The Effect of Core Stability Training with Ball and Balloon Exercise on Respiratory Variables in Chronic Non-Specific Low Back Pain: An Experimental Study

ABSTRACT

Background: Studies have shown the involvement of respiratory characteristics and their relationship with impairments in non-specific low back pain (NS-LBP). The effects of core stability with a combined ball and balloon exercise (CBB) on respiratory variables had not been investigated.

Objective: To evaluate the effectiveness of CBB on respiratory variables among NS-LBP patients.

Study Design: pre- and post-experimental study.

Participants: Forty participants were assigned to an experimental group (EG) [n=20] and control group (CG) [n=20] based on the study criteria.

Interventions: The EG received CBB together with routine physiotherapy and the CG received routine physiotherapy over a period of 8 weeks. Participants were instructed to carry out the exercises for 3 days per week. The training was evaluated once a week and the exercises progressed based on the level of pain. Outcome measures: Primary outcomes were maximum inspiratory pressure (MIP), maximum expiratory pressure (MEP) and maximum voluntary ventilation (MVV). The secondary outcomes were measured in the numeric rating scale (NRS), total faulty breathing scale (TFBS), cloth tape measure (CTM) and lumbo-pelvic stability. Results: The MIP increased significantly among the EG when compared with that in the CG ($p>0.05$).The EG showed a significant increase in MVV ($p=0.04$) when compared to the CG ($p=0.0001$). There was a significant reduction in pain for both groups. The MEP, TFBS, chest expansion and core stability showed no changes in either group. Conclusion: CBB was effective in improving respiratory variables among NS-LBP patients.

Key words: respiration; low back pain; maximum voluntary ventilation; respiratory muscle

INTRODUCTION

Non-specific low back pain (NS-LBP) is considered to be a leading cause of disability throughout the world. Therapies termed as a range of exercises are designed to reduce pain, strengthen the back musculature and promote stabilization of the lumbar segment(Barr et al., 2007, 2005). The selection and administration of exercises depend on the experience of the practitioner and patients acceptability, as per a recently published systematic review (Saragiotto et al., 2016). With reference to such exercise programs, literature inferred that the core stability exercises with other forms of exercises improved lumbar stability and the motor control approach is not greater to other forms of exercise for treating patients with chronic LBP (Javadian et al., 2015; Saragiotto et al., 2016).

Despite the popularity and wide usage of motor control exercises, the effectiveness of core stability exercises is debatable because of the difference in types of exercises depending upon the needs of patients being treated for LBP (Barr et al., 2007, 2005) The National Institute for Health and Care Excellence (NICE) (2016) guideline for "low back pain and sciatica in over 16s: assessment and management" also advised that during the selection of different types of exercises, the specific needs, preferences and capabilities of the patients ought to be considered. In addition, the NICE guideline identified that information on the type, frequency and duration of exercise are difficult to obtain specifically (National Institute for Health and Care Excellence, 2016). The main challenge that researchers face in many experiments is that all core stability exercises have been tested for pain reduction, range of motion and other related musculoskeletal parameters. The other difficulties faced by these experiments, which are being unaddressed, are whether or not these exercises reverse muscle properties, neural firing patterns, improve proprioception and balance? (Barr et al., 2005).

The diaphragm, pelvic floor, transverse abdominis, and multifidus constitute major respiratory and core muscle for spinal stability. Structurally, the diaphragm is located on the top, pelvic floor muscles on the bottom, transversus abdominis and oblique muscles on the front, multifidus and thoracolumbar fascia muscular system on the back, these structures work together to create abdominal pressure and stability to the spine. Dysfunction of at least one component (e.g., diaphragm) can affect core stability and respiratory function. One of the most important fundamental constituents of core function is appropriate breathing patterns which can be optimized through diaphragmatic control. The diaphragm is a dome-shaped muscle that has been identified to have a costal, a lumbar and a sternal portion. The lumbar portion on the right has an attachment at the level of L1-L3 and on the left between L2 and L3 which is responsible for stability and posture (Bordoni and Zanier, 2013). Functionally, the crural region is responsible for appropriate breathing and a costal region prevents gastroesophageal reflux (Bordoni and Zanier, 2013). The abdominal canister which is considered as a functional and anatomical construct is bounded by fascial connection through the diaphragm, abdominal and pelvic viscera (Lee et al., 2008). The abdominal muscles are constituted by transverse abdominis, rectus abdominis, internal and external obliques. These fascial structures work together synergistically. From a functional perspective, the connection between respiratory and pelvic diaphragm helps in controlling intra-abdominal pressure and also for the steadiness of the human trunk. In addition, the thoracolumbar fascia which supports lumbar vertebrae on the sacral spine also plays an important role in respiration, load transfer and posture (Willard et al., 2012). The diaphragm contracts concentrically during inspiration, while transverse abdominis and thoracolumbar fascia are gently stretched. These muscles, then recoil and are activated during forced expiration. Therefore, it could be said when there is a problem with any of these connections there will be decreased respiratory efficiency and core muscle instability. This reduces the ability of the diaphragm to draw air into the lungs. A decrease in an expansion of the rib cage, impaired gaseous exchange, decrease in lung volume, alteration in ventilation/perfusion parameters is predictable when the capacity of the diaphragm to ascent and descent properly is condensed.

