ISSN Print: 2664-7591
ISSN Online: 2664-7605
Impact Factor: RJIF 5.2
IJAN 2024; 6(2): 87-92
www.pharmaceuticaljournal.in
Received: 15-08-2024
Accepted: 21-09-2024

Kubal Swati
Assistant Professor,
PT School & Centre, TNMC,
Mumbai Central, Mumbai,
Maharashtra, India

Mohite Akanksha
MPT, PT School & Centre,
TNMC, Mumbai Central,
Mumbai, Maharashtra, India

Lokwani Mahek
2nd Year MPT,
PT School & Centre, TNMC,
Mumbai Central, Mumbai,
Maharashtra, India

Corresponding Author:
Kubal Swati
Assistant Professor,
PT School & Centre, TNMC,
Mumbai Central, Mumbai,
Maharashtra, India

The relationship between core endurance and balance in premenopausal nursing population

Kubal Swati, Mohite Akanksha and Lokwani Mahek

DOI: https://doi.org/10.33545/26647591.2024.v6.i2b.110

Abstract
Objectives: To study the relationship between core endurance and balance in the premenopausal nursing population.
Materials and Methods: Materials required for this study included Adjustable plinth, Jig, Straps, Adhesive tapes, Stopwatch, Scale, Measuring tape. It was an observational analytical study on 75 primary premenopausal nurses between the age group of 30 – 40 years. We excluded any individual with lower extremity injury, any neurological or musculoskeletal condition affecting balance, class 2 and class 3 obesity, participants who couldn't attain McGill core endurance test postures and the ones who couldn't maintain single leg stance for at least 5 seconds. After obtaining a written consent, the participants were assessed for core endurance using The McGill core endurance tests and for balance using Star Excursion Balance Test (Y balance). It took approximately 30 minutes to complete. Data was collected and analyzed for Normality using Kolmogorov- Smirnov normality test. As the data did not pass normality, Spearman's correlation coefficient test was used to find the relationship between core endurance and balance in premenopausal nursing population.
Results: It was observed that there is a positive non-significant relationship between core endurance (Flexor, extensor, dominant and non-dominant side bridge) and balance (Anterior, postero medial, posterolateral CRDS scores) of bilateral lower limbs.

Keywords: Star excursion balance test, composite reach distance score, core endurance

Introduction

The core plays an important role as it stabilizes the lower extremity and knee movements during activity [1]. Core is also described as a foundation of kinetic chain which facilitates the transfer of torque and momentum between upper and lower extremities for gross motor tasks of daily living, for exercises, sports, etc. [2]. The core also known as the lumbopelvic hip complex is considered as a three-dimensional muscular box with muscular boundaries [3]. Superiorly- Diaphragm, Inferiorly- Pelvic floor and hip girdle musculature, Anteriorly- Abdominals, Posteriorly- Para spinal and gluteal muscles. The inherent nature of these muscles produces a corset-like stabilization effect on trunk and spine [4]. The transverse abdominis / internal oblique acts key dynamic stabilizers of the spine and lumbopelvic region during reaction based tasks like running [5]. The rectus abdominis, external oblique and erector spinae control the trunk position in the base of support. In the lower body movements, the transversus abdominis is the first muscle activated [6].

"Muscle Endurance" is the ability of a muscle to contract repeatedly to generate tension, sustain that tension, and resist fatigue over a prolonged period of time [7]. Core endurance is the most crucial component of core training as it supports the core muscles to maintain an effective trunk position [8]. Although core muscle strength is necessary for activities, it is suggested that its core endurance which has a very important role in spinal stability during prolonged physical activity and protects from injury [9-10]. Rapid fatigue of core musculature indicates poor stability. Therefore, the total amount of time a person is able to maintain a static body position that involves loading of core musculature maybe valuable to quantify the risk of injury to the core and lower extremity [11].

