RESEARCH PAPER

"AN EXPERIMENTAL STUDY TO ASSESS THE IMPACT OF DIAPHRAGMATIC BREATHING EXERCISES ON CORE STABILITY, BALANCE, AND INJURY RISK IN COMPETITIVE ATHLETES"

[1]Vaishnav Vilasrao Shende, [2]Dr. Sourabh Soni, [3]Parul Sharma, [4]Dr. Jafar Khan, [5]Dr. Renuka Pal, [6]Dr. Farukh Mohammad Pinjara, [7]Dr. Divya Tiwari, [8]Dr. Payal Sharma, [9]Laxmi Gupta, [10]Sakshi Agarwal

[1]M.P.Th. scholar, Pacific college of Physiotherapy, Pacific medical university, Udaipur, Rajasthan
[2] Assistant Professor, Pacific college of Physiotherapy, Pacific medical university, Udaipur, Rajasthan
[3]M.P.Th. scholar, Pacific college of Physiotherapy, Pacific medical university, Udaipur, Rajasthan
[4]Dean & HOD, Pacific college of Physiotherapy, Pacific medical university, Udaipur, Rajasthan
[5]Professor, Pacific college of Physiotherapy, Pacific medical university, Udaipur, Rajasthan
[6]Professor, Pacific college of Physiotherapy, Pacific medical university, Udaipur, Rajasthan
[7]Professor, Pacific college of Physiotherapy, Pacific medical university, Udaipur, Rajasthan
[8]Assistant Professor, Pacific college of Physiotherapy, Pacific medical university, Udaipur, Rajasthan
[9]M.P.Th. scholar, Pacific college of Physiotherapy, Pacific medical university, Udaipur, Rajasthan
[10]M.P.Th. scholar, Pacific college of Physiotherapy, Pacific medical university, Udaipur, Rajasthan

ABSTRACT

Background and objective:

Core stability and dynamic balance are essential components of athletic performance and are important modifiable factors associated with sports injury risk. The diaphragm contributes to trunk stability through regulation of intra-abdominal pressure and coordination with the deep core musculature. However, the effect of diaphragmatic breathing exercises on core stability and dynamic balance in competitive athletes remains insufficiently explored. To assess the effect of diaphragmatic breathing exercises on core stability and dynamic balance in competitive athletes, with potential implications for injury-risk-related factors.

Methods:

An experimental study was conducted among 60 competitive athletes aged 18–30 years. Participants were randomly allocated into an experimental group (n=30) and a control group (n=30). The experimental group performed diaphragmatic breathing exercises integrated with routine training for 20–30 minutes per session, 3–4 sessions per week for 6–8 weeks, whereas the control group continued routine training without specific diaphragmatic breathing instruction. Core stability was assessed using the McGill Trunk Endurance Test, comprising trunk flexor endurance, trunk extensor endurance, right side plank, and left side plank tests. Dynamic balance was assessed using the Y-Balance Test/Star Excursion Balance Test. Pre- and post-intervention outcomes were analyzed using Paired and unpaired t –tests, with $p<0.05$ considered statistically significant.

Results:

The experimental group demonstrated significant improvements in all components of the McGill Trunk Endurance Test and dynamic balance ($p<0.001$). Flexor endurance increased from 30.2±2.5 to 50.4±3.1 seconds, extensor endurance from 40.3±3.0 to 66.8±3.5 seconds, right side plank from 25.1±2.2 to 45.7±2.8 seconds, and left side plank from 24.2±2.1 to 44.6±2.6 seconds. The total McGill score increased from 119.8±5.2 to 207.5±7.1. The Y-Balance Test score improved from 88.5±1.5 to 96.8±1.8 ($p<0.001$). Although the control group also showed significant improvements, the experimental group demonstrated significantly greater post-intervention improvements across all measured outcomes ($p<0.001$).

Conclusion: The study concluded that diaphragmatic breathing are highly effective in improving core stability and dynamic balance in competitive athletes. The experimental group demonstrated significantly greater improvements in all components of the McGill Trunk Endurance Test and Y-Balance Test compared to the control group.

Keywords:

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INTRODUCTION:

Core stability and dynamic balance are essential components of athletic performance and injury prevention. Competitive athletes are exposed to repetitive and high-intensity physical demands that require adequate strength, endurance, coordination, and postural control. Poor core stability and impaired balance may affect movement efficiency and increase the risk of sports-related injuries.

