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Reviving the core: Diaphragmatic Strengthening for Postpartum Low Back Pain Using Threshold Device, an Underappreciated Approach

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Abstract
Postpartum low back pain (PLBP) is a prevalent issue affecting 50-60% of women after childbirth. Various interventions including physical therapy, core exercises, and motor control training have been explored to address this concern.
Objective: To evaluate the effectiveness of core stabilization combined with diaphragmatic strengthening using an inspiratory muscle training (IMT®) threshold device in reducing pain and improving core and diaphragm muscle strength in women with PLBP.
Method: A quasi-experimental study was conducted on 30 postpartum women (aged 20-30 years) with PLBP following normal delivery. Participants were randomly assigned into two groups: Group A (n=15) received core stabilization exercises along with diaphragmatic strength training using an IMT® device, while Group B (n=15) received core stabilization exercises with diaphragmatic breathing. Both groups underwent 45-minute sessions, twice daily, three times a week, over six weeks. Pain and muscle strength were assessed using the Visual Analogue Scale (VAS) and Manual Muscle Testing (MMT).
Result: Data analysis using paired and unpaired t-tests showed significant improvements in Group A compared to Group B. A highly significant reduction in VAS scores and an increase in MMT scores were observed in Group A (p=0.00001).
Conclusion: Incorporating diaphragmatic strength training using the IMT® device effectively enhances core and diaphragmatic muscle strength while significantly reducing low back pain in postpartum women.

Keywords: Postpartum low back pain (PLBP), Core muscle strength, Inspiratory Muscle Training (IMT®), Visual Analogue Scale, Manual Muscle Testing

Introduction
Pregnancy is the state of carrying a developing foetus, lasting 266-270 days (9 months) [1]. It is a natural process causing several physiological changes in a woman's body [2]. Pregnancy is a time to reflect on and adopt healthy lifestyle changes. Normal vaginal delivery is a natural, low-intervention process and safest for both mother and foetus [3]. About 80% of deliveries are full-term via spontaneous labour [4]. Pregnancy and postpartum periods often involve complications like diabetes, hypertension, low back pain, urinary incontinence, etc. [5]. These complications arise due to sudden physiological and physical changes [6, 7]. Musculoskeletal changes may result in spinal pain, pelvic girdle pain, and abdominal muscle weakness. Postpartum is defined as the period starting immediately after childbirth and lasts for 6-16 weeks [8, 9]. Low back pain prevalence is 56% (1st trimester), 40-70% (2nd trimester), 70-80% (3rd trimester). About 50% of women continue to experience low back pain up to a year postpartum. In 8-10% of cases, low back pain persists for 1-2 years after childbirth. Low back pain affects daily activities, including newborn care. It is multi-factorial: hormonal changes, weight gain, postural changes, and pre-existing back pain contribute [10, 11, 14]. Lumbar pain may originate from the spine and radiate down the leg [12, 13]. Stability of the spine is maintained by transversus abdominis [15], multifidus [16], pelvic floor muscles [17], and diaphragm [18]. Pregnancy-induced postural changes reduce lumbo-pelvic strength and stability [19]. First-line treatment for low back pain includes analgesics like ibuprofen, acetaminophen. Physiotherapy is crucial and includes TENS, IFT, hot packs, etc.

Exercise therapy includes aquatic exercises, Maitland technique, Mckenzie method, Pilates, lumbar stabilization, etc. Core stability is based on active, passive, and neural control [20, 21]. Spinal stabilization system includes neural, passive (spinal column), and active (muscles) subsystems. Local stabilizers include transversus abdominis, pelvic floor, deep multifidus, and diaphragm [22]. Transversus abdominis supports abdominal viscera and increases intra-abdominal pressure [23, 24]. Multifidus provides spinal stability and its weakness is linked to low back pain [25, 26, 27]. Pelvic floor supports viscera and maintains continence [28, 29]. Rectus abdominis flexes the spine and stabilizes pelvis. Internal oblique forms part of the lateral abdominal wall [30, 31]. Diaphragm is essential for breathing and spinal stability [32, 33, 34]. Proper diaphragm activation increases intra-abdominal pressure [35]. Diaphragm and TrA work together to stabilize and unload the spine [36]. Diaphragm fatigue can reduce spinal stability in recurrent LBP cases [37, 38]. "Soda pop can model" by Mary Massery explains trunk stability using analogy [39]. Diaphragmatic breathing and resistance training enhance core stability and reduce LBP. Respiratory Muscle Training (RMT) includes inspiratory (IMT), expiratory (EMT), and combined methods [40, 41, 42, 43]. IMT improves diaphragm strength and reduces exertional dyspnoea [44, 45, 46, 47, 48]. Threshold IMT® is a widely used device for inspiratory muscle training [44, 49, 50, 51]. Low back pain is assessed using Visual Analogue Scale (VAS) [53]. Abdominal muscle weakness is measured by MMT using Medical Research Council Grading (0-5) [54].

