International Journal of Physiotherapy Research and Clinical Practice

Original Article

Relation of Trunk Extensor Muscle Endurance and Dynamic Postural Stability Among Nurses

Sanjoy Das[1], **Jincy Samuel**[1,*]

[1] *Krupanidhi College of Physiotherapy, Bengaluru, India*

ARTICLE INFO

Article history:
Received 19.05.2022
Accepted 21.08.2022
Published 27.08.2022

[*] *Corresponding author.*
Jincy Samuel
pjincy19@yahoo.com

https://doi.org/10.54839/ijprcp.v1i1.22.11

ABSTRACT

Control of posture is a task that requires the summation of auditory, visual and somatosensory signals. Trunk plays a vital role in the loading of energy and connecting the lower and upper extremities. Nurses spent a lot of time on activities involving frequent bending and turning movements. These postures and movements when used for prolonged duration place static and dynamic stability demands and may increase the demands on the trunk muscle groups resulting in high risk for developing low back pain. The aim of this study was to find a relation between trunk extensor muscle endurance and dynamic postural stability among Nurses. 103 female and male nurses were recruited for the study based on the selection criteria. The nurses were evaluated for the trunk endurance using Bearing-Sorenson's test. The Y-balance test and berg balance scale was used to know the dynamic postural stability. The mean trunk extensor muscle endurance was found to be 83.26±17.72 seconds. The 'Y' balance was 88.24±11.73 on the right side and 89.16±12.09 on the left side. The mean Berg balance score was 30.13±3.59. There was no significant relationship was noted between trunk muscle endurance and Y balance (p=.57). No significant association was observed for trunk muscle endurance with a Berg balance score (p= 0.727). We found no significant relationship existing between trunk extensor muscle endurance on dynamic postural stability among nurses. Trunk extensor muscle endurance may not be the major factor in maintaining dynamic postural stability.

Keywords: Posture; Muscles; Low Back Pain; Balance

INTRODUCTION

Control of posture is a function which undertakes the summation of auditory, visual, and somatosensory signals information to survey the position and movement of body in space and capacity to create force to control body position.[1] To maintain the body in stable position the important postural control strategies mainly focus around two major joints that is hip and ankle.[2] People with no disease condition can reposition their trunk with more clarity in an un-fatigued state.[3]

Balance can be dynamic or static in nature. Static balance is the ability to maintain postural stability and orientation with the mass center based on support and body at rest. The dynamic balance is the ability to maintain stability and postural orientations with the center of mass based on the support, while the body parts are moving. [4]

Balance involves a mixture of stability and postural orientation which is important for sustaining a posture, motion in a managed and organized way, and go through with daily living work and functional activities.[5]

Trunk function which also can be called as torso or core strength, is the combination of the coordination, strength, and endurance of trunk muscles.[6]

There are two groups of muscle in the trunk which are splits into local muscle and global muscle groups. The local muscles are transverses abdominis, multifidus, and obliques internus abdominis and the global muscles are rectus abdominis, longissimus thoracis, and obliques externus abdominis, according to their work in stabilizing the torso.[7]

The trunk takes very important role in the loading of energy and associating the lower and upper extremities.[8] Group of muscles gathered within the trunk and maximum work of these group of muscles is necessary to fulfill the function and position of the torso during daily action.[9]

Nurses who work in different departments have daily activities that needs lifting loads in various uneven position.

These types of work exposure may put them into risk of low back pain incorporated with physical load.[10]

A good amount of nurses' work period is spent in forward lean postures. A study established that at least 22% of the geriatric nurses' work was spent in stooped positions along with frequent twisting.[11] Another study stated that nurses' aides bended forward more than 72 degrees every 3 seconds and were spending an average of 13 minutes per hour in a forward flexed posture of 36 degrees or more.[11] These postures placed excessive static and dynamic staying power demands at the trunk muscle groups putting nurses into a risk of developing low back pain (LBP).[11]

