# The effect of core stability training with and without whole body vibration in chronic low back pain patients

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## ABSTRACT

The subjective of this study was to explore and compare the effects of Whole Body Vibration (WBV) and conventional spinal stabilization exercises on persons with non-specific chronic low back pain (CLBP). Thirty patients with non-specific chronic low back pain randomly received 6 sessions of spinal stabilization therapy with and without whole body vibration over 2 weeks. The severity of pain, functional disability, abdominal and lumbar multifidus muscle endurance were assessed prior to, midway and after two week WBV or spinal stabilization intervention program sequentially by using VAS score, Oswestry disability index and stabilizer pressure biofeedback unit. Repeated measure ANOVA was used for data analysis. A p-value <0.05 was considered as statistically significant. Findings show that multifidus muscle endurance and general functionality increase significantly over time in both groups (P <0/05). Both groups didn't show any statistically significant change in perception of pain, supine and prone time after the treatment period (P>0/05) .Neither of the two exercise interventions wasn't superior in producing more significant results except for multifidus and transverse abdominus muscles endurance where the vibration group showed significant improvement over the non-vibration group. Findings revealed that a slight difference existed in favor of the vibration training group, but not sufficient enough to conclude that it is more effective than core muscle exercises alone.

**Key words:** Whole body vibration; training; non–specific chronic low back pain; core stability

## INTRODUCTION

Despite growing research attempts, nonspecific chronic low back pain remains a great public health burden throughout the industrialized world [1]. Although the common opinion is that 5 to 10% of patients go on to develop chronic pain and disability, higher estimations have been reported for chronic back pain (42–75%) and recurrence of back pain episodes (24–84%)[2]. The prevalence and rising increase in the occurrence of CLBP has been published extensively in the literature [3,4].

Chronic nonspecific low back pain results in both physical and psychological deconditioning that traps the patient in a wrong circle described by decreased physical performance, exacerbated nociceptive sensations, impaired social functioning, work disability, and depression [1]. The physical part of deconditioning involves both stiffness of the lumbar spine - pelvic- femoral unit, decreased muscle strength and endurance, loss of cardiorespiratory adjustment to physical exertion, and neuromuscular inhibition [1]. Increasing rate of sedentary lifestyles, results in the once strong muscle system - that is responsible for maintaining peoples postures and movements, progressively become more inactive, which negatively impinges weakened lumbar core stability in many individuals [7, 8].

The multidimensional nature of this chronic status with a trend to recur, contributes to a large part of work absence, with a consequent loss of efficiency and ultimately imposing a considerable economic burden on health systems as well inflicting great costs on society [4, 5]. The World Health Organization reported that the burden of disability is continuing to grow in developing countries whereas rapid changes occurred in patterns of physical activity [4-6].

Poor spinal and abdominal muscle control was associated with individuals with CLBP[9-11]. Brukner and Khan (2007) agreed with this explanation and reported that individuals with CLBP , illustrated both a delayed timing of onset as well as loss of continuous muscle contraction during activation of the spinal stabilizing muscles [3,12]. Also inhibition and atrophy of multifidus have been observed in LBP-patients [13-15]. In individuals with low back pain, trunk muscle strength and endurance are frequently impaired [4,7,17].

The most important function of the trunk muscles is supporting the vertebrae [15]. The extensor muscles of the lower back are important in the dynamic control of the moving segments [15]. While each of the local paraspinal muscles contributes to spinal stability, the multifidus alone is responsible for more than two-thirds of the increase in stiffness with sagittal plane movements during contraction of the local paraspinal muscles [7,18]. The synergistic contractions of the multifidus and deep abdominal muscles function as a dynamic corset for the lumbar vertebrae [16]. It has been proposed that these muscles via elevated intra abdominal pressure increase spinal stiffness as a result of tensioning the lumbar spine , generation of a posterior shear force against the lumbar spine , decreasing the compliance of abdominal contents , or indirectly by increasing the tension in the thoracolumbar fascia. Intra abdominal pressure has been argued to impress spinal stability through the production of an extensor moment by applying force down on the pelvic floor and up on the diaphragm [20].