"Balance" is the condition in which all the forces acting on the body are balanced such that the center of mass lies within the stability limits in the boundaries of the base of support [12]. "Dynamic balance" refers to the potential reactions of the motor system where an individual is able to cope with the quick alterations of body segments while performing activities that

add stress to the joints [13]. Deficits in the neuromuscular postural stability or balance have also been suggested to cause lower extremity injury risk [14]. The Star Excursion Balance Test (SEBT) is a measure of dynamic balance. The original version is composed of 8 lines extending 45 degrees from the center of a grid made with an adhesive tape on the floor. Hertel *et al*. reported redundancy of some of the directions and proposed a shorter version, which includes the Anterior, Posteromedial and Posterolateral directions. Intra- rater reliability (ICC=0.84-0.87) and test- retest reliability (ICC=0.89-0.93) have been reported. There is also literature to support the construct and predictive validity of SEBT, although no gold standard exists to measuring dynamic balance [15].

The nursing population constitutes about 33% of the hospital workplace and is at a high risk of 60% of occupational injuries [16]. Menopause refers to the permanent cessation of menstruation at the end of reproductive life due to loss of ovarian follicular activity. It is the point when the last and final menstruation occurs.

The clinical diagnosis is confirmed when menstruation has ceased for twelve consecutive months, and there is no presence of any other underlying pathology. Premenopausal refers to the period prior to menopause and post menopause is the period after menopause [17]. Postural stability and balance decreases with age. Loss of balance and increased sway are important risk factors causing falls in post-menopausal women. Bone mineral density reduction and structural integrity deterioration result in an increased risk of osteoporosis in women. Although the muscular and skeletal systems are structurally independent, low mineral density affects posture and center of gravity that hinders balance [18].

The relationship between core endurance and balance has been found to be mild to moderate in subjects with osteoarthritis of knee and low back pain which are prevalent in nursing population [19]. Menopause and aging is associated with loss of strength [20]. and endurance which further causes loss of balance and gait disorders [21]. But there are only few studies conducted in the premenopausal nursing population.

Thus, it is important to identify whether there is any relationship between core endurance and balance in premenopausal nursing population

Methods

Materials required for this study were Adjustable plinth, Jig, Straps, Adhesive tapes, Stopwatch, Scale, Measuring tape. The study design employed an observational, analytical study and sampling method was convenience sampling. Patients included in this study were 75 Female premenopausal nurses in Tertiary care hospital aged between 30-40 years, with more than 5 years of clinical experience and BMI ≤ 34.9.

Patients were excluded from the study if they had the following conditions: a) Lower extremity injury, b)Any neurological or musculoskeletal condition affecting their mobility and balance, c) Participants who cannot perform single leg stance for 5 seconds. d) Hysterectomy, e) Class 2 and class 3 obesity.[22] Approval from the Departmental Review Board and Institutional Ethics Committee (IEC) was sought. The data collection was commenced after the approval from Ethics Committee and Maharashtra University of Health Sciences (MUHS). Subjects were screened according to the eligibility criteria. A written informed consent (ICD) was taken. The subjects were given an information sheet which include the details of the study.

Core endurance was determined using McGill core endurance tests after demonstrating and giving a trial test prior to performing the actual test. Each test followed by rest interval. Balance was evaluated using Star Excursion Balance Test (SEBT). Data was collected and appropriate statistical analysis was performed for the same.

McGill Core Endurance tests- (Reliability coefficient of >0.97) [23]

The test consists of four positions: The trunk anterior flexor test, the right and left lateral plank and the trunk Posterior Extensor test [24].

Prior to the test

- Instructions for the McGill core endurance test were given.
- All the McGill Core Endurance tests were demonstrated to the participants and a practice trial test was taken prior to the actual test.
- Appropriate rest interval was given between each test.
- The participants were advised to maintain the test positions as long as possible.
- In case of fatigue, the participants were told to rest immediately to the given support.

Flexor Endurance test

It was used to assess the anterior core musculature-Rectus abdominis. The test began with the participant in a sit up position with the back resting against a jig angled at 60° from the floor. Both the knees and hips are flexed to 90°, the arms folded across the chest with the hands placed on the opposite shoulders and the feet are secured. To begin, the jig was pulled back 10 cm and the person holds the isometric posture as long as possible. The duration for which the participant can maintain this position was recorded in seconds using a stopwatch. Failure was determined when any part of the person's back touched the jig.