Core stability refers to the ability to control the position and movement of the trunk and pelvis during functional activities. It involves the coordinated contribution of the abdominal muscles, multifidus, diaphragm, pelvic floor, and other trunk musculature. In athletes, adequate trunk muscular endurance and neuromuscular control are important for maintaining spinal stability, efficient force transmission, and optimal movement patterns.

Although the diaphragm is primarily involved in respiration, it also contributes to trunk stability through regulation of intra-abdominal pressure. The diaphragm works synergistically with the abdominal and pelvic floor muscles to provide postural and spinal stability. Diaphragmatic breathing may therefore influence trunk muscle activation, spinal stability, and movement efficiency. Appropriate diaphragmatic activation has also been associated with postural stability and postural control.

Dynamic balance is particularly important in competitive sports because athletes frequently perform rapid movements, changes in direction, acceleration, deceleration, jumping, and landing. The Y-Balance Test/Star Excursion Balance Test is commonly used to assess dynamic balance and functional symmetry, while poor balance has been associated with increased injury risk in athletic populations. Similarly, the McGill Trunk Endurance Test, which evaluates trunk flexor, extensor, and lateral muscle endurance, provides an objective assessment of core stability.

Despite the potential role of diaphragmatic breathing in improving trunk stability and postural control, limited research has examined its effects specifically in competitive athletes. Most existing research has focused on clinical or recreationally active populations. Therefore, incorporating diaphragmatic breathing into conventional athletic training may provide an additional approach for improving core stability and dynamic balance.

Hence, the present study was conducted to assess the impact of diaphragmatic breathing exercises on core stability and balance in competitive athletes, using the McGill Trunk Endurance Test and Y-Balance Test as outcome measures. Improvements in these factors may have potential implications for addressing modifiable factors associated with sports injury risk.

AIM & OBJECTIVES OF THE STUDY

To investigate the impact of diaphragmatic breathing exercises on core stability, balance, and injury risk in competitive athletes.

- To assess the effect of diaphragmatic breathing exercises on core muscle endurance and stability.
- To evaluate changes in static and dynamic balance following diaphragmatic breathing training.
- To determine the role of diaphragmatic breathing in reducing injury risk among competitive athletes

MATERIALS AND METHOD

An experimental study was conducted among 60 competitive athletes aged 18–30 years. Participants were selected according to the predefined inclusion and exclusion criteria of the study. Participants were randomly allocated into two groups: an experimental group (n=30) and a control group (n=30) and Ethical approval was taken from the Institutional Ethical Committee (IEC) of the Pacific Medical College with the registration number - **PMU/IEC/MPT/2025/62.**

All participants were informed about the purpose and procedure of the study, and written informed consent was obtained prior to participation. Confidentiality of participant information was maintained throughout the study.

The experimental group received diaphragmatic breathing exercises along with routine training for 20–30 minutes per session, 3–4 sessions per week for 6–8 weeks. The control group continued their routine athletic training without specific diaphragmatic breathing exercises.

PROCEDURE/INTERVENTION

EXPERIMENTAL GROUP

Intervention — Diaphragmatic Breathing Exercises (DBE) protocol

Therapist training and standardization

- Therapists/physiotherapists delivering DBE undergo a 2-hour training workshop to standardize instructions, hand placements, cueing, timing and progression. A script and video demo are used.

Session format and supervision

- Duration: 20–30 minutes per session.
- Frequency: 3 sessions/week supervised + 2 short home practice sessions (10–15 minutes) on other days. Total: 5 sessions/week equivalence.
- Intervention length: 6–8 weeks (choose 6 or 8 depending on study timeline; be consistent).

Equipment required

- Mat, stopwatch, metronome (or app) for pacing, visual feedback mirror, optional smartphone breathing app (for home practice), diary/logbook.

Baseline education (first session)

- Explain diaphragm anatomy/function and purpose of the exercises. Demonstrate correct posture (neutral spine, slight knee flexion if supine practice) and hand placements (hand on upper chest, one on upper belly) to provide tactile feedback.