Recent developments in NS-LBP have heightened the need to investigate members of the population who face respiratory compromise, which could involve altered breathing pattern, reduced respiratory muscle strength, endurance, reduced chest expansion and altered movement of the diaphragm (Kolar et al., 2012; Smith et al., 2006). Very few quantitative analyses showed the influence of respiratory characteristics indirectly among LBP patients, following eight weeks of respiratory muscle training (Janssens et al., 2015, 2013). Although evidence suggested that respiratory rehabilitation needs to be initiated in NS-LBP, whether a respiratory compromise could be improved by undertaking exercise programs has not been revealed clearly. Therefore, it could be argued that having direct outcome measures related to respiratory compromise for testing an exercise regimen would be advantageous for LBP related studies by understanding the therapeutic effects of exercises on respiratory variables.

Furthermore, in order to overcome the difference in core stability exercises and to examine the influence and involvement of respiratory characteristics, this study adapted to earlier protocols of core stability exercises among NS-LBP patients (Hagins et al., 1999). In addition, Boyle et al, 2010 suggested “90/90 bridge” with ball and balloon exercises for improving suboptimal breathing pattern and trunk stability as in the protocol of this study. The 90/90 bridge with ball and balloon exercises was suggested to reduce pain immediately among LBP participants(Boyle et al., 2010). However, the clinical effectiveness of core stability exercise along with the ball and balloon exercises was not tested on NS-LBP populations. Ball and Balloon exercise approach which was implemented in this study is believed to enhance stability and improve neuromuscular control of the diaphragm, abdominal muscles and diaphragm to promote suboptimal breathing. Therefore, this study hypothesized that the inclusion of ball and balloon exercise, together with other core stability exercises, would be advantageous for the NS-LBP population by improving respiratory parameters. Therefore, the objective of this study was to research the effect of core stability with a combined ball and balloon (CBB) exercise on respiratory muscle strength and endurance, breathing pattern, pain intensity, chest expansion and core stability among individuals with NS-LBP.

METHODS

Design

The trial had a prospective design with a pre- and post-trial [TCTR20200302003], and this study followed the Consolidated Standards of Reporting Trial statement for Non-pharmacologic treatment (Boutron et al., 2008). This study received ethics approval from the local Research Ethics Committee [600-IRMI (5/1/6)]; written consent was obtained from each individual participant.

Participants

Male and female participants aged between 18 and 55 years were considered eligible for this study. All of them were diagnosed by physicians from the physician clinic to physiotherapy department clinic, as patients with chronic LBP between the last ribs and gluteal sulcus for a period of at least 6 months (Brumagne et al., 2008; Lawand et al., 2015). The patients had at least three episodes of LBP symptoms for the previous six months (Janssens et al., 2015), with intensity ranging between 2/10 and 5/10 in the numeric rating scale (NRS) and forced expiratory volume of > 80% in the 1st second (FEV1%). FEV1% of more than 80% is considered as normal pulmonary function values

(Gibson et al., 2002). Participants were excluded if they had respiratory disease, pregnancy, numbness or neural signs on their legs or history of surgeries to the lumbar spine (Janssens et al., 2015). The study was conducted in a public university. The participants were recruited from 27 March 2016 to 28 February 2017. The flow of participants is presented in **Figure 1**.

Randomization-sequence generation

The patients were selected randomly and divided into two groups: the experimental group (EG) and control group (CG), and the patients were blinded until they had completed the exercise program. The research assistants were assigned randomly, with each one delivering the protocol for either one of the groups.

Interventions

Both of the groups received treatment for a period of 8 weeks, with exercises carried out for 3 days per week. The patients were selected blindly for the training and evaluated once a week by the research assistants under the supervision of an investigator, and the progression of the exercise was given according to the level of pain. If the level of pain remained the same or was reduced, then the exercise progressed. On the other hand, if the level of pain increased and the participants were unable to maintain +/- 10 mmHg using a pressure biofeedback device, exercise progression ceased. The CG received routine physiotherapy such as ultrasound, spinal flexion or extension exercises, whereas the EG received a predesigned exercise protocol together with routine physiotherapy (**Supplementary 1)** (Boyle et al., 2010; Hagins et al., 1999).

Outcomes

The primary outcomes comprised of maximal inspiratory pressure (MIP), maximal expiratory pressure (MEP) for measuring respiratory muscle strength and maximum voluntary ventilation (MVV) for measuring respiratory muscle endurance using the spirometer. Secondary outcome measures were chest expansion using Cloth Tape Measure (CTM), pain using NRS, faulty breathing pattern using Total Faulty Breathing Scale (TFBS) and core stability using pressure biofeedback device (Mohan et al., 2018). All of the outcome measures were evaluated at baseline and after 8 weeks of treatment**.**

Sample size

MIP was considered as the primary outcome in this study and used for calculating the sample size (using the G*power program 3.1.0 for two tails, paired test). The MIP was taken for sample size estimation with mean $\pm$ SD; 136 $\pm$ 34 cm H_2O and 94$\pm$26 cm H_2O for the high and low Inspiratory Muscle Training (IMT), respectively(Janssens et al., 2015). The estimated sample (power of 80% and a significant alpha level of 95%) required a total of 34 participants. Therefore, at least 17 participants with NS-LBP were required for a treatment group, and another 17 participants were needed to serve as a control group (CG). However, 10% of the sample size was added to account for the possibility of drop-outs. Therefore at least 20 participants per group were examined.