Fig 1: McGill flexor endurance test

Extensor Endurance test

The test was used to assess the posterior core musculature-erector spinae and multifidus. The test began with the participant lying prone on a low plinth with the lower body fixed to the examination table till the ASIS and the hips and upper body extended over the edge of the table provided with a stool to rest the upper limbs in case of fatigue. The participants were asked to maintain the horizontal position with arms crossed over the chest for as long as possible.

Failure was determined when upper body drops below the horizontal position.

Fig 2: McGill extensor endurance test

Side Bridge Endurance test

The test was used to assess the lateral core musculature- obliques, transverse abdominals and quadrates lumborum.. The test began with the person lying in the full side bridge position, first on the dominant and then on the non-dominant side. The legs are extended and the top foot is placed in the front of the lower foot for support. Participants supported themselves on one elbow and on their feet while lifting their hips off the floor to form a straight line from head to toe. The uninvolved arm is held across the chest with the hand on the opposite shoulder or on the hips.

Fig 3: McGill side bridge endurance test

Star excursion balance test- (Interrated reliability (0.84 to 0.87) and test-retest reliability (0.89 TO 0.93) [25]

Prior to the test

- Instructions for the Star Excursion Balance test were given.
- Test was demonstrated to the participants and a practice trial test was taken before the actual test.
- The participants were advised to reach as far as possible in all the directions.
- Report any discomfort or fatigue if occurs.

It is a measure of dynamic balance. SEBT has 8 components, 45° from each other. The shorter reductant version will be used to assess the dynamic balance- Y balance test [26]. The directions were constructed by affixing 3 tape measures with a centimeter scale on the floor. The first reach direction was aligned anterior to the apex and the other was 135° to the first in posteromedial and posterolateral direction [27]. The limb length of the subjects was measured from the ASIS to the medial malleolus.[28] Starting position- the lateral malleolus is positioned at the intersection of the 3 directions with the foot's longitudinal axis oriented at the anterior direction with the hands placed on the hips. Maintaining a single leg stance the participants reached out as far as possible with nonstance limb along the marked tape. The distal most point reached by the great toe was marked. This was followed by recording 3 successful trials in each direction with both legs, always with 10 sec rest between each test [28].

Composite Reach Distance Score [29]

$$= \frac{\text{sum of mean of mean reach distance of 3 trials in 3 directions}}{3 \times \text{limb length}} \times 100$$

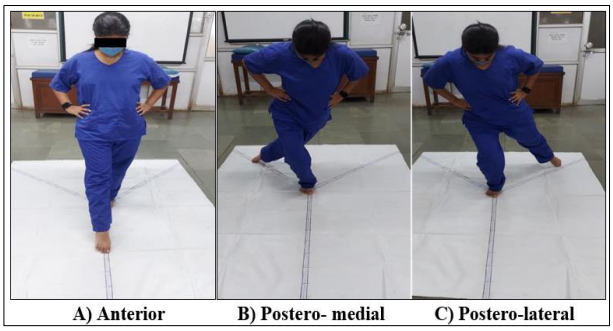

Fig 4: Star Excursion Balance test

Data Analysis

Data was analyzed using Graph Pad Prism (Version 9.2.0 July 15, 2021). The data was tested for normality using Kolmogorov – Smirnov normality test. As data did not pass the normality, correlation was measured using a non-parametric test, i.e. Spearman correlation to find the relationship between Core endurance and CRDS score of balance.