Managing position and the capability to hold the secure equilibrium is the basis for most of the activities of day-to-day life. Reduced stability may have a negative effect on quality of life and, which can ultimately lead to an increased risk of injury and falls.[12]

Dynamic postural stability can be described as one's ability to hold the balance when transforming from an energetic to an inactive state. Both dynamic postural and static postural stability are the after effect of complex association of gathering from visual, auditory, and somatosensory pathways, simply as the resultant efferent reaction.[13]

The Y-balance test can be utilized to evaluate the dynamic limits of postural stability and non-symmetrical equilibrium in three different directions which are anterior, posterolateral and posteromedial.[14] Berg balance scale is an effective scale to check the dynamic stability which include 14 components with total score of 56.[15]

The fatigued state in the extensor muscle of the torso can decrease the capacity to hold a particular position at the trunk region. Postural control includes physiological and mental capacities, for example, vestibular, visual, and proprioceptive and exteroceptive criticism just as inspiration and focus.[16] The trunk muscular endurance or core muscle endurance tests, which calculate the holding duration of a particular pose is often used as an evaluation tool for the trunk function. Biering-Sorenson's test is used to calculate endurance of trunk extensor muscles.[17,18]

To ensure the line of gravity in the given base of support, the rapid and continuous change in the muscles is required which includes the activation of postural muscle in feed-forward manner.[19]

Daily activities need core muscle endurance for longer duration of use and to maintain different postures with longer duration of times and the ability to resist fatigue. Overall strength of the core is important for activities of day-to-day life and along with the strength, the endurance also contributes significantly in core stability during extended physical activity and prevents from damage.[20]

Adequate amount of endurance in abdominal muscles has an important function in maintaining balance, co-ordination and daily activities. Any injury or deterioration in torso muscles, such as poor trunk power or endurance, results in etiologic changes which impact stability and mobility of the body.[21,22]

Nurses spend most of their time in physical efforts for their treatment purpose and work.[20] They have a multidimensional role in caregiving, decision making, subject advocator, communicator as well as a teacher. To ensure this they need to have a good dynamic postural stability.[21] Knowing the relation between trunk extensor muscle endurance and dynamic postural stability is necessary so as to design strategies to improve the endurance and thereby improve dynamic postural stability.

Our study aims to find the relation between trunk muscle endurance and dynamic postural stability among nurses with the objectives to evaluate the trunk extensor muscle endurance among nurses, to evaluate the dynamic postural stability among nurses and to evaluate the co-relation between trunk extensor muscle endurance and the dynamic postural stability among nurses.

METHODOLOGY

This study was a correlational study conducted from 20th April 2020 to 31st June 2021. 103 nurses were selected based on the selection criteria from the hospitals of south Bengaluru. Approval to continue with the research work was granted by the ethical board of our institution (Ethical ref. number: MPT/20/PHY/015). The study population was selected using disproportionate sampling technique. All subjects were given a brief introduction about the purpose of this research, the procedures to be undertaken, possible risks as well as the benefits. Upon the approval from the participants, a signed consent form was attained.

103 nurses between age of 25-35 years, and BMI of 18.5-25.5 kg/m^2 were considered in the study using the following sample size calculation.

$SSUKP = z^2\ p\ (1-p)$
e^2
z= 1.96
p= power of confidence i.e. 10% e= 0.05 type 1 error
$SSUKP = (1.96)^2 \times 0.1(1-0.1)$
$(0.05)^2$
$= 3.8416 \times 0.1 \times 0.9$
0.0025
= 0.3456
0.0025
= 138.24
= 138 (sample size for unknown population)
SSKP = SSUKP
1+ SSUKP/ N
= 138
1+138/400
= 138.24
1.3455
= 102.74
= 103 (Sample size for known population)

Nurses having back or lower limb pain, history of ankle, hip or knee injuries in past 2 years, history of musculoskeletal condition or neurological condition, vestibular pathologies, visual impairment, any back injury, ankle condition were not considered for the study.