Despite the magnitude of the problem, little is known about the exact cause of CLBP [21]. One important risk factor for low back pain is weakness of superficial trunk and abdominal muscles. Another independent risk factor for CLBP is the weakness and lack of motor control of deep trunk muscles, such as the lumbar multifidus (LM) and transverse abdominal (TrA) muscles[9]. Various interventions are used to alleviate pain and reduce disability in persons with low back pain, such as exercise, mobilization, manipulation, electrical and thermal modalities, acupuncture, injection and surgery [4]. Stabilization exercises are a traditional type of exercise frequently prescribed for patients with low back pain. Stabilization exercises are intended to train the trunk musculature and promote muscular strength and endurance to better control intervertebral movements and thus reduce pain and pain related disability [12].

Whole Body Vibration, by contrast, is an alternative method of neuromuscular training that exposes whole body to mechanical vibrations in a controlled way by the selection of pre-set intensities, amplitudes and frequencies. Neuromuscular training reduces stress to healing tissue and perceived pain and enhances general coordination as well as facilitates the effectiveness of strength and endurance exercises [4].

Whole Body Vibration training is a novel neuromuscular mode of exercise that has recently received awareness as both a medium for improving speed-strength performance in elite athletes, but also as an alternative or complementary training modality to existing exercise programs in most biokinetics practices , health and fitness centers [1] . As vibration therapy in the form of WBV is relatively a new mode of training, little research could be found on the impact of WBV training on selected dependent variables, such as perception of pain and general functionality, spinal and abdominal muscle endurance in chronic low back pain patients. Part of the importance and challenge of this study arose in bridging the gap in the lack of documented evidence. So the aim of the present study was to explore and compare the effects of Whole Body Vibration (WBV) and conventional spinal stabilization exercises on persons with non-specific chronic low back pain (CLBP).

We hypothesized that vibration/acceleration training would be a better form of core stability exercises and would be effective in the management of non-specific chronic low back pain, in terms of both subjective and objective clinical findings.

## METHODS AND MATERIALS

Thirty patients with non-specific chronic low back pain randomly received either 6 sessions of spinal stabilization therapy with whole body vibration or without vibration over 2 weeks. They were recruited from the general population. Our participants consisted of 18 males and 12 females with mean age of 27.63 years (range: 20-45).

The inclusion criteria required that all participants presented with symptoms of nonspecific LBP and were experiencing continuous or intermittent symptoms of LBP for period of at least three months, aged between 20-45 years, VAS between 3-5 score. The patient should not have any signs of spinal tumors or metastases , recent fractures of the axial skeleton , inflammatory disease of the spine , progressive neurological defects , heart disease , recent abdominal surgery during the last two years , hip or knee endoprothesis or metal implants , recent venous thrombosis , pregnancy , epilepsy , diabetes, chronic migraine , gallstone, renal stone , balance problem and the patient should not be an athlete.

Exclusion criteria consist of vertigo, paresthesia, heart rate increase, pain severity increase, nausea, anxiety, blurred vision during the treatment period, if the patient doesn't tolerate the vibration and if the patient doesn't want to cooperate. Patients who undertook any type of medication during the study and their BMI were greater than 25 kg/m2 were excluded from the study.

All participants were randomly assigned to one of the two study groups (*i*) a vibrating plate (*n* = 15; WBV group); or (*ii*) spinal stabilization group (*n* = 15). Training was performed three times a week, with at least 1 day of rest between any 2 consecutive sessions and participants were instructed to report any adverse events.

All participants gave their signed informed consent to participate after receiving verbal and written information about the study.

The subjective and objective assessments were measured at baseline, mid – test and at the end of the treatment. Pain was assessed by a visual analogical scale (VAS). The VAS consists of a 10-cm line, with the left extremity indicating ‘‘no pain’’ and the right extremity indicating ‘‘untolerable pain.’’ Participants were asked to use the scale to indicate their current level of pain. Higher values suggest more intense pain[9].

Functional disability was estimated by the Oswestry disability questionnaire, a functional scale assessing the impact of low back pain on daily activities. The score is accounted by the summation of the values assigned for each of the 10 individual questions and is used to classify disability as: mild or no disability (0- 20%); moderate disability (21%-40%); severe disability (41% to 60%); incapacity (61% to 80%); restricted to bed (81% to100%) [9].