Materials & Methods

Study Design

Quasi-Experimental Study Design

Study Setting

This study was conducted in the department of obstetrics and gynaecology, Sri Ramakrishna Hospital, Coimbatore - 641044. Informed consents were obtained from all patients and were included for the study.

Sampling Method

Based on the selection criteria, 30 subjects were selected and was alloted into 2 groups by non-probability sampling method.

Sample Size

A total of 30 patients with postpartum low back pain 3 months following delivery were selected and assigned into two groups, with 15 subjects in each group.

Study Period

The study duration was 6 months.

Treatment Duration

Both the groups received 45 minutes treatment per session, two sessions a day , three days per week for about 6 weeks

Criteria for Selection

Incusion Criteria

- Woman who underwent normal vaginal delivery with or without episiotomy.
- Multiparous women with normal delivery
- Age between 20 to 30 years
- BMI $\leq$30 Kg/m^2
- Ability to perform diaphragmatic breathing.
- Patients with low back pain of normal vaginal delivery (VAS $\geq$ 4)
- Pregnancy related pain in the lower back and pelvic region from 3 days after delivery utpo 3 months.
- Women referred to physiotherapy for low back pain after delivery.
- Patient willing to participate in the study.

Exclusion Criteria

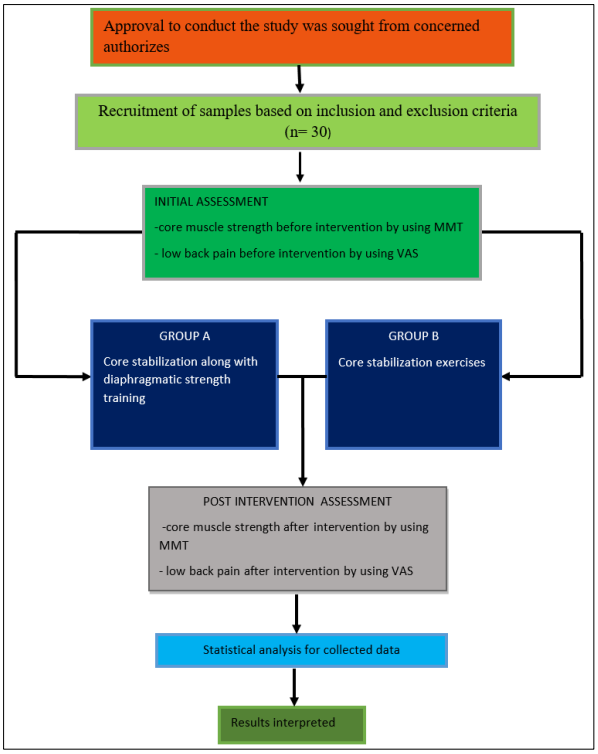
- Lower segmental caesarean section
- Abdominal operations
- Antenatal or associated complications - bleeding, urinary tract infections, preeclampsia, anemia.
- *In vitro* fertilization
- Diastasis rectus abdominis
- Pelvic inflammatory conditions
- Neural pathologies - spinal stenosis, spondylolisthesis
- Structural disc lesions
- Musculoskeletal deformities - osteoarthritis, rheumatoid arthritis, gout etc.
- Carcinoma
- History of previous lumbar surgery
- Severe cardio-respiratory diseases
- Subjects with systemic disease.

Procedure

A total of 30 subjects were selected based on the selection criteria and was randomly divided into two groups of 15 subjects each using computer assisted randomization. All subjects were involved for pre-test for the performance of core stabilizers and diaphragmatic strength.