Statistical methods

The data were analyzed using Statistical Package for the Social Sciences (SPSS) software (version 21.0). The measurement variables were subjected to descriptive and inferential analysis. Description of demographic and study variables was presented as mean, standard deviation, frequency, and percentage. Results were tested for normal distribution using the Shapiro-wilk test.

Demographic details between the groups were tested using the Mann-Whitney U-test. The Wilcoxon signed rank test was used to compare pre- and post-values of the EG and CG, based on the assumption of normality. Improvements were reported in different scores and changes in percentage. Comparisons between the two groups were made by using the Mann-Whitney U-test ($p<0.05$).

RESULTS

Table 1 presents the demographic characteristics of the study samples. The results showed no significant differences in characteristics between the EG and CG ($p>0.05$). These findings indicated that the participants were similar in the demographic characteristics.

The clinical background and their results of pre- and post-values were presented in **Table 2** and **Table 3** for primary and secondary variables, respectively. Three EG subjects and two in the CG dropped out during training as they were lost to follow-up due to lack of compliance and thus not considered in the final analysis. MVV values were lower in both baseline- and post-values in the CG when compared with those in the EG. MIP was reduced in the EG in both pre- and post-values when compared with that in the CG. The MEP values were similar.

Primary outcome variables

There was a significant increase in percentage MIP score ($p=0.020$) in the EG, but the CG did not show a change ($p=0.421$). With regard to MEP, there was no significant increase in either the EG ($p=0.282$) or CG ($p=0.782$). This indicated no improvement in MEP for either group. The participants in the EG showed a significant increase in the percentage MVV score ($p<0.05$). The CG showed a similarly significant increase in the percentage MVV score ($p <0.001$). Therefore, this study finding illustrated a significant improvement in respiratory muscle endurance following both treatments.

Secondary Outcome Variable

The participants in the EG and CG did not show improvement in chest expansion measurements for the axilla, 4th intercostal space (ICS) and xiphoid process ($p>0.05$). A significant reduction in NRS scores occurred after treatment for both EG ($p=0.034$) and CG ($p=0.046$). This signified an additional reduction in pain scores in the EG when compared to those in the CG. TFBS and core stability component scores did not change in either group.

A comparison between the EG and CG was calculated using different scores and percentage changes, which showed no differences in primary and secondary variables between the groups (**Table 3**).

DISCUSSION

This study set out with the intention to evaluate the importance of CBB exercises among NS-LBP patients. Its general findings indicated that NS-LBP patients were experiencing reduced pain, improved inspiratory muscle strength, and respiratory muscle endurance with the aid of a designed protocol.

Primary variable

The utilization of forced expiration using a CBB exercise showed improvement in both statistical and clinical viewpoints. The component of respiratory muscle force, which is inspiratory muscle strength, improved in the EG (2.89%) when compared with that in the CG (-3.63%). On the other hand, expiratory muscle strength did not improve in either group. More specifically, the exercise training program prescribed in this study utilized CBB exercises, whereas a previous study used equipment with a mouthpiece(Janssens et al., 2015). Why the expiratory muscle strength did not improve could be due to insufficient exercise intensity in the exercise program utilized for the present study. Similar results of improvement in inspiratory muscle strength were encountered in an earlier study on LBP, in which the results in a high-IMT group showed significant improvements following intervention(Janssens et al., 2015). Hence, it could be stated that the components of CBB exercises, which were designed in this present study and an earlier study, yielded a significant improvement in respiratory parameters(Janssens et al., 2015). The probable reason for the improvement in the inspiratory muscles could be due to the type of muscle spindle, as those muscles have a dense network of blood vessels, which would have been activated to improve the blood flow in resting and exercising muscle (Janssens et al., 2015). The reason for this could be due to improved transverse abdominis muscle activity, increased intra-abdominal pressure, lumbar and core muscle stability. This signifies the inspiratory and expiratory muscle which are indulged in the exercise program through balloon exercise would have altered the efficiency of respiration, breathing pattern, increased activity of paraspinal muscle, improved diaphragm excursion and promoted length-tension relationship through optimizing the zones of apposition (ZOA) which resulted in improvement of MIP values (Boyle et al., 2010). Improvement in lung volume and respiratory mechanics could be distinct following the CBB exercise, and this is typically distinguished in earlier literature through an increase in spirometer values following two sessions of ball and balloon exercise in a male asthma patient (Coughlin et al., 2005).

Improvements that were noted in respiratory muscle endurance among NS-LBP patients were similar to those in earlier studies of chronic obstructive pulmonary disease (COPD) and myasthenia gravis(Rassler et al., 2011; Scherer et al., 2000). Respiratory muscle training for COPD patients was carried out using a newly developed device containing a tube connected to a rebreathing bag (Scherer et al., 2000). This indicated that each study had different types of exercise protocol and equipment to assess the impact of respiratory muscle endurance with a difference in the measurement unit. However, this study utilized the CBB exercise protocol in which assessment of respiratory muscle endurance was carried out using a spirometer. According to the authors' knowledge, this was the first study to explore respiratory muscle endurance following CBB exercises among NS-LBP patients. Therefore, it was not possible to compare the results directly with earlier studies.