All the 103 subjects then were assessed for their trunk muscle endurance using the Beiring's Sorenson's Test. After a rest period of 5 minutes, the subjects were made to perform the Y balance test and the Berg's balance scale to assess the dynamic postural stability.

MEASUREMENTS

Sorensons test[17]

The Biering-Sorensen test used to assess the endurance of the trunk extensors and demonstrates good validity and his reliability in the evaluation of trunk muscles endurance with an intra rater reliability of 93.2%.[17,18] Subject is made to lie down prone on the examination table with their upper border of iliac crest in alignment with border of table. The lower part of the body is held constant into the examination table through 3 straps folded across the ankle, knees and pelvis respectively and arms folded across the chest. The subjects maintain horizontal position of the upper body while the time is recorded. Once the subject reaches 240sec, the test is stopped.

Y-balance test (YBT) [23]

The Y-balance test used to evaluate the asymmetrical balance and dynamic limits of stability in three different directions. The YBT is a reliable measure of dynamic balance with intraclass correlation coefficients ranging from 0.85 to 0.91 for intra-rater reliability and from 0.85 to 1.00 for inter-rater reliability.[14] For the test, Y-shaped marking was made on the floor using a micropore tape. The posterior direction of the Y shaped marking was positioned each at 135 degrees from the previous and 90 degrees between them.[24] The participants were then instructed to stand on their right limb with the edge of their toes at the marked starting line. With their hands placed on their hips, they had to reach as far as possible with the non-stance limb in the anterior, posteromedial, and posterolateral directions. Three successful repetitions were performed in each direction, and the mean scores for each direction were used for the statistical analysis. To express reach distance as a percentage of limb length, the normalized value was calculated as reach distance divided by limb length then multiplied by 100%. Composite reach distance was the sum of the 3 reach directions divided by 3 times limb length, and then multiplied by 100%.

Berg Balance Scale (BBS)[25]

The BBS scale is highly reliable for measuring balance with an intra-rater reliability of 0.98.[15] The Berg Balance Scale is able to detect many clinically significant changes in balance with 95% confidence.[15] BBS is a combination of 14-item scale with a total score of 56.

RESULTS

Statistical analysis

Co-relational statistical analysis was done for this study using SPSS version 29 0

Table 1: Basic Character of the participants

		N=103
Basic characters	**Mean**	**S.D**
Age	29.21	3.14
BMI	19.97	1.85
Gender: Male subjects	42	40.8
Female subjects	61	59.2

M- Mean, S.D- Standard deviation, N- Number, %- Percentage

Table 2: Trunk muscle endurance of the study participants

Sorenson (Seconds)	Mean	S.D
Sorenson test	83.26	17.72

Table 3: Analysis of 'Y' balance test of the participants

Y balance test (cm)	Mean	S.D
Anterior		
Right	78.70	11.39
Left	80.04	9.69
Posterolateral		
Right	72.54	8.22
Left	71.28	7.39
Posteromedial		
Right	78.70	12.61
Left	80.92	11.11
Y balance test total		
Right	229.95	21.93
Left	232.24	21.66
Y balance score		
Right	88.24	11.73
Left	89.16	12.09

M- Mean, S.D- Standard deviation

Table 4: Correlation of trunk muscle endurance with 'Y' balance score

Y balance test (cm)	Pearson's correlations analysis	
	r	p
Y balance score (Cm)		
Right	0.55	0.578
Left	0.035	0.725

r- Correlation coefficient, p- probability

Table 5: Analysis of Berg balance score

Berg balance score	M	S.D
Berg balance score	30.13	3.59

M- Mean, S.D- Standard deviation

Table 6: Correlation of trunk muscle endurance with Berg Balance score

Sorenson Vs. Berg balance score	Pearson's correlations analysis	
	r	p
Correlation analysis	0.035	0.727

r- Correlation coefficient, p- probability

DISCUSSION

The purpose of the study was to find out a relation between trunk extensor muscle endurance and dynamic stability among nurses. For this study 103 nurses were included of which 42 were male and 62 were female nurses. The mean age of the participants was 29.21±3.14 years. The trunk extensor muscle endurance and Dynamic Postural Stability were assessed using Beiring Sorenson's Test, Y balance test and Berg's balance scale respectively. The results shows that no significant relation was found between trunk extensor muscle endurance and dynamic postural stability.