Group A (experimental group) is the group which received core stabilization exercise along with diaphragmatic strength training. Group B (control group) is the group which received only core stabilization exercises

Study Methodology



Variables

Independent variables

- Core stabilization
- Diaphragmatic strength training

Dependent variables

- Low back Pain
- Diaphragm muscle strength
- Core muscle strength

Outcome Measures

- Visual Analogue Scale (VAS)
- Manual Muscle Testing (MMT)

Materials Required

- Consent Form.
- Post-natal assessment chart.
- Inspiratory Muscle Training threshold device (IMT®)
- Pen
- Pencil
- Mat
- MMT grading chart.
- VAS chart for pain.
- Exercise chart.
- Follow up chart.

Procedure

Group A: Core Stabilization Exercises Along with Diaphragmatic Strength Training

Patient is made to lie in a comfortable pain free neutral posture to determine the comfortable neutral posture, the subject was made to lying supine position then therapist put one hand on the abdomen and the other hand on the lumbar region and then tilted the pelvis, which flexed and extended the lumbar spine, until achieving the least pain position.

The Diaphragmatic Strength Training Program Consisted of the Following

1. Diaphrammatic Breathing with Abdominal Bracing
2. Box Breathing (Four Square Breathing) And Jacobson's Progressive Muscle Relaxation Technique:
3. Inspiratory Muscle Training Using Threshold Device(IMT®)

Core Stabilization Exercises

- Tra-Activation
- Crunches
- Oblique Crunches
- Bridges
- Leg Raises
- Side Planks
- Bird-Dog
- Cat-Cow
- Kegel's Exercise

Group B: Core Stabilization Exercises

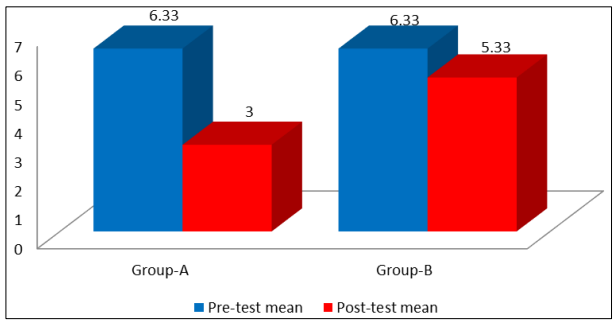
Subjects in the group B received only the core stabilization exercises which were mentioned above.

Statistical Analysis

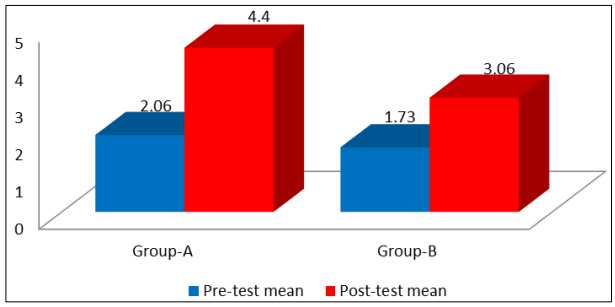
Pre-test and post-test values of the study were collected and assessed for variations in improvement and their results were analysed using independent t test and parried t test. The statically analysis of the study showed that there is a significant difference between the group in low back pain, diaphragm muscle strength, core muscle strength.

Result

Data analysis using paired and unpaired t-tests showed significant improvements in Group A compared to Group B. A highly significant reduction in VAS scores and an increase in MMT scores were observed in Group A (p=0.00001).



Graph 1: Pre and post-test value of VAS for group A and group B



Graph 2: Pre and post-test value of manual muscle testing for abdominal muscle of Group A and Group B.

Discussion

Low back pain is a common postpartum complication, affecting 40-50% of women and significantly impacting daily activities, mental health, and overall quality of life. Although symptoms often improve after delivery and within six months postpartum, early intervention is crucial. This study explores the effectiveness of combining core stabilization exercises with diaphragm strength training using a threshold device to manage low back pain and improve abdominal and diaphragm strength in postpartum women. Core stabilization enhances abdominal muscle strength and pelvic stability, while diaphragm training increases the thickness of key stabilizer muscles like the transversus abdominis and multifidus (Regina Finta *et al.*, 2018). Lumbar instability is a major contributor to low back pain, and spinal stability depends on the co-contraction of trunk muscles—including the diaphragm, pelvic floor, and abdominal muscles—as described by Akuthota and Nadler. Michael *et al.* emphasized that co-contraction increases intra-abdominal pressure (IAP), stabilizes the trunk, and reduces spinal stress, especially during heavy lifting. This synergy can reduce lumbar load by up to 50% and back muscle strain by over 50%, highlighting the importance of strong abdominal muscles in spinal health. Glory Dangmei *et al.* (2023) demonstrated that six weeks of corrective exercises—including pelvic floor and diaphragmatic