Exercise progression and detailed steps

Phase A – Familiarization (Week 1, Sessions 1–3)

1. **Positioning:** supine with knees flexed (hook-lying), neutral pelvis; or seated if supine is uncomfortable.
2. **Hand placement:** non-dominant hand over upper chest, dominant hand over the abdomen (just below costal margin).
3. **Instruction:** "Breathe in slowly through the nose so the hand on your abdomen rises while the hand on your chest stays still; exhale slowly through pursed lips."
4. **Breath timing:** 4 s inhale : 6 s exhale (adjust to participant comfort). Use metronome.
5. **Repetitions:** 8–10 breaths per set, 3 sets with 60–90 s rest. Emphasize minimal upper-chest movement.
6. **Tactile & visual feedback:** therapist corrects chest lift and ensures diaphragm movement.

Phase B – Stabilization (Weeks 2–4)

1. **Positions:** progress to seated → tall kneel → standing.
2. **Integrate pelvic floor cue:** pre-contract pelvic floor lightly at end of exhale (if participant comfortable).
3. **Add gentle core activation:** couple DBE with submaximal transverse abdominis contraction (draw-in) during exhalation (no breath holding).
4. **Dynamic tasks:** perform DBE during slow pelvic tilts, bridges, and single-leg balance holds (10–15 s holds) to encourage co-activation of stabilizers.
5. **Sets/reps:** 3 sets × 10–12 breaths + 4–6 task-specific repetitions.

Phase C – Functional integration (Weeks 5–6/8)

1. **Positions & tasks:** DBE during sport-specific warm-ups, plyometrics, agility runs, loaded lifts (light loads) and dynamic single-leg tasks.
2. **Challenge:** reduce cueing and increase automaticity — participants perform DBE while completing moderate intensity sport tasks.
3. **Respiratory endurance:** perform sustained DBE for 3–5 minutes as part of cool-down.
4. **Progression:** increase task complexity and reduce rest; incorporate quick transitions (e.g., DBE + unanticipated reach).
5. **Daily home program:** 10–15 min session twice daily (morning & night) with diary recording.

Week 1-2: Isometric Exercises of rectus abdominis.

Week 3: Foundation

- **Crunches:** 2-3 sets of 10-15 repetitions.
- **Reverse Crunches:** 2-3 sets of 10-15 repetitions.
- **Pelvic Tilts:** 2-3 sets of 10-15 repetitions.

Week 4: Adding Stability

- **Crunches:** 2-3 sets of 12-18 repetitions.
- **Reverse Crunches:** 2-3 sets of 12-18 repetitions.
- **Plank:** 2-3 sets, hold for 20-30 seconds.

Week 5: Increasing Intensity

- **Crunches with Stability Ball:** 2-3 sets of 12-18 repetitions.
- **Leg Raises:** 2-3 sets of 10-15 repetitions.
- **Plank:** 2-3 sets, hold for 30-45 seconds.

Week 6: Adding Weight

- **Weighted Crunches:** 2-3 sets of 10-15 repetitions.
- **Jackknife Crunches:** 2-3 sets of 10-15 repetitions.
- **Plank:** 2-3 sets, hold for 45-60 seconds

CONTROL GROUP

Continue usual training routines without specific breathing instruction.

- To control attention, control group may receive general stretching sessions of equivalent time (20–30 min, same frequency) that do not include diaphragmatic training.

STATISTICAL ANALYSIS

Prior to inferential analysis, the distribution of data was assessed for normality using appropriate tests such as the Shapiro-Wilk test. Since the data followed a normal distribution ($p > 0.05$), parametric tests were applied for further analysis.

Statistical analysis was performed using paired t-tests for within-group comparisons and unpaired t-tests for between-group comparisons, with the level of significance set at $p < 0.05$.

RESULTS

A total of 60 competitive athletes were included in the present study. All participants fulfilled the predicted inclusion and exclusion criteria and completed the assessment and were equally divided into two groups: An experimental group (n = 30) and a control group (n=30). The outcome measures analyzed in this study included components of the McGill Trunk Endurance Test (flexor endurance, extensor endurance, right and left side plank), total McGill score, and the Y-Balance Test.