A collective contribution of systems is necessary to have a good postural control and for maintaining balance. This is a complex process in which there is involvement of the CNS which comprises the brain and the spinal cord, on the other side peripheral nervous system which comprises of afferent and efferent pathways, sensory system which includes the sensory receptors, vestibular, visual system and lastly the musculoskeletal system. A collective contribution of these system in the controlling postural stability could be a reason for non-significant relation being found between trunk endurance and dynamic postural stability.[26]

Our study results have been similar to the findings of Ozmen which suggested that core muscle endurance was not associated with dynamic balance.[27] Another study done by Krishna et al. also found no significant correlation been found to exist between core endurance and dynamic balance suggesting that core has an important and stabilizing part in the movement pattern of the lower extremity however endurance of the core muscle alone may not account much in dynamic balance.[28] Supporting our study findings, a study done by Behennah J et al observed no relation existing between trunk extensor endurance and dynamic balance in both subjects with and without Chronic low back pain.[29]

Our study results show no significant relation have found between trunk extensor muscle endurance and dynamic postural stability. However, few of the previous studies contradict our findings. There has been evidence which shows that a decrease in muscular endurance could be a cause, as well as a consequence, of certain musculoskeletal related disorders. Low static tolerance in the extensor muscles of the back is associated with a higher incidence of low back pain (LBP), decreased consciousness of proprioception, poor balance and reduced productivity at work, increased muscle fatigue and overloaded soft tissues and passive structures of the lumbar spine.

The tensile strength or endurance of the torso has a greater effect on functional performance than flexor strength and maximum force.[27] Helbostad et al in their study of the consequences of fatigue of the muscles of the torso and lower extremities for balance and functional tasks confirmed that fatigue of the torso extensor muscles which may relate to poor endurance is associated with a violation of the somatosensory process, which leads to a reduction in stability and coordination. They concluded that static balance was affected by trunk extensor fatigue through an exaggerated postural sway.[30] A study by Anoop Joy et al concluded that a strong correlation existed between trunk extensor endurance and dynamic postural control and that a good amount off muscle endurance is necessary to maintain an erect posture and muscular imbalance can cause postural instability.[31]

Our study suggests that trunk muscle endurance may not be a significant related factor impacting dynamic postural stability. Involvement of multiple systems in maintaining balance may be crucial toward attaining dynamic postural stability. Various kinetic and kinematic factors such as range of motion of hip joint strength of lower limb muscles may affect dynamic stability.[27] Control of balance which is a complex mechanism with different systems working together can also be an important factor effecting balance. Thus, focusing on improving the trunk muscle endurance may not be sufficient to enhance balance and reduce the risk of Low back ache in Nurses.

LIMITATION

- Sample size was relatively small.
- Level of physical fitness was not taken into consideration.

RECOMMENDATION

- Further studies can be done on larger sample size.
- Functional limitation could be assessed to get significant results.

- Further studies can be done to find out the relationship between male and female individual.

CONCLUSION

This study concludes that there was no significant relationship between the strength of the trunk muscles and dynamic postural stability among nurses**.** As a good dynamic stability is dependent on multiple systems working in a collective manner, trunk muscle endurance may not be having a significant contribution towards dynamic postural stability.