breathing—enhance core stability by promoting synergistic muscle contractions that increase IAP and support posture. The diaphragm, a key muscle in respiration, also contributes to trunk stability, while the trans versus abdominis aids in motor control and posture. Studies by Hall, Richardson, and Roussel support respiratory muscle training as a method to improve lumbar stability and breathing patterns in chronic low back pain patients. This study aimed to evaluate the efficacy of core stabilization combined with diaphragm strength training using a threshold device. Participants were divided into two groups: Group A received both interventions, while Group B received only core stabilization. Starting from the second postpartum day, both groups followed a 6-week program, exercising three times per week for 45 minutes. Pain and muscle strength were assessed using the Visual Analogue Scale (VAS) and Manual Muscle Testing (MMT), both reliable and valid tools. Results showed significant improvements in both groups, with Group A demonstrating greater reductions in pain and increases in abdominal strength. Post-test VAS scores were lower, and MMT scores were higher compared to pre-test values, indicating the effectiveness of the combined approach. These findings align with Jan Dommerholt *et al*. (2023), who emphasized the importance of incorporating diaphragm training into core stabilization programs for low back pain rehabilitation. Facilitating normal breathing patterns and restoring postural control of the diaphragm are essential components of a comprehensive recovery strategy.

Conclusion

The statistical analysis and interpretations has clearly shown that, the core stabilization exercises along with diaphragmatic strength training using threshold device (Group A) has reduced the score of VAS and increased the score of abdominal muscles MMT thereby improving the diaphragm strength. Therefore, core stabilization along with diaphragm strength training has improved abdominal muscle strength and thereby improving diaphragm strength and decreased LBP. Therefore, it was clearly, accepting alternative hypothesis.

Declaration by Authors

Ethical Approval: Ethical approval was obtained from the institutional review board of Sri Ramakrishna institute of paramedical sciences. All respondents agreed to participate in the study and informed consent was obtained from all the subjects. The privacy of the participant's information was maintained, and there was no disclosure of their names or any information that could identify them.

Conflict of Interest

The authors declare no conflict of interest.