DEMOGRAPHIC DATA

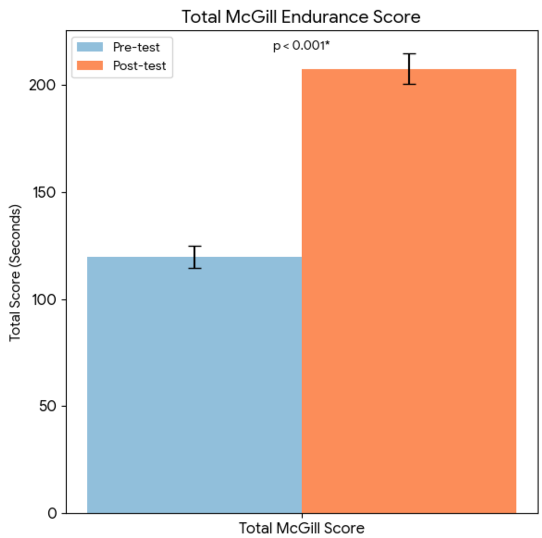
Table 1: Baseline Demographic Characteristics

Variable	Experimental (n=30)	Control (n=30)	p-value
Age (years)	22.3 ± 1.5	22.4 ± 1.6	0.78
Weight (kg)	65.2 ± 4.8	65.5 ± 5.1	0.82
Gender (M/F)	15/15	15/15	1.00

WITHIN-GROUP COMPARISON (PAIRED T-TEST)

Table 2: McGill Components – Experimental Group

Variable	Pre-test (Mean ± SD)	Post-test (Mean ± SD)	t-value	p-value
Flexor Endurance	30.2 ± 2.5	50.4 ± 3.1	18.5	<0.001
Extensor Endurance	40.3 ± 3.0	66.8 ± 3.5	19.2	<0.001
Right Side Plank	25.1 ± 2.2	45.7 ± 2.8	17.8	<0.001
Left Side Plank	24.2 ± 2.1	44.6 ± 2.6	17.5	<0.001
Total McGill Score	119.8 ± 5.2	207.5 ± 7.1	22.3	<0.001



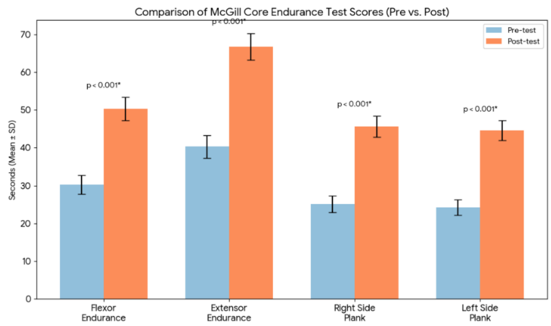
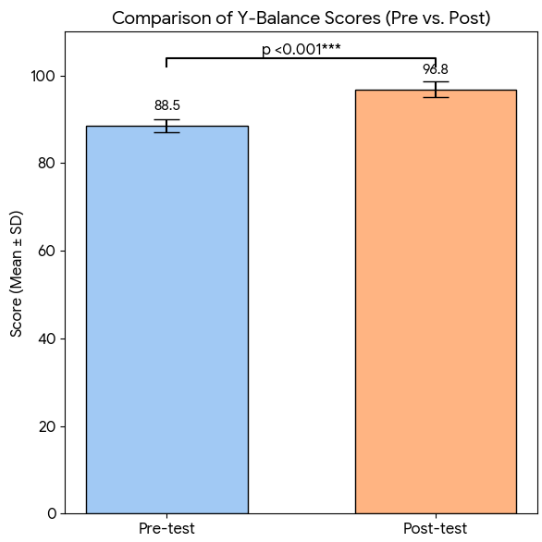


Table 3: Y-Balance Test – Experimental Group

Variable	Pre-test	Post-test	t-value	p-value
Y-Balance Score	88.5 ± 1.5	96.8 ± 1.8	15.6	<0.001