A possible physiological explanation for the decrease in values of respiratory muscle endurance among the EG could be due to the impact of exercises on the inspiratory muscles. Increasing work of the inspiratory muscles would have induced fatigue of the diaphragm following exercise in the CBB group. In general, each neuron has a function that activates other neurons. The central and peripheral fatigue of the diaphragm muscle in this study might be due to the failure of exercises in neural activation. In addition, it can be argued that this could be due to the contractile dysfunction of the respiratory muscles(Janssens et al., 2013). Overall, it could be alleged that the intensity and duration of the exercises in this study need to be modified in the future, in order to activate the appropriate neuronal network.

Secondary variable

An important finding was a reduction in pain levels in both groups. It also was interesting that four patients in the EG had no pain at all following intervention. This finding suggested that the detected intensity of pain was reduced and CBB exercises were established and substantiated as an effective tool in improving NS-LBP. This was probably because this protocol enhanced posture and stability(Boyle et al., 2010). The findings were comparable with an earlier study in which pain was reduced following IMT (Janssens et al., 2015). However, the study by Janssens and co-workers could not be compared directly with the current study because of the difference in protocol and the scales used for assessing pain was different (Janssens et al., 2015).

Variables such as chest expansion, TFBS, and core stability did not show changes that were considered convincing as unanticipated findings. The reason for no improvement could be due to the limited periods of training, which if extended probably would have yielded changes in these variables. This study asked the participants to perform three days per week, whereas an earlier one requested the participants to perform inspiratory muscle training seven days per week(Janssens et al., 2015).

Clinical significance

It has been observed that any statistical difference alone in treatment intervention may not be appropriate to present in the results (Cook et al., 2015). On the other hand, specification of target difference for the primary outcome measures used in the study by Cook and co-workers was considered as a key component of randomized controlled trials, and recommended by Difference Elicitation Trials (DELTA) in a recently published article that acted as guidance for researchers (Cook et al., 2015). When considering the statistics component, this study identified the primary outcome as MIP, MEP, and MVV to witness the target difference. In general, the observed change in the outcome was detected usually through minimal clinically important difference (MCID). This study opted for distribution-based methods to calculate the MCID and choose its formula as $1.96 \times \sqrt{2} \times SEM$, where $SEM = SD \times \sqrt{(1\text{-test retest reliability})}$ (Beckerman et al., 2001). The MCID value for MIP and MEP was 39.97 and 34.09, respectively. The results showed significant changes in MIP values following CBB exercises. However, when values of MIP were compared with those of MCID, the results showed 1.95 for MIP following CBB exercises in the EG. Even though the values were not met by MCID as predicted, the percentage change seemed to be increased in CBB exercises (2.89%). With regard to MEP, the MCID values were not met following CBB exercise sessions. Next, with respect to MVV, the standard deviation values were wider, and hence the calculation for MCID yielded 69.07, and this was not comparable with the changes made following CBB exercises. Moreover, the MCID values were calculated for the variables, and they were the only values available to the authors' knowledge. Therefore, further exploration is required in other populations with similar types of evaluations.

Clinical recommendations

This study may provide additional benefit from a more specific clinical observation and application of CBB exercise on the respiratory function, and in particular its role in managing specific respiratory complaints. It is inferred that NS-LBP patients with a faulty breathing pattern with a score of > 2 in TFBS and those with the NRS pain score between 2/10 and 5/10 would be an ideal candidate for this exercise approach as this will optimize the breathing and reduces pain.

Limitations

A possible limitation of these results might be the lack of appropriate training and understanding among the participants who performed MVV maneuvers. A few days of training in MVV maneuvers before the actual reading would have achieved worthy results between the groups. Therefore, appropriate training for the participants is recommended for future studies. The study did not account for psychological issues with relation to NS-LBP which might affect respiration. In addition, there were no normative values for the variables tested in this study to compare with those in NS-LBP patients. Hence, developing normative values for the measurement of variables regarding the healthy person and NS-LBP patients would be advantageous for this area of research.

Conclusions

CBB exercise was effective in improving inspiratory muscle strength and respiratory muscle endurance for NS-LBP. The data in this study suggests that CBB exercise sessions for people with NS-LBP might improve respiratory variables by optimizing breathing and enhancing posture and stability.

Funding: The research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

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Table 1 Demographical Details of the Participants

Characteristics	**Experimental (n=20)**	**Control (n=20)**
Age (Years)	27.10±7.19	30.30±13.47
Gender (%)	Female - 14 (70%)	Female -14 (70%)
	Male - 6 (30%)	Male -6 (30%)
BMI (Kg/m^2)	22.73±4.05	24.76±4.94

Note: No significant differences in the participants' demographics between the groups ($p>0.05$)

Table 2 Comparison of the Primary Outcome Variables between Experimental and Control Group

Parameters	Group	Before (n=20 Both Groups)	After [Experimental: n=17, Control :n=18]	Different Score-Post – Pre (% Change)
MVV (l/min)	Experimental	85.13 ± 23.53	93.82±27.31[a]	8.69 (10.21%)
	Control	75.16 ± 28.06	89.21±26.88 [a]	14.05 (18.69%)
MIP (cm H_2O)	Experimental	67.40 ±15.62	69.35±14.90 [a]	1.95 (2.89%)
	Control	78.80±19.18	75.94±20.82	-2.86 (-3.63%)
MEP (cm H_2O)	Experimental	60.90±10.91	60.52±12.40	-0.38 (-0.62%)
	Control	62.90 ±15.48	63.77±15.23	0.87 (1.38%)