References

1. Jukic A, Baird D, Weinberg C, McConnaughey D, Wilcox A. Length of human pregnancy and contributors to its natural variation. Hum Reprod. 2013;28(10):2848-55.
2. Forczek W, Staszkiewicz R. Changes of kinematic gait parameters due to pregnancy. Acta Bioeng Biomech [Internet]. 2012 [cited 2021 Nov 25];14(4):113-9. Available from: https://www.actabio.pwr.wroc.pl/
3. Lagrew DC, Low LK, Brennan R, Corry MP, Edmonds JK, Gilpin BG, *et al*. National Partnership for Maternal Safety: Consensus bundle on safe reduction of primary cesarean births—supporting intended vaginal births. Obstet Gynecol. 2018;131(3):503-13.
4. Iams JD. Prediction and early detection of preterm labor. Obstet Gynecol. 2003;101(2):402-12.
5. Fiat F, Merghes PE, Scrurtu AD, Guta BA, Dehelean CA, Varan N, *et al*. The main changes in pregnancy—therapeutic approach to musculoskeletal pain. Medicina (Kaunas). 2022;58(8):1115.
6. Pascual ZN, Langaker MD. Physiology, pregnancy. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2022.
7. Bhatia P, Chhabra S. Physiological and anatomical changes of pregnancy: implications for anaesthesia. Indian J Anaesth. 2018;62(9):651-7.
8. World Health Organization. WHO recommendations on postnatal care of the mother and newborn: executive summary. Geneva: WHO; 2013.
9. Romano M, Cacciatore A, Giordano R, La Rosa B. Postpartum period: three distinct but continuous phases. J Prenat Med. 2010;4(2):22-5.
10. Chang HY, Lai YH, Jensen MP, Shun SC, Hsiao FH, Lee CN, *et al*. Factors associated with low back pain changes during the third trimester of pregnancy. J Adv Nurs. 2014;70(5):1054-64.
11. Katonis P, Kampouroglou A, Aggelopoulos A, Kakavelakis K, Lykoudis S, Makrigiannakis A, *et al*. Pregnancy-related low back pain. Hippokratia. 2011;15(3):205-10.
12. Glinkowski WM, Tomasik P, Walesiak K, Głuszak M, Krawczak K, Michoński J, *et al*. Posture and low back pain during pregnancy: 3D study. Ginekol Pol. 2016;87(8):575-80.
13. Wuytack F, Begley C, Daly D. Risk factors for pregnancy-related pelvic girdle pain: a scoping review. BMC Pregnancy Childbirth. 2020;20(1):739.
14. To WW, Wong MW. Factors associated with back pain symptoms in pregnancy and persistence of pain 2 years after pregnancy. Acta Obstet Gynecol Scand. 2003;82(12):1086-91.
15. Lynders C. The critical role of development of the transversus abdominis in the prevention and treatment of low back pain. HSS J. 2019;15(3):214-20.
16. Inanir A, Cakmak B, Hisim Y, Demirturk F. Evaluation of postural equilibrium and fall risk during pregnancy. Gait Posture. 2014;39(4):1122-5.
17. Vesentini G, Prior J, Ferreira PH, Hodges PW, Rudge M, Ferreira ML. Pelvic floor muscle training for women with lumbopelvic pain: a systematic review and meta-analysis. Eur J Pain. 2020;24(10):1865-79.
18. Kocjan J, Gzik-Zroska B, Nowakowska K, Burkacki M, Suchoń S, Michnik R, *et al*. Impact of diaphragm function parameters on balance maintenance. PLoS One. 2018;13(12):e0208697.
19. Barz T, Melloh M, *et al*. A conceptual model of compensation/decompensation in lumbar segmental instability. Med Hypotheses. 2014;83(3):312-6.
20. Panjabi MM. The stabilizing system of the spine. Part II. Neutral zone and instability hypothesis. J Spinal Disord. 1992;5(4):390-7.
21. Bruno P. The use of "stabilization exercises" to affect neuromuscular control in the lumbopelvic region: a