Results

Table 1: Demographic data

	Age	Clinical Experience	Weight	Height	BMI	Right limb Length	Left Limb Length
Number of Values	75	75	75	75	75	75	75
Minimum	30	5	40	1.25	16.1	73	73
Maximum	40	21	80	1.67	34.6	98	98
Range	10	16	40	0.42	18.4	25	25
Mean	35.2	13.3	59	1.53	25.4	84.2	84.3
Std. Deviation	3.96	4.56	8.87	0.0839	4.31	5.21	5.12
Std. Error of Mean	0.457	0.526	1.02	0.00968	0.497	0.601	0.591

Table 1: Correlation between McGill

Flexor endurance and Right CRDS	
Spearman r	
R	0.1941
95% confidence interval	-0.04115 to 0.4090
P value	
P (two-tailed)	0.0951
P value summary	Ns
Exact or approximate P value?	Approximate
Significant? (alpha = 0.05)	No
Number of XY Pairs	75

Table 2: Correlation between McGill extensor endurance and Right CRDS

Extensor endurance and Right CRDS	
Spearman r	
R	0.13
95% confidence interval	-0.1067 to 0.3527
P value	
P (two-tailed)	0.2663
P value summary	Ns
Exact or approximate P value	Approximate
Significant? (alpha = 0.05)	No
Number of XY Pairs	75

Table 3: Correlation between McGill dominant side bridge and Right CRDS

Dominant side bridge and Right CRDS	
Spearman r	
R	0.1921
95% confidence interval	-0.04327 to 0.4073
P value	
P (two-tailed)	0.0987
P value summary	Ns
Exact or approximate P value?	Approximate
Significant? (alpha = 0.05)	No
Number of XY Pairs	75

Table 4: Correlation between non-dominant side bridge and Right CRDS

Non dominant side bridge and Right CRDS	
Spearman r	
R	0.115
95% confidence interval	-0.1216 to 0.3394
P value	
P (two-tailed)	0.3257
P value summary	ns
Exact or approximate P value?	Approximate
Significant? (alpha = 0.05)	No
Number of XY Pairs	75

Table 5: Correlation between McGill flexor endurance and Left CRDS

Flexor endurance and Left CRDS	
Spearman r	
R	0.07499
95% confidence interval	-0.1613 to 0.3031
P value	
P (two-tailed)	0.5225
P value summary	Ns
Exact or approximate P value?	Approximate
Significant? (alpha = 0.05)	No
Number of XY Pairs	75

Table 6: Correlation between McGill extensor endurance and Left CRDS

Extensor endurance and Left CRDS	
Spearman r	
R	0.06227
95% confidence interval	-0.1737 to 0.2915
P value	
P (two-tailed)	0.5956
P value summary	Ns
Exact or approximate P value?	Approximate
Significant? (alpha = 0.05)	No
Number of XY Pairs	75

Table 7: Correlation between McGill dominant side bridge and Left CRDS

Dominant side bridge and Left CRDS	
Spearman r	
R	0.05532
95% confidence interval	-0.1804 to 0.2851
P value	
P (two-tailed)	0.6374
P value summary	ns
Exact or approximate P value?	Approximate
Significant? (alpha = 0.05)	No
Number of XY Pairs	75

Table 8: Correlation between McGill non-dominant side bridge and Left CRDS

Non Dominant side bridge and Left CRDS	
Spearman r	
r	0.03782
95% confidence interval	-0.1974 to 0.2689
P value	
P (two-tailed)	0.7474
P value summary	ns
Exact or approximate P value?	Approximate
Significant? (alpha = 0.05)	No
Number of XY Pairs	75

The study examined correlations between core endurance tests and balance in both right and left lower limbs. For the right lower limb, no significant correlations were found between flexor endurance (r = 0.1941, p = 0.0951), extensor endurance (r = 0.13, p = 0.2663), dominant side bridge endurance (r = 0.1921, p = 0.0987), and non-dominant side bridge endurance (r = 0.115, p = 0.3257). Similarly, for the left lower limb, no significant correlations were observed for flexor endurance (r = 0.07499, p = 0.5225), extensor endurance (r = 0.06227, p = 0.5956), dominant side bridge endurance (r = 0.05532, p = 0.6374), and non-dominant side bridge endurance (r = 0.03782, p = 0.7474). In summary, the study found no significant correlation between core endurance and balance in either lower limb.