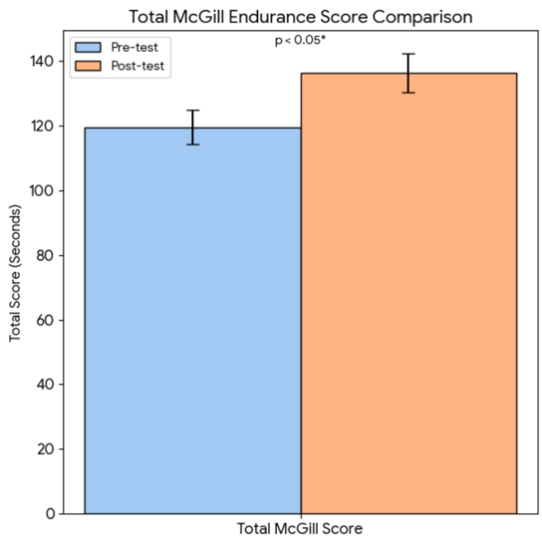


Table 4: McGill Components – Control Group

Variable	Pre-test	Post-test	t-value	p-value
Flexor Endurance	30.1 ± 2.6	35.2 ± 2.8	4.2	<0.05
Extensor Endurance	40.2 ± 3.1	45.3 ± 3.3	4.5	<0.05
Right Side Plank	25.0 ± 2.3	28.4 ± 2.5	3.9	<0.05
Left Side Plank	24.1 ± 2.2	27.3 ± 2.4	3.8	<0.05
Total McGill Score	119.4 ± 5.3	136.2 ± 6.0	5.1	<0.05

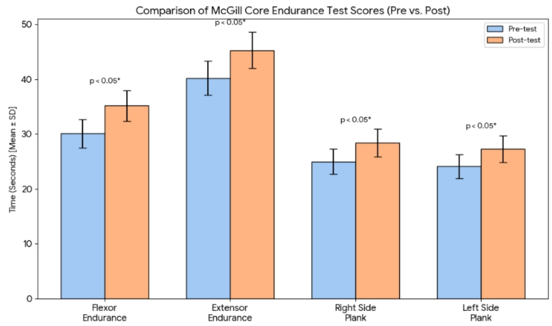
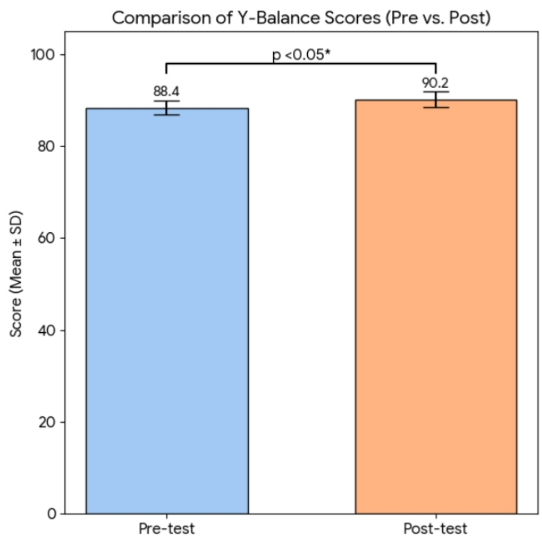
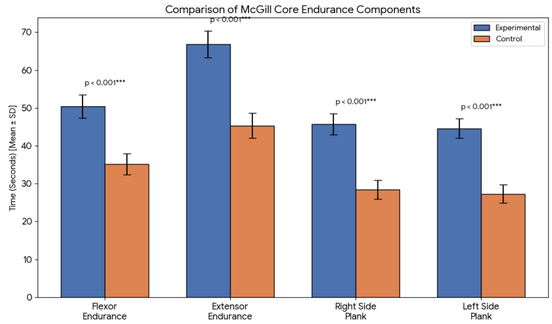


Table 5: Y-Balance Test – Control Group

Variable	Pre-test	Post-test	t-value	p-value
Y-Balance Score	88.4 ± 1.6	90.2 ± 1.7	3.5	<0.05

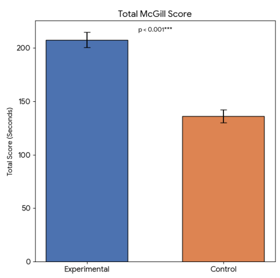


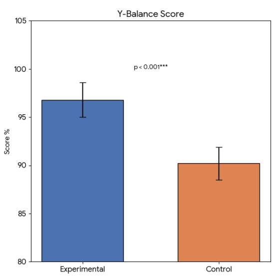


BETWEEN-GROUP COMPARISON

Table 6: Post-test Comparison Between Groups

Variable	Experimental	Control	t-value	p-value
Flexor Endurance	50.4 ± 3.1	35.2 ± 2.8	12.8	<0.001
Extensor Endurance	66.8 ± 3.5	45.3 ± 3.3	14.2	<0.001
Right Side Plank	45.7 ± 2.8	28.4 ± 2.5	13.5	<0.001
Left Side Plank	44.6 ± 2.6	27.3 ± 2.4	13.1	<0.001
Total McGill Score	207.5 ± 7.1	136.2 ± 6.0	18.6	<0.001
Y-Balance Score	96.8 ± 1.8	90.2 ± 1.7	10.4	<0.001