REFERENCES

1. Akulwar I, Mulgaonkar S. Effect of Trunk Extensor Muscle Fatigue on Postural Stability in Healthy Young Adults. *Journal of Physiotherapy & Physical Rehabilitation*. 2017;02(02):1–5. Available from: https://doi.org/10.4172/2573-0312.1000144.
2. Larson DJ, Brown SHM. The effects of trunk extensor and abdominal muscle fatigue on postural control and trunk proprioception in young, healthy individuals. *Human Movement Science*. 2018;57:13–20. Available from: https://doi.org/10.1016/j.humov.2017.10.019.
3. Taylor JL, Butler JE, Gandevia SC. Changes in muscle afferents, motoneurons and motor drive during muscle fatigue. *European Journal of Applied Physiology*. 2000;83(2-3):106–115. Available from: https://doi.org/10.1007/s004210000269.
4. Browne JE, O'hare NJ. Review of the different methods for assessing standing balance. *Physiotherapy*. 2001;87(9):489–495. Available from: https://doi.org/10.1016/S0031-9406(05)60696-7.
5. Torres SF, Reis JG, De Abreu DCC. Influence of gender and physical exercise on balance of healthy young adults. *Fisioterapia em Movimento*. 2014;27(3):399–406. Available from: https://doi.org/10.1590/0103-5150.027.003.AO10.
6. Ageberg E, Roberts D, Holmström E, Fridén T. Balance in single-limb stance in healthy subjects. *BMC Musculoskeletal Disorders*. 2003;4:14. Available from: https://doi.org/10.1186/1471-2474-4-14.
7. Arokoski JP, Valta T, Airaksinen O, Kankaanpää M. Back and abdominal muscle function during stabilization exercises. *Archives of physical medicine and rehabilitation*. 2001;82(8):1089–1098. Available from: https://doi.org/10.1053/apmr.2001.23819.
8. Imai A, Kaneoka K. The Relationship Between Trunk Endurance Plank Tests and Athletic Performance Tests In Adolescent Soccer Players. *Int J Sports Phys Ther*. 2016;11(5):718–724.
9. Joyce D, Lewindon D. High-performance training for sports. 2014.
10. Goswami S, Haldar P, Sahu S. An ergonomic study of postural stress of nurses working in orthopedic wards. *International Journal of Occupational Safety and Health*. 2013;3(1):26–31. Available from: https://doi.org/10.3126/ijosh.v3i1.9097.
11. Denis S, Shannon HS, Wessel J, Stratford P, Weller I. Association of Low Back Pain, Impairment, Disability & Work Limitations in Nurses. *Journal of Occupational Rehabilitation*. 2007;17(2):213–226. Available from: https://doi.org/10.1007/s10926-007-9065-4.
12. Kuznetsov NA, Luberto CM, Avallone K, Kraemer K, Mcleish AC, Riley MA. Characteristics of postural control among young adults with asthma. *Journal of Asthma*. 2015;52(2):191–197. Available from: https://doi.org/10.3109/02770903.2014.954290.
13. Wikstrom EA, Tillman MD, Smith AN, Borsa PA. A new force-plate technology measure of dynamic postural stability: the dynamic postural stability index. *J Athl Train*. 2005;40(4):305–309. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1323292/.
14. Alshehre Y, Alkhathami K, Brizzolara K, Weber M, Wang-Price S. Reliability and Validity of the Y-balance Test in Young Adults with Chronic Low Back Pain. *Int J Sports Phys Ther*. 2021;16(3):628–635. Available from: https://doi.org/10.26603/001c.23430.
15. Downs S, Marquez J, Chiarelli P. The Berg Balance Scale has high intra- and inter-rater reliability but absolute reliability varies across the scale: a systematic review. *Journal of Physiotherapy*. 2013;59(2):93–99. Available from: https://doi.org/10.1016/s1836-9553(13)70161-9.
16. Adlerton AK, Moritz U. Does calf-muscle fatigue affect standing balance? *J Med Sci Sports*. 1996;6(4):211–216. Available from: https://doi.org/10.1111/j.1600-0838.1996.tb00093.x.
17. Ghroubi S, Jribi S, Jdidi J, Yahia A, Elleuch W, Chaaben M, et al. Study of the validity and reproducibility of the Biering-Sorensen test in chronic low back pain. *Annals of Physical and Rehabilitation Medicine*. 2015;58:e88. Available from: https://doi.org/10.1016/j.rehab.2015.07.215.