Transverse abdominus endurance was assessed by using the Stabilizer Pressure Biofeedback Unit (PBU, Chattanooga Group INC. Alixon TN 37343.USA). The PBU consists of a combined gauge/inflation bulb connected to a pressure cell that registers pressure change in an air-filled pressure cell allowing body movement, especially spinal movement, to be detected during exercise. The pressure cell measures from 0-200 mmHg, with a precision of 2 mmHg. Changes in body position alter the pressure, and they are recorded by the sphygmomanometer[9].The device was placed centrally below the lumbar spine with the bottom of the sleeve in line with the Posterior Superior Iliac spines (PSIS's) while participants were in supine position. The depression of the abdominal muscles over the device decreases the pressure by 2 mmHg. Before individuals were asked to contract the muscle, the device was inflated to a pressure of 40 mmHg. The subject was then instructed to draw the abdominal wall up and in without moving the spine or pelvis. A time-based reading of this contraction was taken by a stop watch. To assess transverse abdominus and internal oblique endurance, the same procedure was done except that the PBU was placed below their abdomen, with the center at navel and the distal edge at the anterior superior iliac spine (ASIS) while participants were in prone position. The depression of the abdominal muscles decreases the pressure by 4-10 mmHg. Before individuals were asked to contract the muscle, the device was inflated to a pressure of 70 mmHg.

The Sorensen test was used in the assessment of back extensor muscles endurance. It measures how long the participant can keep the unsupported trunk (from the anterior iliac crests level up) horizontal, while lying prone on a plinth (standard treatment table) while their arms are held along the sides. During the test, two non-elastic straps were lightly fastened around the participants gluteus maximus and ankles (just superior to the medial and lateral malleoli) for stability on the plinth[23]. The participants were asked to hold the horizontal position until they can no longer control the posture or tolerate the procedure. The total time from the onset of the test to trunk flexion and loss of the static neutral position is recorded as the endurance time or the isometric holding time (in seconds) with the stop watch. Postural awareness and correct technique were essential during every exercise session.

***Whole body vibration group***

During the first consultation, the patient would be trained on how to contract the transverse abdominal muscle by using four point kneeling position tests. After warm up, the patient would be prepared for vibration training on the Power-plate starting at 30 seconds on a frequency of 25Hz per position. The frequency was fixed during 6 sessions but the time increased 15 seconds per two sessions, thereafter, ending on 60 seconds training with the plate on amplitude of 1-3mm (low). Cool down was done after each session.

***Spinal stabilization group***

All the exercises in this program were identical to those performed by the WBV group, but they were done without the vibration platform. Progression was applied by increasing the number of sets and repetitions that took place every two sessions. At first two sessions, all exercises were performed with 8 repetitions. At second two sessions all exercises were performed 2 set with 8 repetitions and the last two sessions all exercises were performed 3 set with 10 repetitions.

***Exercise program [4]***

1- Modified side bridge 2- Abdominal crunch
3-Bridging 4- one arm superman
5- modified superman 6- All fours superman
7- lower abdominal exercise

***Statistics***

Data was entered and analysed in SPSS version 20 (for windows; SPSS Inc., Chicago, IL, USA). Baseline demographics were compared between two treatment groups to ensure that they were equivalent prior to the intervention using independent samples't-tests. To assess normal distribution of the dependent variables, Shapiro-Wilk test was used. Repeated measures ANOVA was used to assess the presence of a treatment effect in each group and compare effects of two groups. A p-value <0.05 was considered as statistically significant.

## RESULTS

The demographic variables of the patients are shown in Table 1. Multifidus muscle endurance increases significantly over time in both groups (P<0.001). Also there was a statistically significant difference between two treatments (P <0.05). The vibration group showed a greater rate of increase than the non-vibration group . A significant multifidus * group interaction effect (P <0.001) signified a statistically significant treatment effect of whole body vibration. Descriptive data of multifidus endurance is shown in table 2. General functionality increases significantly over time in both groups (P <0.05), but there was no statistically significant difference between the groups in terms of rate of change (P = 0.221). No statistically significant functionality * group interaction effect (P = /054) was seen. Descriptive data of multifidus endurance is shown in table 2.