DISCUSSION

The present experimental study evaluated the effectiveness of diaphragmatic breathing exercises on core stability, balance, and injury risk in competitive athletes. The findings demonstrated statistically significant improvements in the experimental group across all outcome measures, including the McGill Trunk Endurance Test components and Y-Balance Test, supporting the effectiveness of diaphragmatic breathing in improving core endurance and dynamic balance.

Within-group analysis revealed highly significant improvements in the experimental group across all components of the McGill Trunk Endurance Test, including flexor endurance, extensor endurance, and bilateral side plank endurance ($p < 0.001$). These findings indicate a substantial enhancement in core muscle endurance following the intervention. Core endurance is a critical factor in maintaining spinal stability during prolonged physical activity, as it prevents fatigue-induced biomechanical alterations that may predispose athletes to injury.

The observed improvements in trunk endurance can be explained by the physiological role of the diaphragm in regulating intra-abdominal pressure (IAP). Diaphragmatic breathing enhances IAP, which acts as a stabilizing force for the spine by increasing trunk stiffness and reducing the load on passive structures such as ligaments and intervertebral discs. This mechanism allows for improved force transmission and efficient movement patterns, which are essential for athletic performance.

The findings of this study are consistent with previous research demonstrating the role of the diaphragm in postural control. Studies have shown that the diaphragm is activated not only during respiration but also during tasks requiring trunk stabilization, indicating its dual function. This supports the concept that breathing exercises can be effectively used to improve core stability in athletic populations.

Although the control group also demonstrated statistically significant improvements ($p < 0.05$), the magnitude of improvement was considerably smaller compared to the experimental group. This may be attributed to general physical activity, familiarization with the test procedures, or placebo effects. However, the significantly greater improvement in the experimental group highlights the additional benefit of diaphragmatic breathing exercises beyond routine training.

Between-group analysis showed significantly better post-intervention outcomes in the experimental group for all components of the McGill Trunk Endurance Test and Y-Balance Test ($p < 0.001$). This suggests that diaphragmatic breathing provides additional benefits beyond routine physical training.

The improvement in core endurance and dynamic balance may have implications for athletic performance and injury- risk-related factors. However, injury risk was not directly measured in the present study; therefore, the findings should be interpreted as suggesting a potential relationship between improved core stability/dynamic balance and injury-risk-related factors rather than a direct reduction in injury incidence. The simple, non-invasive nature of diaphragmatic breathing makes it a potentially useful addition to athletic conditioning and physiotherapy rehabilitation programs.

CONCLUSION

Based on the findings of the present study, it can be concluded that diaphragmatic breathing exercises are highly effective in improving core stability and dynamic balance in competitive athletes. The experimental group demonstrated significantly greater improvements in all components of the McGill Trunk Endurance Test and Y-Balance Test compared to the control group.

LIMITATION

- Small sample size
- Short duration of study
- No long term follow-up
- Limited outcome measures

RECOMMENDATION

Further study could be performed with

- Large number of samples
- Duration of study for long period
- Athletes from different sports are recommended to determine sport-specific effects.
- Future research should directly assess injury incidence and compare diaphragmatic breathing with other core stability interventions.