18. Champagne A, Descarreaux M, Lafond D. Comparison between elderly and young males' lumbopelvic extensor muscle endurance assessed during a clinical isometric back extension test. *J Manipulative Physiol Ther*. 2009;32(7):521–527. Available from: https://doi.org/10.1016/j.jmpt.2009.08.008.
19. Kahlaee AH, Bahrpeyma F, Esteki A. The effect of fatigue and instability on postural control parameters in standing posture in healthy adults and patients with chronic low back pain. *Zahedan Journal of Research in Medical Sciences*. 2012;14(6):17–22.
20. Dejanovic A, Harvey EP, Mcgill SM. Changes in torso muscle endurance profiles in children aged 7 to 14 years: reference values. *Archives of physical medicine and rehabilitation*. 2012;93(12):2295–2301. Available from: https://doi.org/10.1016/j.apmr.2011.12.023.
21. Mandal S, Roy B, Saha GC. A relationship study between trunk muscle endurance with static and dynamic balance in female collegiate students. *International journal of physical education, sports and health*. 2017;4:382–384.
22. Barati A, Safarcherati A, Aghayari A, Azizi F, Abbasi H. Evaluation of Relationship between Trunk Muscle Endurance and Static Balance in Male Students. *Asian Journal of Sports Medicine*. 2013;4(4):289–294. Available from: https://doi.org/10.5812/asjsm.34250.
23. Shaffer SW, Teyhen DS, Lorenson CL, Warren RL, Koreerat CM, Straseske CA, et al. Y-balance test: a reliability study involving multiple raters. *Mil Med*. 2013;178(11):1264–1270. Available from: https://doi.org/10.7205/milmed-d-13-00222.
24. Neves LF, Souza CQ, Stoffel M, Picasso CL. The Y balance test-how and why to do it. *International Physical Medicine & Rehabilitation Journal*. 2017;2(4):58. Available from: https://doi.org/10.15406/ipmrj.2017.02.00058.
25. Laratta JL, Glassman SD, Atanda AA, Dimar JR, Gum JL, Crawford CH, et al. The Berg balance scale for assessing dynamic stability and balance in the adult spinal deformity (ASD) population. *J Spine Surg*. 2019;5:451–456. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6989922/.
26. Joshi SM, Sheth MS, Jayswal MM. Correlation of core muscles endurance and balance in subjects with osteoarthritis knee. *International Journal of Medical Science and Public Health*. 2019;8(5):347–351. Available from: https://doi.org/10.5455/ijmsph.2019.0102108032019.
27. Ozmen T. Relationship between core stability, dynamic balance and jumping performance in soccer players. *Turkish Journal of Sport and Exercise*. 2016;18(1):110–113. Available from: https://doi.org/10.15314/tjse.93545.
28. Krishna HS, Shetty S, Raj AS. Relationship between core endurance and dynamic balance in college level football players: A pilot study. *Int J Phys Educ Sports Health*. 2020;7(5):149–153.
29. Behennah J, Conway R, Fisher J, Osborne N, Steele J. The relationship between balance performance, lumbar extension strength, trunk extension endurance, and pain in participants with chronic low back pain, and those without. *Clinical Biomechanics*. 2018;53:22–30. Available from: https://doi.org/10.1016/j.clinbiomech.2018.01.023.
30. Helbostad JL, Sturnieks DL, Menant J, Delbaere K, Lord SR, Pijnappels M. Consequences of lower extremity and trunk muscle fatigue on balance and functional tasks in older people: A systematic literature review. *BMC Geriatrics*. 2010;10(56). Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2936909/.
31. Joy A, Baby L, Kv R. Relationship of trunk extensor endurance on dynamic postural control and functional performance in non-specific low back pain. *International Journal of Physical Education, Sports and Health*. 2021;8(3):436–440. Available from: http://dx.doi.org/10.22271/kheljournal.2021.v8.i3g.2121.