Both groups showed no statistically significant increases in supine (P = /062) and prone time during the treatment period (P = /056) but the difference between two treatment groups in rate of increase, was quite statistically significant in supine time (P <0.05). The vibration group showed a greater rate of increase than the non-vibration group (figure 1) .There was no statistically significant difference between the two treatments in prone time (P =/139) (figure2). However figure 2 shows a trend toward a treatment effect of vibration group. A significant supine * group and prone * group interaction effect (P <0.05) signified a statistically significant treatment effect. A decrease in the perception of pain was noticeable over time in both groups, but the results were not statistically significant (P = /167). There was no statistically significant difference between the two treatments (P = /548) (figure 3). However figure 3 Shows a trend toward a treatment effect of vibration group. No statistically significant pain * group interaction effect (P = /174) was seen.

**Table** 1**.** Demographic characteristics of patients

| | **WBV Group** | | | | **NWBV Group** | | | |
|---|---|---|---|---|---|---|---|---|
| | **maximum** | **Mean** | **SD** | **Minimum** | **maximum** | **Mean** | **SD** | **Minimum** |
| **Age** | 27.13 | 4.94 | 20 | 37 | 28.13 | 5.64 | 20 | 40 |
| **Height** | 166.47 | 4.94 | 153 | 188 | 167.53 | 7.20 | 155 | 180 |
| **Weight** | 61.53 | 11.12 | 50 | 85 | 62.47 | 8.71 | 49 | 76 |
| **BMI(kg / m$^{2)}$** | 22.07 | 1.80 | 17.30 | 24.38 | 22.14 | 1.76 | 17.73 | 24.18 |

**Table2.**Descriptive indices of multifidus endurance and function in two groups

| | **Multifidus endurance** | | | | | | **Function** | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **WBV group** | | | **NWBV group** | | | **WBV group** | | | **NWBV group** | | |
| | **pre** | **mid** | **post** | **Pre** | **mid** | **post** | **pre** | **mid** | **post** | **pre** | **mid** | **post** |
| **Mean** | .31 | .88 | 1.67 | .28 | .75 | 1.11 | 22.36 | 18.81 | 14.6 | 22.45 | 20.6 | 17.71 |
| **SE** | .02 | .07 | .08 | .02 | .05 | .04 | .77 | .66 | .51 | .73 | .72 | .97 |
| **Minimum** | .15 | .41 | 1.11 | .15 | .38 | .56 | 15 | 11.11 | 11.11 | 15 | 15 | 11.11 |
| **maximum** | .49 | 1.45 | 2.44 | .49 | 1.12 | 1.39 | 30 | 24.44 | 20 | 2 | 28 | 28 |