REFERENCES

1. *Med.* 2006;36(3):189–98.
2. Akuthota V, Nadler SF. Core strengthening. *Arch Phys Med Rehabil.* 2004;85(3 Suppl 1):S86–92.
3. McGill SM. Low back stability: from formal description to issues for performance and rehabilitation. *Exerc Sport Sci Rev.* 2001;29(1):26–31.
4. Leetun DT, Ireland ML, Willson JD, Ballantyne BT, Davis IM. Core stability measures as risk factors for lower extremity injury in athletes. *Med Sci Sports Exerc.* 2004;36(6):926–34.
5. Richardson CA, Hodges PW, Hides JA. *Therapeutic exercise for lumbopelvic stabilization: a motor control approach.* Edinburgh: Churchill Livingstone; 2004.
6. Hodges PW, Gandevia SC. Activation of the human diaphragm during a repetitive postural task. *J Physiol.* 2000;522(Pt 1):165–75.
7. Chaitow L, Bradley D, Gilbert C. *Multidisciplinary approaches to breathing pattern disorders.* London: Churchill Livingstone; 2014.
8. Courtney R. The functions of breathing and its dysfunctions and their relationship to breathing therapy. *J Bodyw Mov Ther.* 2009;13(1):78–85.
9. Kolar P, Sulc J, Kyncl M, Sanda J, Neuwirth J, Bokarius A, et al. Stabilizing function of the diaphragm: dynamic MRI and synchronized spirometric assessment. *J Appl Physiol.* 2010;109(4):1064–71.
10. Janssens L, Brumagne S, McConnell AK, Hermans G, Troosters T, Gayan-Ramirez G. The assessment of inspiratory muscle fatigue in healthy individuals: a systematic review. *Eur Spine J.* 2013;22(8):1882–91.
11. Shumway-Cook A, Woollacott MH. *Motor control: translating research into clinical practice.* 4th ed. Philadelphia: Lippincott Williams & Wilkins; 2012.
12. Plisky PJ, Rauh MJ, Kaminski TW, Underwood FB. Star excursion balance test as a predictor of lower extremity injury. *J Orthop Sports Phys Ther.* 2006;36(12):911–9.
13. Smith CA, Chimera NJ, Warren M. Association of Y balance test reach asymmetry and injury in Division I athletes. *Int J Sports Phys Ther.* 2015;10(1):100–8.

14. McGill SM, Childs A, Liebenson C. Endurance times for low back stabilization exercises: clinical targets for testing and training. *Arch Phys Med Rehabil.* 1999;80(8):941–4.
15. Bahr R, Holme I. Risk factors for sports injuries—a methodological approach. *Br J Sports Med.* 2003;37(5):384–92.
16. Zazulak BT, Hewett TE, Reeves NP, Goldberg B, Cholewicki J. Deficits in neuromuscular control of the trunk predict knee injury risk. *Am J Sports Med.* 2007;35(7):1123–30.
17. Jerath R, Edry JW, Barnes VA, Jerath V. Physiology of long pranayamic breathing: neural respiratory elements. *Med Hypotheses.* 2006;67(3):566–71.
18. Kibler WB, Press J, Sciascia A. The role of core stability in athletic function. *Sports Med.* 2006;36(3):189–98.
19. Hrysomallis C. Balance ability and athletic performance. *Sports Med.* 2011;41(3):221–32.
20. Granata KP, Wilson SE. Trunk posture and spinal stability. *Clin Biomech (Bristol, Avon).* 2001;16(8):650–9.
21. Panjabi MM. The stabilizing system of the spine. Part I: function, dysfunction, adaptation, and enhancement. *J Spinal Disord.* 1992;5(4):383–9.
22. Willson JD, Dougherty CP, Ireland ML, Davis IM. Core stability and its relationship to lower extremity function. *J Athl Train.* 2005;40(1):11–6.
23. Behm DG, Drinkwater EJ, Willardson JM, Cowley PM. The use of instability to train the core musculature. *Sports Med.* 2010;40(9):717–33.
24. Vera-Garcia FJ, Elvira JL, Brown SH, McGill SM. Effects of abdominal stabilization maneuvers on the control of spine motion. *J Biomech.* 2000;33(8):1005–12.
25. Borghuis J, Hof AL, Lemmink KA. The importance of sensory-motor control in providing core stability. *Sports Med.* 2008;38(11):893–916.
26. Hibbs AE, Thompson KG, French D, Wrigley A, Spears I. Optimizing performance by improving core stability. *Sports Med.* 2008;38(12):995–1008.
27. Lee D, Hodges PW, Behm D. Trunk muscle activation patterns during lifting. *Clin Biomech.* 2006;21(3):256–63.
28. Hodges PW, Richardson CA. Contraction of the abdominal muscles associated with movement of the lower limb. *Spine.* 2001;26(5):E132–8.
29. Janssens L, McConnell AK, Pijnenburg M, Claeys K, Brumagne S. Inspiratory muscle training affects proprioception and balance. *Gait Posture.* 2015;42(3):319–24.