Discussion

This study was conducted on 75 premenopausal nurses in a tertiary care hospital. All the subjects in the study were females with the mean age of 35.2 years and minimum 5 years of clinical experience. Out of total 75 subjects, 41.33% were Overweight, 37.33% were within normal BMI, 13.33% were Grade 1 obese, and 8% were underweight.

The nursing population contributes about 33% of hospital workspace and is at a high risk of 60% of the occupational injuries [16].

Various studies have shown the main occupational risk factor associated with low back pain in nurses are lifting and moving patients, sustained postures, job organization, poor ergonomic structures, improper work design, low social support, poor job satisfaction, staff shortage and working condition [30].

In our study, we assessed core endurance of the subjects using McGill core endurance tests. The study participants' flexor score was 47.79±34.94 (Seconds), extensor score was 31.61±31.61 (Seconds), Dominant Side Bridge score was 22.19±16.95 (Seconds), and non-dominant side bridge score was 22.41±13.92 (Seconds). The participants score had large standard deviation possibly due to the nature of the test that allowed the participants to use different strategies to maintain test position.

In our study the balance of the participants was assessed using Star Excursion Balance test (Y balance test). The mean reach distance of Right lower limb was found out to be 60.24 cm in anterior direction, 54.70 cm in posteromedial direction and 60.08 cm in posterolateral direction.

Similarly, the mean reach distance of left lower limb was found out to be 59.21cm in anterior direction, 54.68cm in posteromedial direction and 58.88cm in posterolateral direction. There was not much difference between the Right and left distance scores. The anterior reach distance score was seen to be highest among the 3 directions. The possible explanation for this is can be because of less availability of hip extension in posterior direction and feedback mechanism. The visual system provides the body with visual cues for use as a reference point to keep the body oriented in space. In normal conditions, it is reported that somatosensory and visual subsystems are primary mediators of balance and postural awareness [31]. In the anterior direction, the participant receives visual feedback from the reach leg and one can observe the distance reached in each trial. However, in posteromedial and posterolateral directions the visual awareness is reduced.

Therefore, resulting in decreased reach distance as the visual feedback is reduced.

There was no significant difference between posteromedial and posteromedial Composite Reach Distance Scores. This is in agreement with a study done by Coughlan *et al.* (2012) [32].

The mean Composite Reach distance score (CRDS) of Right lower limb was 69.19% and that of left lower limb was 68.28%. There is no significant difference between Right and left CRDS which is in agreement with a study done by Coughlan *et al.* (2012).These observations may be due to postural control strategies used to complete the dynamic balance tasks [32].

The objective of our study was to find the relationship between core endurance and balance in premenopausal nursing population. The results showed positive non-significant relationship between core endurance and balance.

The compensatory mechanisms for reduced Core endurance may have influenced the results of our study. For example, compensatory factors like flexibility of the joints, strength of the muscles and neuromuscular control of the joints.

Theoretically, the greater the core muscle strength and endurance, the less the body will have to compensate to maintain stability during the perturbation and performing movements. However, our study failed to find any significant relationship between core endurance and balance. The study findings are in agreement with another report of a study done by Ambegaonkar *et al.*, (2016) who found that there is no correlation between core endurance and balance in female collegiate dancers [33]. A Similar study was done by Jatin P. Ambegaonkar *et al.*, (2014) who found that no correlation exits between core endurance and balance in collegiate female athletes [34]. In contrast, SM Joshi *et al.*, (2019) in their study found that there was a weak to moderate correlation between core endurance and balance in subjects with osteoarthritis of knee [19]. The difference between these observations may partly be due to different measures used to assess the core function and stability which were used in different studies and the lack of consensus in how to measure core stability in all the research. Ambegaonkar *et al.*, (2016) used the anterior plank test, right and left plank test to assess core endurance. Both McGill core endurance tests and planks tests require participants to maintain core stability in static position. Core stability exists in continuum where the core muscles must produce increasing amount of force over decreasing amount of time from core endurance to strength to power [35]. The measures used in our study and by Ambegaonkar *et al.* (2016), were closer to core endurance spectrum while the ones used in Zazulak *et al.* (2007) were closer to core power spectrum [36]. Thus, it appears that the core power and neuromuscular control may be more influential in maintaining lower extremity stability and balance than the core endurance [37].