Note: [a]Significant change within the groups ($p<0.05$) from pre- to post-; [b]Significant change between the groups ($p<0.05$)

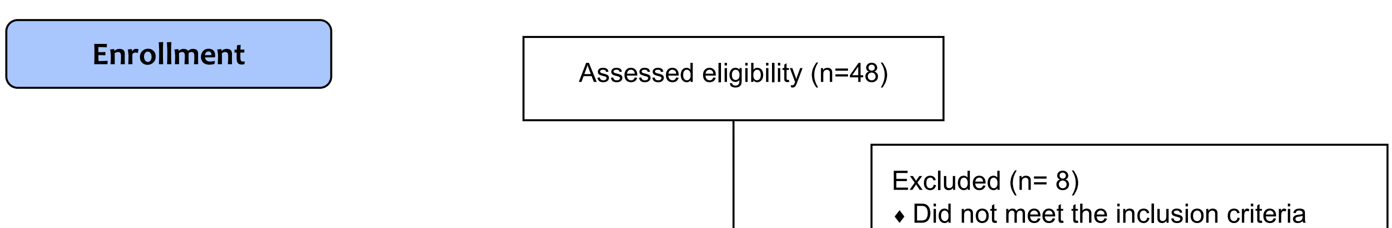
Table 3 Comparison of the Secondary Outcome Variables between the Experimental and Control Group

Parameters	Group	Pre-Values (n=20 Both Groups)	Post-Values (Experimental: n=17, Control: n=18)	Different Score-Post - Pre (% change)
Axilla (cm)	Experimental	1.47±.443	1.50 ± .500	0.03 (2.04%)
	Control	1.50±.513	1.20 ± .460	-0.3 (-20%)
4^{th} ICS (cm)	Experimental	1.45±.484	1.60 ± .523	0.15 (10.34%)
	Control	1.62 ± .455	1.60 ± .613	-0.02 (-1.23%)
Xiphoid (cm)	Experimental	2.27±.658	1.90 ± .544	-0.37 (-16.3%)
	Control	2.42±.466	2.40 ± .591	-0.02 (-0.83%)
Numerical Rating Scale	Experimental	Mild-18(90%) Moderate-2(10%)	None – 4 (20%) [a] Mild – 13 (60%)	0 (0 %)
	Control	Mild-15(75%) Moderate-5(25%)	Mild–17(85%) [a] Moderate –1(5%)	0(0%)
Total Faulty Breathing Scale	Experimental	Mild- 20(100%)	Mild- 17(85%)	0 (0%)
	Control	Mild- 20(100%)	Mild- 18(90%)	0 (0%)

Core Stability	Experimental	Level 2- 2(10%)	Level 2 – 4(20%)	1 (50%)
		Level 3-14(70%)	Level 3 – 10(50%)	
		Level 4-4(20%)	Level 4 – 3(15%)	
	Control	Level 2- 5(25%)	Level 2 – 2(10%)	
		Level 3-9(45%)	Level 3 – 10(50%)	3 (150%)
		Level 4-6(30%)	Level 4 – 5(25%)	
			Level 5- 1 (5%)	

Note:[a]Significant change within groups ($p<0.05$) from pre- to post-; [b]Significant change between the groups ($p<0.05$)

Figure 1 Flow Chart of the participants.



SUPPLEMENTARY 1

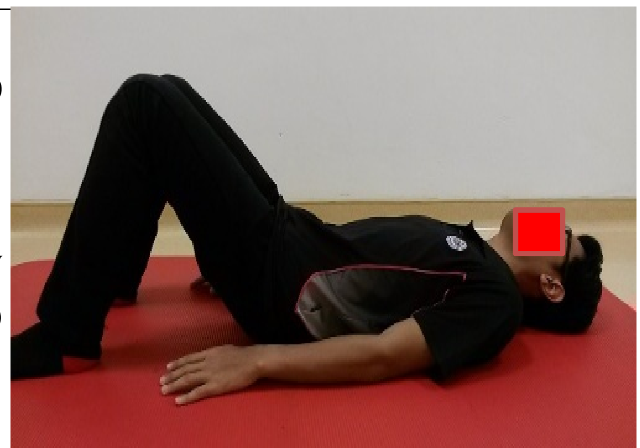
Core Stability combined Ball and Balloon Exercises (CBB)

LEVEL 1 (week 1 and week 2)

Abdominal exercises

1. Draw Lower stomach to spine (1 minute)

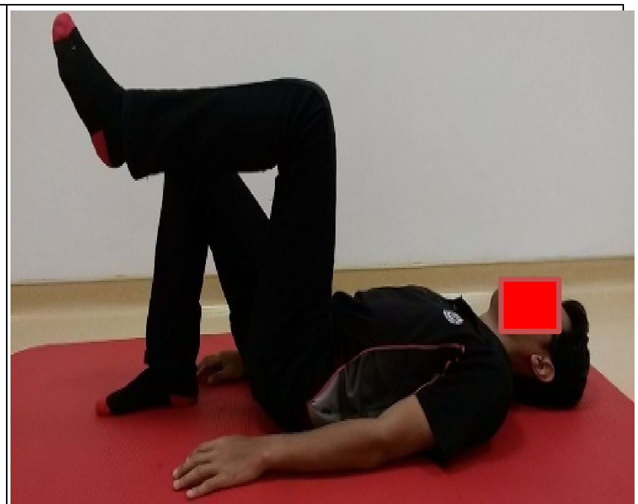
- Lying flat on the back
- Feet on the floor, knees bent to 60 degrees
- Find your neutral spinal position
- Holding that position, gently draw lower stomach to spine (30-40% effort)
- Hold for 5 seconds, keep breathing
- Repeat for 10 times