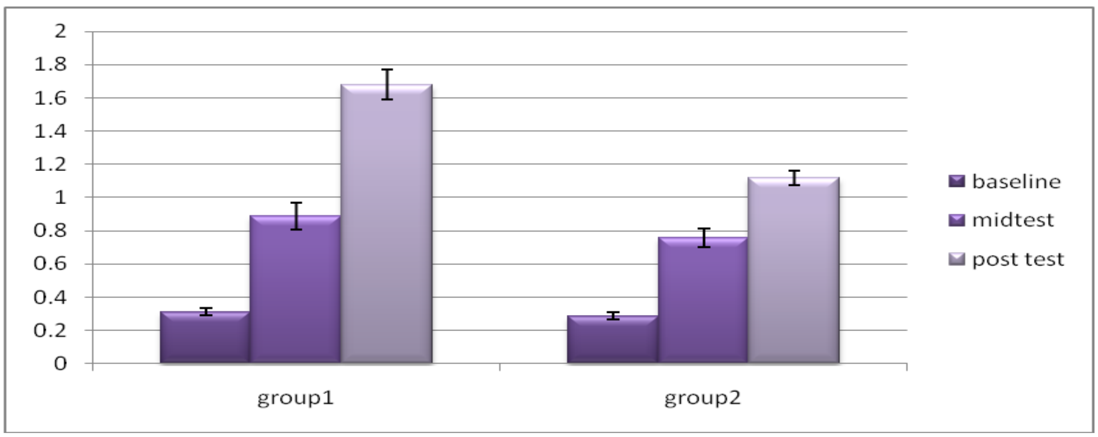


**Figure 1.** Mean and standard error of transverse abdominus endurance in two groups

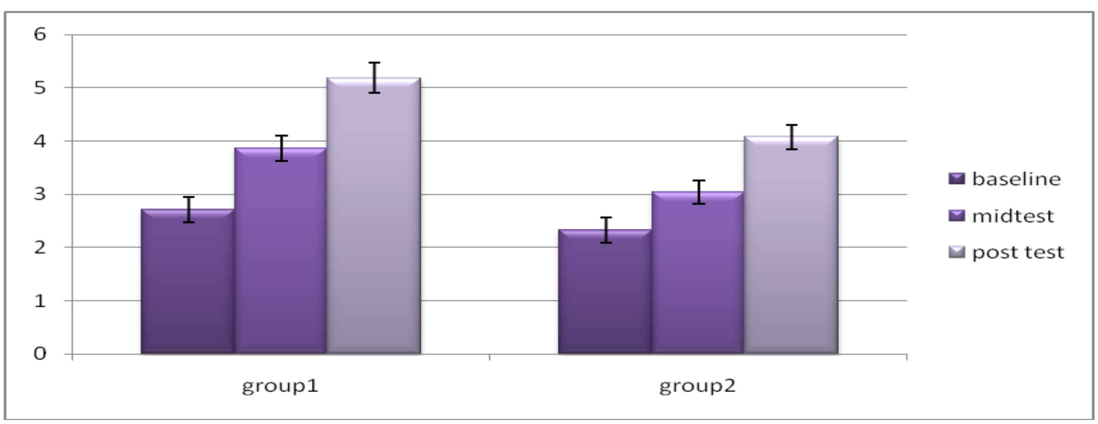


**Figure 2.** Mean and standard error of transverse abdominus and internal oblique endurance in two groups

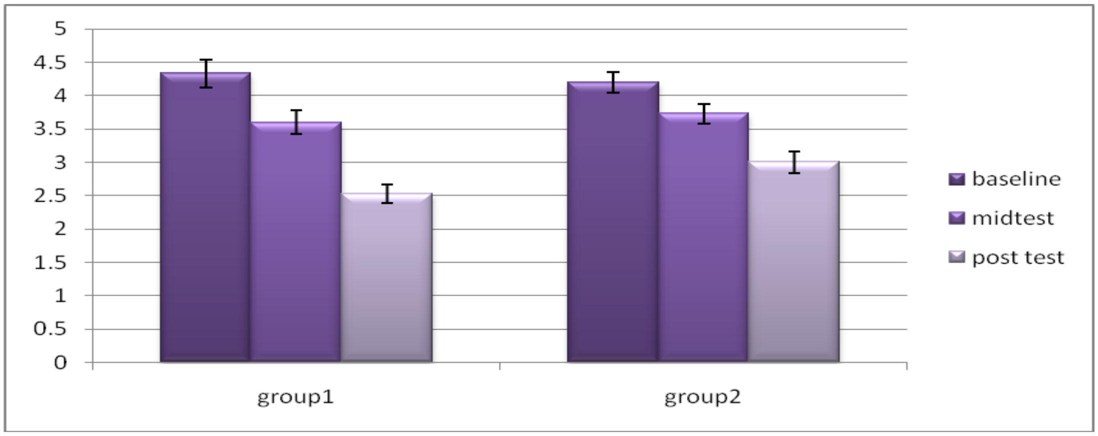


**Figure 3.** Mean and standard error of pain severity in two groups

## DISCUSSION

The aim of this study was to determine the most effective method of intervention for the management of CLBP by comparing WBV and the conventional method of spinal stabilization exercises. The literature indicated functional instability as a major characteristic in LBP. According to literatures, stability of the lumbar intervertebral segments is not only provided by osseous and ligamentous restraints, but also by precise neural input and output referred to as neuro-muscular control [3]. Core stability and movement are dependent on the coordination of all the muscles surrounding the lumbar spine and not only on the lumbar multifidi and transverse abdominal [23]. Studies specified that intervertebral joints, paraspinal muscles and local nerves contribute to CLBP and should be recognized and corrected [3]. Exercise therapy, including postural awareness and re-education, flexibility, stability and strengthening in form of the Alexander technique, Feldekrais method, McKenzie therapy, Pilates and spinal stabilization exercises have been well documented as an essential rehabilitation component in the management of CLBP [4]. The literature mentioned the restorative role of exercise as intervention as well as for the maintenance of a full range of motion and the provision of additional mechanical support to the lower back.

