic balance of right lower limb.

DISCUSSION

The primary purpose of this study was to determine the relationship between trunk extensor endurance and dynamic balance that subsequently affects functional movement and performance. The results obtained suggests that the trunk extensor endurance has effects on dynamic balance.

Trunk extensor muscles are physiologically postural muscles being rich in Type 1 muscle fibres . Erector Spinae and multifedus are found to be tonically active in quite standing too.[23]It was found that core muscles provide a stable biomechanical platform for peripheral muscles to act.Pelvic as well as abdominal muscles are segmental links of kinetic chain between upper and lower body.They tend to act as fulcrum and the upper and lower body act as movable levers. Hence, Trunk Extensor weakness may lead to Lower Extremity Injuries and imbalance during Athletic performance[24].

In this particular study, total 70 healthy female physiotherapy students of age group (22±4) had participated.These participants were evaluated as per the Data Collection sheet which included Demographic Data ,Assessment of Trunk Extensor endurance by Sorenson test whereas Dynamic

balance by SEBT. Initially,Sorenson Test that elicited Isometric muscle contraction during the time was performed on the examining table.It was found that out of 70 subjects 42(60%) were considered well above average,7(10%) were above average ,15(21%) subjects were average,5(8%) performed below average whereas 1(1%) subject performed well below average.On the other hand, SEBT was used to measure the dynamic balance quantitatively .It was assessed separately for both left as well as right side in all the 8 marked directions on the floor that is (Anterior,Anterolateral,Lateral,Posterolateral,Posterior,Posteromedial,Medial and Anteromedial).It was found that Dynamic balance of right side(mean=88.5) is more as compared to that of the left side(mean=88.165).

Hodges and Richardson examined the sequence of Muscle Activation during whole Bodily Movement and found out that Core Stabilizers (Multifedus and Transversus Abdominis) were activated before any limb movement occurs.These findings support the theory that development of movement control and stability occurs in a core to extremity (proximal to distal) progression[12]. In 2009, Michael L.Madigan et al found out that Trunk inputs may play a more important role in triggering correction of balance and recent evidence highlights that poor Trunk Extensor endurance may compromise Postural Control[10,11].Therefore,It is quite sensible that maintaining an optimal Trunk Extensor Endurance is quite important in providing and maintaining dynamic stabilization.According to Faries and Greenwood "balance comes from core ,Strong core equals good balance"[25]

Sports Participation /Sports training has an effect on balance ability.Long term athletic training augments neurosensory pathways and stimulates Cutaneous Nerve Receptors/mechanoceptors in the muscles,Ligaments as well as the joint capsule of knee and ankle joint as demonstrated by improved balance and proprioception.Hence,The effects that are established after long term athletic training on Balance and Proprioception.Hence,The effects that are established after long term athletic training on balance and propripoception could be one of the rationale for balance performance of female physiotherapy students[13].

A few studies have been conducted that are sports specific,such as tennis having a positive correlation of Core with 8 SEBT Excursions.A Correlational study entitled "The relationship between core stability performance and lower Extremities Static and dynamic balance performance in healthy individuals,'done by Dr.Saqib Syed et al. concluded that there is a significant correlation between the core stability and static and dynamic balance in healthy individuals[26].Earl and Herted found EMG Activities of the Lower extremity during SEBT and the study reported that SEBT is direction dependent with Posterolateral,Posterior and Anterolateral excursions recruiting higher activity than other excursions.The Mc Gill Score showed that the more endurance the core muscle has ,the faster an athlete will be[24].

In our study,It was found that a positive correlation existed between the Sorenson Test and SEBT(right) as well as SEBT(left) with p=0.001 and r=0.487 whereas p=0.0018 and r=0.489 respectively. Hence. It suggests that there is a strong relationship between Trunk Extensor Endurance and Dynamic balance in female physiotherapy students.

Kahle and Gribble also found an improvement in SEBT scores among healthy individuals after a core stabilization training program.[21,24]A study done by Lust et al and Basset also reported an improvement in Dynamic balance among the Baseball players and gymnasts after a core training program. Granacher et al compared 2 different types of core training programs (Stable and unstable) and found that both programs led to improvement in Dynamic balance[24].According to a research study done by Pradeep Suri et al (2009) entiltled"Trunk muscle attributes are associated with balance and mobility in older adults" and found that trunk extensor endurance and strength have positive correlation with mobility and balance in older adults[27].Hence,from a performance perspective Specific training that is aimed at improving the trunk extensor endurance must be incorporated in balance training.

CONCLUSION

The study concluded that there is a significant relationship between the trunk extensor endurance and dynamic balance in female physiotherapy students between the age group of 18-26 years.

CLINICAL IMPLICATIONS

- Being a physiotherapist it is quite important that the core muscles have well above average endurance so that they can perform strenuous and prolonged physical tasks without prone to injury or LBP ,may it be long treatment sessions ,ADLs or on the playing field.
- By this study, we can find out the subjects with poor trunk extensor endurance and further Recreational activities sessions can be added to their college hours itself.
- The established effects of this long term Training on balance and proprioception could be one of the rationale for balance performance in female physiotherapy students.

LIMITATIONS AND RECOMMENDATIONS

Limitations-

- Only the trunk extensor endurance was analyzed .
- A specific Core Strengthning program and balance training was not incorporated for the subjects in this particular study.

Recommendations-

- Other more appropriate tests for assessing dynamic balance can be used.(Balance sensor,videography)
- Alongwith Trunk Extensors' Endurance ,flexors as well as lateral Flexors can also be assessed.
- Besides Dynamic balance,Even static balance could be evaluated.

FUTURE SCOPE

- Assessment of the Trunk Extensor endurance and Dynamic balance may be followed by a proper Core strengthning program and balance improvement strategies on a large sample size.
- It may be done with respect to recreational and sports activities.
- It may include Core strengthening program ,alongwith pre strengthning and post strengthning evaluation of core strength and Dynamic balance.

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