Conclusion

In this study we concluded the following points

There is a positive non-significant relationship between core endurance and balance of bilateral lower limb in premenopausal nursing population. Various compensatory mechanisms may have influenced the results of the study.

References

1. Borghuis J, Hof AL, Lemmink KA. The importance of sensory-motor control in providing core stability. Sports Med. 2008 Nov 1;38(11):893-916.
2. Butowicz CM, Ebaugh DD, Noehren B, Silfies SP. Validation of two clinical measures of core stability. Int. J Sports Phys. Ther. 2016 Feb;11(1):15-23.
3. Akuthota V, Nadler SF. Core strengthening. Arch Phys. Med Rehabil. 2004 Mar 1;85(3-1):86-92.
4. Akuthota V, Ferreiro A, Moore T, Fredericson M. Core stability exercise principles. Curr Sports Med Rep. 2008 Jan 1;7(1):39-44.
5. Smith CE, Nyland J, Caudill P, Brosky J, Caborn DN. Dynamic trunk stabilization: a conceptual back injury prevention program for volleyball athletes. J Orthop Sports Phys Ther. 2008 Nov;38(11):703-720.
6. Key J. 'The core': understanding it, and retraining its dysfunction. J Bodyw Mov Ther. 2013 Oct 1;17(4):541-559.
7. Hodges PW, Richardson CA. Contraction of the abdominal muscles associated with movement of the lower limb. Phys Ther. 1997 Feb 1;77(2):132-142.
8. Kulas AS, Schmitz RJ, Shultz SJ, Henning JM, Perrin DH. Sex-specific abdominal activation strategies during landing. J Athl Train. 2006 Oct;41(4):381-386.
9. Zazulak BT, Hewett TE, Reeves NP, Goldberg B, Cholewicki J. The effects of core proprioception on knee injury: A prospective biomechanical-