Drawing Lower Stomach to Spine

2. Leg movements (1-2 minutes)

- Continue in the same position knee bend between 60 to 90 degrees
- Keep that neutral position and draw your stomach in
- Slowly lift one foot off the floor, keep your knee bent and return
- Your hip should stay level and not drop as you lift your foot
- Breathe in as you lift your foot and breathe out as you place it down
- Repeat with the opposite leg
- **Repeat 10 times at each side**



Leg Movements

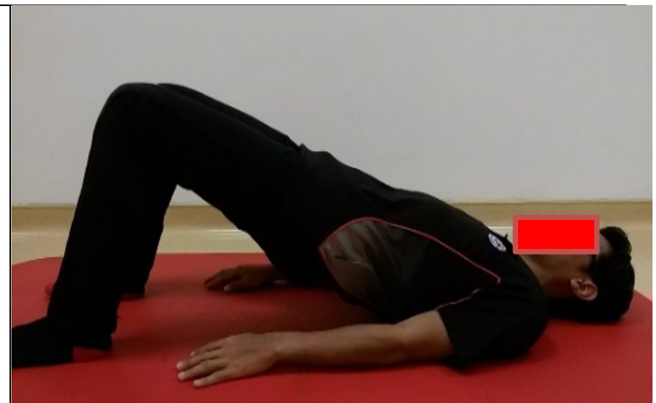
3. Abdominal controlled curls (5-6 minutes)

- Make sure the starting at the same position as above. Find neutral spine and draw your lower stomach in
- Put your hands/arms by your side slowly and curl up by lifting your shoulder blades off the floor
- As your lower do not let your stomach muscles go, keep that lower stomach draw in
- Breathe in as you curl up and out as you in lower
- Repeat for 3 sets with10 times repetitions in each set.

Abdominal Controlled Curls

Buttock/back exercises

4. Bridging (1-2 minutes)

• Again lying flat on your back, find your neutral spine and draw your lower stomach in • Slowly push down through your feet and lift your bottom right up so the trunk is straight (shoulder, hips and knees in line) • Breathe in as you lift and out as you lower • Hold the lift for 5-10 seconds and squeezing your buttock as you lift • **Repeat for 10 times**	 Bridging

5. Wall squats (3-4 minutes)

- Standing with your back to the wall
- Take one step away from the wall, with the leaning against the wall
- Your toes should be in line and slightly turned out
- Find your neutral spine position and draw your lower stomach in
- Holding this position, slowly perform a half squat (your bottom should stay in contact with the wall)
- Hold the squat position for 5 seconds and return to starting position and keep that lower stomach drawn in
- **Repeat 10 times, including 3 sets**

Wall Squats

LEVEL 2 (Week 3 and week 4) Stomach exercises

6. Heel slides (1-2 minutes)

<table>
<tr>
<td>

Starting with the lying flat on the floor
Draw your stomach in by keeping that neutral position.
Slowly lift one foot off the floor. At the same time your hips should stay at that level and not drop as you lift your foot
Slide your heel along the floor until your knee is straight then return to a bent knee
Maintain a strong trunk with very little to no movement
Do it alternatively and repeat it for 10 times at each side.

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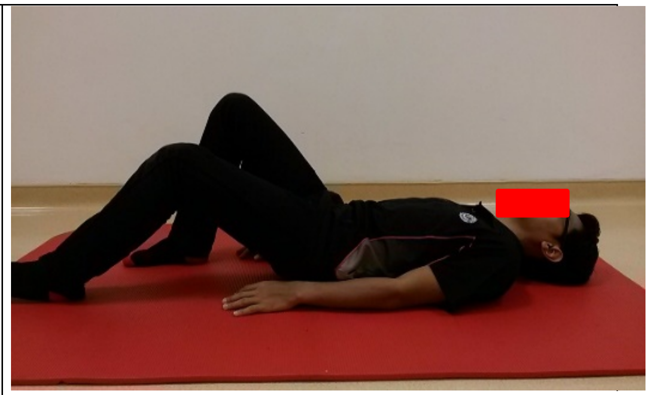
Heel Slides
</td>
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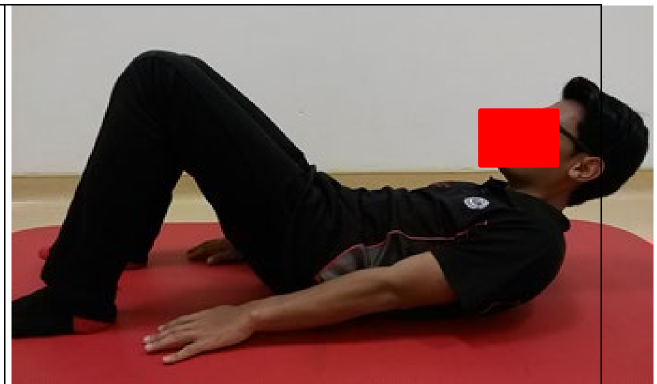
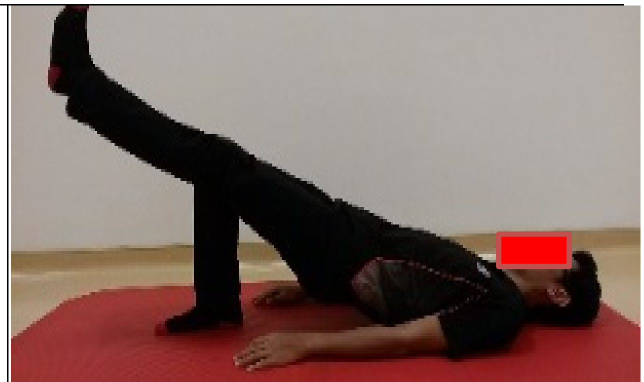
</table>