narrative review. J Can Chiropr Assoc. 2014;58(2):119-30.
22. Selkow NM, Eck MR, Rivas S. Transversus abdominis activation and timing improves following core stability training: a randomized trial. Int J Sports Phys Ther. 2017;12(7):1048-56.
23. Verywell Health. Transverse abdominal muscle [Internet]. Available from: https://www.verywellhealth.com/transverse-abdominal-muscle-297289
24. Drake R, Vogl AW, Mitchell AW. Gray's anatomy for students. 2nd ed. Philadelphia: Elsevier Health Sciences; 2009.
25. Zheng Y, Ke S, Lin C, Li X, Liu C, Wu Y, *et al*. Effect of core stability training monitored by rehabilitative ultrasound image and surface electromyogram in local core muscles of healthy people. Pain Res Manag. 2019;2019:1-9.
26. Kliziene I, Sipaviciene S, Klizas S, Imbrasiene D. Effects of core stability exercises on multifidus muscles in healthy women and women with chronic low back pain. J Back Musculoskelet Rehabil. 2015;28(4):841-7.
27. Boyle R, Hay-Smith EJ, Cody JD, Mørkved S. Pelvic floor muscle training for prevention and treatment of urinary and fecal incontinence in antenatal and postnatal women: a short version Cochrane review. Neurourol Urodyn. 2014;33(3):269-76.
28. Sartori DV, Gameiro MO, Yamamoto HA, Kawano PR, Guerra R, Padovani CR, *et al*. Reliability of pelvic floor muscle strength assessment in healthy continent women. BMC Urol. 2015;15:1-6.
29. Hislop HJ, Montgomery J. Muscle testing: techniques of manual examination. 8th ed. Philadelphia: Saunders; 2007.
30. Punekar IRA, Khouri JS, Catanzaro M, Shaikh AL, Langstein HN. Redefining the rectus sheath: implications for abdominal wall repair. Plast Reconstr Surg. 2018;141(2):473-9.
31. Hodges PW, Gurfinkel VS, Brumagne S, Smith TC, Cordo PC. Coexistence of stability and mobility in postural control: evidence from postural compensation for respiration. Exp Brain Res. 2002;144(3):293-302.
32. Schünke M, Schulte E, Schumacher U, Voll M, Wesker K. Atlas of anatomy: general anatomy and musculoskeletal system. Stuttgart: Thieme; 2006.
33. Sannasi R, Dakshinamurthy A, Dommerholt J, Desai V, Kumar A, Sugavanam T. Diaphragm and core stabilization exercises in low back pain: a narrative review. J Bodyw Mov Ther. 2023;36:221-7.
34. Bains KN, Kashyap S, Lappin SL. Anatomy, thorax, diaphragm. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2021.
35. Panjabi MM. The stabilizing system of the spine. Part I. Function, dysfunction, adaptation, and enhancement. J Spinal Disord. 1992;5(4):383-97.
36. Macintosh JE, Bogduk N, Gracovetsky S. The biomechanics of the thoracolumbar fascia. Clin Biomech. 1987;2(2):78-83.
37. Janssens L, Brumagne S, Polspoel K, Troosters T, McConnell A. The effect of inspiratory muscle fatigue on postural control in people with and without recurrent low back pain. Spine. 2010;35(10):1088-94.
38. Massery PT. If you can't breathe, you can't function [Internet]. YouTube; 2009 [cited 2009 Jun 6]. Available from: https://www.youtube.com/watch?v=IeiKhMmjDGc
39. Markov G, Spengler CM, Knopfli-Lenzin C, Stuessi C, Boutellier U. Respiratory muscle training increases cycling endurance without affecting cardiovascular responses to exercise. Eur J Appl Physiol. 2001;85(3-4):233-9.
40. McConnell A. Respiratory muscle training: theory and practice. London: Elsevier; 2013.
41. Sezer N, Ordu NK, Sutbeyaz ST, Koseoglu BF. Cardiopulmonary and metabolic responses to maximum exercise and aerobic capacity in hemiplegic patients. Funct Neurol. 2004;19(4):233-8.
42. Geddes EL, Reid WD, Crowe J, O'Brien K, Brooks D. Inspiratory muscle training in adults with chronic obstructive pulmonary disease: a systematic review. Respir Med. 2005;99(11):1440-58.
43. West CR, Taylor BJ, Romer LM. Effects of inspiratory muscle training on exercise responses in Paralympic athletes with cervical spinal cord injury. Scand J Med Sci Sports. 2013;23(5):e121-9.
44. Suzuki S, Sato M, Okubo T. Expiratory muscle training and sensation of respiratory effort during exercise in normal subjects. Thorax. 1995;50(4):366-70.
45. Akiyoshi F, Takahashi H, Sugawara K, Satake M, Shioya T. The effect of expiratory muscle training on respiratory muscle strength. Rigaku Ryohogaku. 2001;28:47-52.
46. Pereira MC, Dacha S, Testelmans D, Gosselink R, Langer D. Assessing the effects of inspiratory muscle training in a patient with unilateral diaphragm dysfunction. Breathe. 2019;15(2):e90-6.
47. Seixas MB, Almeida LB, Trevizan PF, Martinez DG, Laterza MC, Vanderlei LC, *et al*. Effects of inspiratory muscle training in older adults. Respir Care. 2020;65(4):535-44.
48. Geddes EL, O'Brien K, Reid WD, Brooks D, Crowe J. The effects of respiratory muscle training on improvement of the internal and external thoraco-pulmonary respiratory mechanism in COPD patients. Ann Phys Rehabil Med. 2013;56(3):193-211.
49. Paiva DN, Assmann LB. Inspiratory muscle training with threshold or incentive spirometry: which is most effective? A randomized clinical trial. Rev Port Pneumol. 2015;21(2):76-81.
50. Smart NA, Giallauria F, Dieberg G. Inspiratory muscle training in patients with heart failure: a systematic review. Cardiopulm Phys Ther J. 2012;23(2):29-36.
51. Laidley M. The pop can core [Internet]. 2019 Apr 9. Available from: https://www.depthtraining.ca/the-pop-can-core/
52. Saleh MSM, Botla AMM, Elbehary NAM. Effect of core stability exercises on postpartum lumbopelvic pain: a randomized controlled trial. J Back Musculoskelet Rehabil. 2019;32(2):205-13.
53. Cuthbert SC, Goodheart GJ Jr. On the reliability and validity of manual muscle testing: a literature review. Chiropr Osteopat. 2007;15:4.