epidemiological study. Am J Sports Med. 2007 Mar;35(3):368-373.
10. Huxel Bliven KC, Anderson BE. Core stability training for injury prevention. Sports Health. 2013 Nov;5(6):514-522.
11. Holmström E, Moritz U, Andersson M. Trunk muscle strength and back muscle endurance in construction workers with and without low back disorders. Scand J Rehabil Med. 1992;24(1):3-10.
12. O'Sullivan SB, Schmitz TJ, Fulk G. Physical rehabilitation. Philadelphia (PA): FA Davis; c2019 Jan 25.
13. Chevidikunnan MF, Al Saif A, Gaowgzeh RA, Mamdouh KA. Effectiveness of core muscle strengthening for improving pain and dynamic balance among female patients with patellofemoral pain syndrome. J Phys Ther Sci. 2016;28(5):1518-1523.
14. Olmsted LC, Carcia CR, Hertel J, Shultz SJ. Efficacy of the star excursion balance tests in detecting reach deficits in subjects with chronic ankle instability. J Athl Train. 2002 Oct;37(4):501-506.
15. Appiah-Dwomoh E, Müller S, Hadzic M, Mayer F. Star Excursion Balance Test in young athletes with back pain. Sports (Basel). 2016;4(3):44.
16. Tinubu BM, Mbada CE, Oyeyemi AL, Fabunmi AA. Work-related musculoskeletal disorders among nurses in Ibadan, South-west Nigeria: a cross-sectional survey. BMC Musculoskelet Disord. 2010 Dec;11(1):12.
17. Dutta DC. D C Dutta's Textbook of Gynecology and Textbook of Obstetrics. J Obstet Gynaecol India. 2016 Aug;66(4):303-304.
18. Cangussu LM, Nahas-Neto J, Nahas EA, *et al*. Evaluation of postural balance in postmenopausal women and its relationship with bone mineral density: a cross-sectional study. BMC Musculoskelet Disord. 2012 Jan 4;13(1):2.
19. Joshi SM, Sheth MS, Jayswal MM. Correlation of core muscles endurance and balance in subjects with osteoarthritis knee. Int J Med Sci Public Health. 2019 Mar;8(5):384.387.
20. Phillips SK, Rook KM, Siddle NC, Bruce SA, Woledge RC. Muscle weakness in women occurs at an earlier age than in men, but strength is preserved by hormone replacement therapy. Clin Sci. 1993 Jan;84(1):95-98.
21. American College of Sports Medicine. Position stand on osteoporosis and exercise. Med Sci Sports Exerc. 1995;27.
22. Garvey WT, Mechanick JI, Brett EM, *et al*. American Association of Clinical Endocrinologists and American College of Endocrinology comprehensive clinical practice guidelines for medical care of patients with obesity. Endocr Pract. 2016;22 (Suppl 3):1-203.
23. McGill SM, Childs A, Liebenson C. Endurance times for low back stabilization exercises: Clinical targets for testing and training from a normal database. Arch Phys Med Rehabil. 1999 Aug;80(8):941-944.
24. Nesser TW, Huxel KC, Tincher JL, Okada T. The relationship between core stability and performance in division I football players. J Strength Cond Res. 2008 Nov;22(6):1750-1754.
25. Olmsted LC, Carcia CR, Hertel J, Shultz SJ. Efficacy of the star excursion balance tests in detecting reach deficits in subjects with chronic ankle instability. J Athl Train. 2002 Oct;37(4):501-506.
26. Hertel J, Braham RA, Hale SA, Olmsted-Kramer LC. Simplifying the star excursion balance test: analyses of subjects with and without chronic ankle instability. J Orthop Sports Phys Ther. 2006 Mar;36(3):131-137.
27. Coughlan GF, Fullam K, Delahunt E, Gissane C, Caulfield BM. A comparison between performance on selected directions of the star excursion balance test and the Y balance test. J Athl Train. 2012 Jul;47(4):366-371.
28. Magee DJ. Orthopedic physical assessment. Philadelphia (PA): Elsevier Health Sciences; c2013 Dec 4.
29. Holden S, Boreham C, Doherty C, Wang D, Delahunt E. Dynamic postural stability in young adolescent male and female athletes. Pediatr Phys Ther. 2014 Dec;26(4):447-452.
30. Al Dajah S, Al Daghdi A. Prevalence and risk factors of low back pain among nurses in Sudayr region. Eur Sci J. 2013;9(33):198-205.
31. Riemann BL, Lephart SM. The Sensorimotor System, Part II: The Role of Proprioception in Motor Control and Functional Joint Stability. J Athl Train. 2002;37(1):80-84.
32. Coughlan GF, Fullam K, Delahunt E, Gissane C, Caulfield BM. A comparison between performance on selected directions of the star excursion balance test and the Y balance test. J Athl Train. 2012 Jul;47(4):366-371.
33. Ambegaonkar JP, Cortes N, Caswell SV, Ambegaonkar GP, Wyon M. Lower extremity hypermobility, but not core muscle endurance influences balance in female collegiate dancers. Int J Sports Phys Ther. 2016 Apr;11(2):220-229.
34. Ambegaonkar JP, Mettinger LM, Caswell SV, Burtt A, Cortes N. Relationships between core endurance, hip strength, and balance in collegiate female athletes. Int J Sports Phys Ther. 2014 Oct;9(5):604-616.
35. Rickman AM, Ambegaonkar JP, Cortes N. Core stability: implications for dance injuries. Med Probl Perform Art. 2012 Sep;27(3):159-164.
36. Zazulak BT, Hewett TE, Reeves NP, Goldberg B, Cholewicki J. Deficits in neuromuscular control of the trunk predict knee injury risk: A prospective biomechanical-epidemiologic study. Am J Sports Med. 2007 Jul;35(7):1123-1130.
37. Benis R, Bonato M, La Torre A. Elite female basketball players' body-weight neuromuscular training and performance on the Y-Balance Test. J Athl Train. 2016;51(9):688-695.