7. Hundreds (1-2 minutes)

• Start with lying flat on the floor, knees bent and feet on the floor • Elbows and wrists should be straight along your sides • Spine should place in neutral and your lower stomach should drawn in curl up which will put off your shoulder blades from the floor • 5 per inspiration during arm press down, 5 per expiration during arm press up • Repeat it for 4 times and then take rest for few seconds. Do it for 2 sets.	 Hundreds

8. Single leg bridging (4-5 minutes)

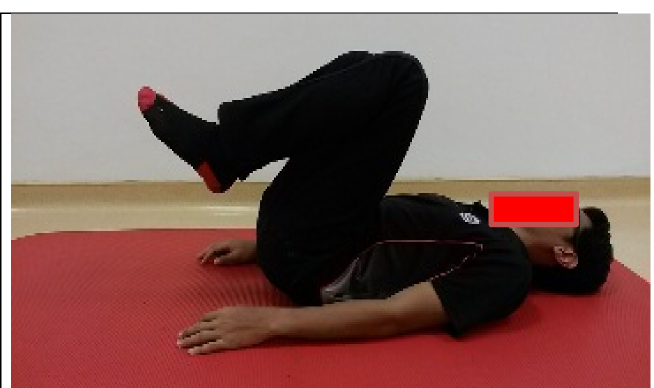
- Again lye flat on your back, find your neutral position.
- Draw your lower stomach in
- Slowly push down through your feet and lift your bottom right up. Therefore, your trunk will be straight (shoulders, hips and knees in line)
- Holding the position slowly lift one foot off the floor
- Again your trunk and hips should stay at the same level and should not dip
- Return your foot in neutral position and repeat on the opposite side
- Breathe in as you lift your leg and out as you return it to the floor
- Repeat it for 10 times with 2 sets



Single Leg Bridging

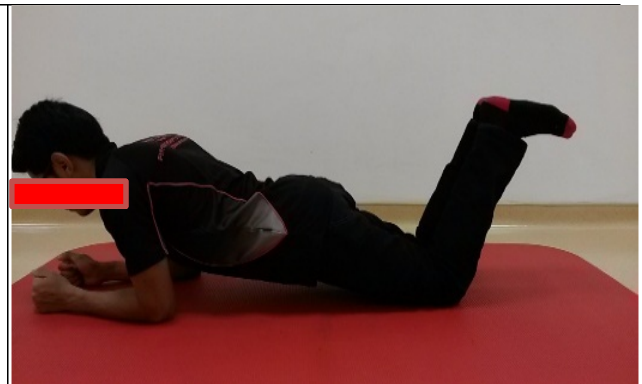
9. Double knee to chest (1-2 minutes)

- Start with lying flat on the back with both knees bend
- Keeping that neutral position draw the lower stomach in
- At the same time bring both knees to the chest and return.



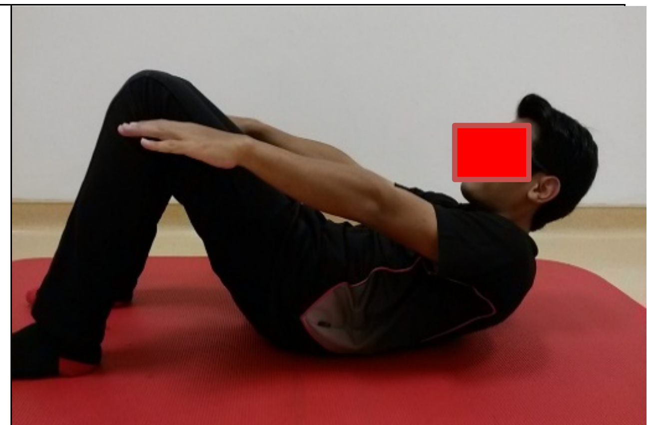
• Repeat for 10 times	Double Knee to Chest

10. Modified plank (4-5 minutes)

• Lying on the stomach, place the elbow on the floor (shoulder width apart and directly under the shoulders) • Take support on the elbows and knees, and be sure that the body is in a flat line (no dip or arch in your spine and bottom tuck in) • Keep the spine in neutral and draw the lower stomach in • Hold the position for 20 seconds, rest for 30 seconds and repeat 3 times.	 Modified Plank

LEVEL 3 (week 5 and week 6)