As the etiology of CLBP is often mechanical in nature, biomechanical modification in the performance of ADLs and sport technique is necessary to eliminate the stresses and loads that are responsible for, or deteriorate the CLBP [4]. Motor control endurance is essential to achieve the stability target under all possible conditions of performance [23] . In addition, studies demonstrated that elevated intra-abdominal pressure and contraction of the diaphragm and transverse abdominal provided a mechanical support to the control of spinal intervertebral stiffness or stabilization - particularly with regards to the drawing-in of the abdominal wall [24] .

The results of this study illustrated that both the WBV and spinal stabilization exercises alleviated pain and improved functional disability in the performance of ADLs in individuals with CLBP. This finding is in contrast to the literature in that WBV in industrial and non-industrial status had been considered as a predisposing risk factor in the etiology of CLBP [25,26] . However, differentiation between industrial and therapeutic WBV therapy on variables have been made such as the method of the vibratory application, the individual's posture, the frequency of the application and the duration of exposure to the vibration, as well as the resulting fatigue [30].The results of this study is in parallel with the findings of the literature which indicates that ,well-controlled vibration training might present a cure rather than the cause of CLBP[4,7,27].

The mechanism of proprioceptive feedback potentiation of inhibition of pain whereby an individual's pain threshold was increased, could have contributed to the above mentioned results [24]. Literature approved that WBV had an analgesic effect and indicated a 1.1 – 2.3 times increase in pain threshold as compared with the pre-stimulation threshold [27]. In addition, the result of increased abdominal and spinal muscle endurance after the two-week intervention programs, could have contributed to the alleviation of the pain cycle[28]. Stanford (2002) reported a decrease in perception of pain after spinal stabilization intervention . He also reported a decrease in pain during the performance of functional ADLs which supports the findings in the current study[29]. Both the WBV and spinal stabilization groups indicated increase in abdominal and multifidus muscle endurance. These findings are comparable with the results obtained by the literature which reported increase in abdominal and multifidus muscle endurance after WBV intervention program in persons with CLBP[4,7]. Support for abdominal musculature endurance gains, after participation in WBV intervention program was found in various studies [4,7,30] . These authors showed that vibratory waves irritated the primary endings of the muscle spindle that activated a larger fraction of the motor neuron pool and recruited previously inactive motor units into contraction, thus resulting in a more effective use of the force production potential of the muscle groups involved. This mechanism of motor neuron pool activation was further reinforced during WBV by the recruitment of previously inactive motor neurons, together with their activity synchronization, and increased discharge of the neutral drive which led to greater improvements in neuro-motor control during voluntary muscle contraction. Literature reported increased spinal muscular endurance after completion of a WBV intervention program which supported the findings of this study that indicated an increase in abdominal muscle endurance in WBV group over the two-week intervention period[27].

The spinal stabilization group similarly achieved increase in spinal muscle endurance after two weeks of the intervention. The rationale discussed for the increased abdominal musculature endurance also applied to results obtained for this variable.

The results of the present study indicate that there was no statistically significant difference between two genders in terms of both subjective and objective data. These findings were in contrast to findings of other literatures in which they stated that women generally exhibit greater fatigue resistance than men and demonstrated greater static endurance capacity than men [31,32]. These differences may be as result of lower proportion of women in comparison to men in the current study. Based on the findings for all the selected dependent variables, the proposal can be made that WBV would be considered by the health care professional as means for decreasing the perception of pain and increasing the selected health-related variables in individuals with CLBP.

## CONCLUSION

The present study indicate that both WBV and spinal stabilization training are effective methods of intervention in terms of reducing pain during general functional performance of ADLs and increase in abdominal and multifidus muscle endurance in individuals with CLBP. Overal findings shows that neither of the two exercise interventions wasn't superior in producing more significant results except for multifidus and transverse abdominus muscles endurance where the vibration group showed significant improvement over the non-vibration group . This study has not shown that vibration treatment is a statistical better treatment for this condition according to most of the outcome measurements used in this study, except for the multifidus and transverse abdominus endurance measurements, where the vibration group showed significant improvement over the non-vibration group.

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