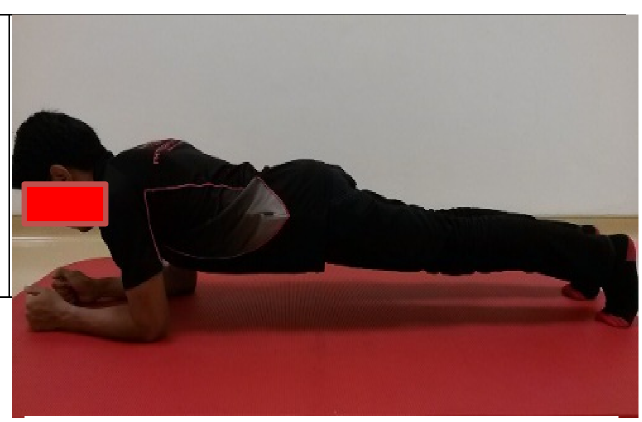
11. Advanced roll ups (2-3 minutes)

• Start with lying flat on the floor, knees bent and feet on the floor • Place the arms and hands along your sides • Gently/slowly lift your head off the floor and draw your lower stomach to your spine like you slowly start to sit up. Then lift your arm to hold your knees • Slowly breathe in as you continue sitting up until you are straight • Pause when you are straight. Begin again with rolling back down and breathing out • Start with your pelvis and slowly unfold your spine as you return to the starting position • Repeat for 20 times	 Advanced Roll Ups

12. Hundreds plus (1-2 minutes)

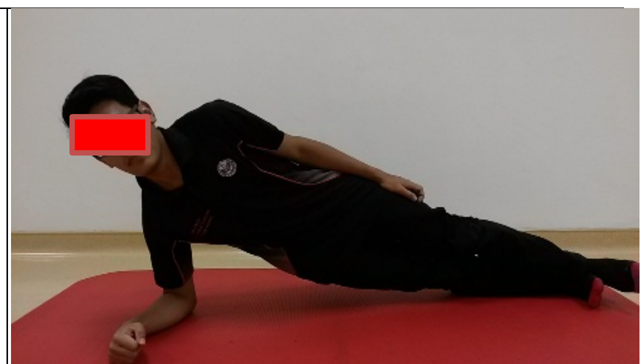
• Start in the same position as you were in level 2 • Instead of keeping your feet on the floor, lift your lower legs so your hips and knees are at 90 degrees and your shins are parallel to the floor • Draw your lower stomach in perform a curl up so your shoulder blades will be off from the ground • Holding this position, perform 5 beats per inspiration and 5 beats per expiration • Repeat for 6 times and rest for few seconds	 Hundreds Plus

13. Front plank (1-2 minutes)

• Place your elbows on the floor shoulder width apart and directly under your shoulders • Support yourself on your elbows and toes. Be sure your body is in a flat line	 Front Plank

(no dip or arch in your spine and bottom tucked in) • Keep your spine neutral and draw in your lower stomach • Hold this position 20-30 seconds and rest for 30 seconds. Repeat it for 3 times	

14. Side plank (2-3 minutes)

▪ Lie on a side on the mat ▪ Place forearm on mat under your shoulder perpendicular to body ▪ Place upper leg directly on the top of lower leg and straighten your knees and hips. ▪ Raise your body upwards by straightening waist ▪ Hold this position for 5 seconds **Repeat it for 10 times each side	 Side Plank

15. Lunges (5-6 minutes)

- Stand in stride position of walking, with your feet hip width apart
- Find your neutral spine and draw in your lower stomach. Think of stretching from your trunk
- Shift 90% of your weight on your bended knee in front. Keep your knee and hip at 90 degrees with your trunk directed straight down but not forward
- Your back heel should come off the ground and keep your arms by your side for balance
- Straighten your knee
- Repeat for 15 times on each leg. Do it for 2-3 sets
- To challenge your core stability and balance start with your feet together and include a step lunge, in between right and left legs alternatively.
- Each and every exercises in all the levels will be interspersed with 1 minute rest.

Lunges

16. Ball and balloon exercises (15 minutes)

The exercise carried out in all the levels starting from first week until eighth week**.** Participants were explained about procedure of testing. Following the procedure first, respondents were instructed to lie on back with feet flat on wall while knees and hips were flexed at 90°. Then, 4-6 inch ball was placed in between the knees**.** Sequentially, the right arm was placed above the head and a balloon held by left hand.

Participants were asked to inhale through nose and perform pelvic tilt while exhaling through mouth. As a result, the tailbone is raised slightly off the mat. The lower back flats on mat without pressed feet into the wall, rather pulled down with heels were ensured. Participants were reminded to feel their back thighs and engage inner ones, try to keep the pressure on the ball, and to maintain this position for the rest of the exercises. Then, instructed to inhale through the nose and blow out into the balloon slowly. There should be a pause of three seconds with tongue positioned on the roof of mouth to prevent airflow out of balloon. Again, the participants were reminded to avoid pinch the neck of the balloon and keep the tongue on the roof of the mouth, following inhale again through nose. Participants stabilize the balloon with left hand, blow out into the balloon slowly. Participants were observed and prevented from straining neck or cheeks as they blew. After the fourth breath in, the neck of the balloon was pinched and removed from the mouth. The air putted away from the balloon. Participants were relaxed and requested to repeat the sequence for four more times(Boyle et al., 2010).

Ball and Balloon Exercise
One session per week, lasted for an hour under supervision for a period of 8 consecutive weeks.

Level I, II and III (Week 7 and week 8)

All the above exercises were practiced in the last two weeks with reduced number of repetitions between 3-5 times and 30 seconds rest between the exercises. This session lasted for an hour along with the ball and balloon exercises.