Medicina Sportiva (2017), vol. XIII, no 1, 2860-2867
Journal of the Romanian Sports Medicine Society

Comparative effects of muscle energy technique and core stability exercise in the management of patients with non-specific chronic low back pain

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Abstract. This study examined the effect of muscle energy technique (MET) and core stability exercise (CSE) on pain, functional disability, and lumbar range of motion in patients with non-specific chronic low back pain. *Material and Method***.** This study involved 69 non-specific chronic low back patients. They were randomly assigned into four different groups using computer generated numbers. Group 1 received MET, group 2 received CSE, group 3 received MET and CSE and group 4 served as control that received stretching exercise and back care advice. Assessment of pain, functional disability, lumbar range of motion (LROM) were done using visual analogue scale (VAS), modified Oswestry disability questionnaire (MODQ), modified Schober's method, respectively at baseline, end of 4th and 8th week post intervention. Data was analysed using statistical package for social science version 20. Level of significance was set at $p \leq 0.05$. *Results***.** Findings from this study revealed an improved clinical outcome - pain, functional disability, lumbar range of motion of the four groups post intervention ($p \leq 0.05$). However, there was a statistically significant difference between groups. Combination of MET and CSE group produced better clinical outcome in pain, functional disability and ROM ($p \leq 0.05$). *Conclusion.* All participants had improved outcomes following intervention. However the use of both MET and CSE is clinically more beneficial compared to MET alone and CSE alone.
Key words: *muscle, core stability, exercises, functional disability, range of motion*.

Introduction

Low Back Pain (LBP) is a leading cause of disability (1). It occurs in similar proportion in all cultures, interferes with quality of life, work performance and it is the reason for medical consultation (2). Pain in the lower back is a common concern, affecting up to 90% of population at some point in their lifetime and up to 50% have more than one episode (3). It has been found that annual expenditure on the LBP management range from $30-70 billion in United State of America (4).

Low back pain is a discomfort in the area of the lower part of the back and spinal column (5). The low back is susceptible to injury because it supports most of the body weight (6). Chronic low back pain is the pain that persists longer than the expected time period for healing, with duration of more than three months (7). It is the non-specific LBP population which often develops into a chronic fluctuating problem with intermittent flares (8).

Considering the serious economic and social implication of chronic low back pain (CLBP), appropriate management is highly required. Different treatment modalities have been used, but with temporary relief of symptoms and lack of improvement of the atrophy of lumbar multifidus muscle which improves the stability of the lumbar spine (9).

Symptoms of LBP are relieved with the use of physiotherapy modalities such as Transcutaneous Electrical Nerve Stimulator (TENS), massage and manipulative therapy. Temporary effects of these modalities have increased the attention being paid to preferential retraining of local stabilising muscles (10, 5).

Core stability exercises in LBP rehabilitation have become popular due to observed changes in abdominal muscle activation patterns in the presence of LBP (11). Core stability exercises facilitate co-contraction between abdominals and back extensors to maintain the spinal stability so as to transfer the loads equally and to make the patient functionally active (12).

It was reported that Muscle Energy Technique is as effective as manipulation in the treatment of low back pain and results obtained from the different outcome measures considered suggested that both interventions were moderately effective in managing pain and disability in patients with chronic low back pain (13).

This study was therefore designed to compare the effects of Muscle Energy Technique and core stability exercises on pain, disability and range of motion of patients with non-specific chronic low back pain.

Material and Method

A total of ninety six (96) patients (51 males and 45 females) were screened for this study. Seventy four (74) patients met inclusion criteria, while twenty two (22) patients did not meet inclusion criteria and five (5) patients were withdrawn due to illness, transport and lack of effect (Figure 1).

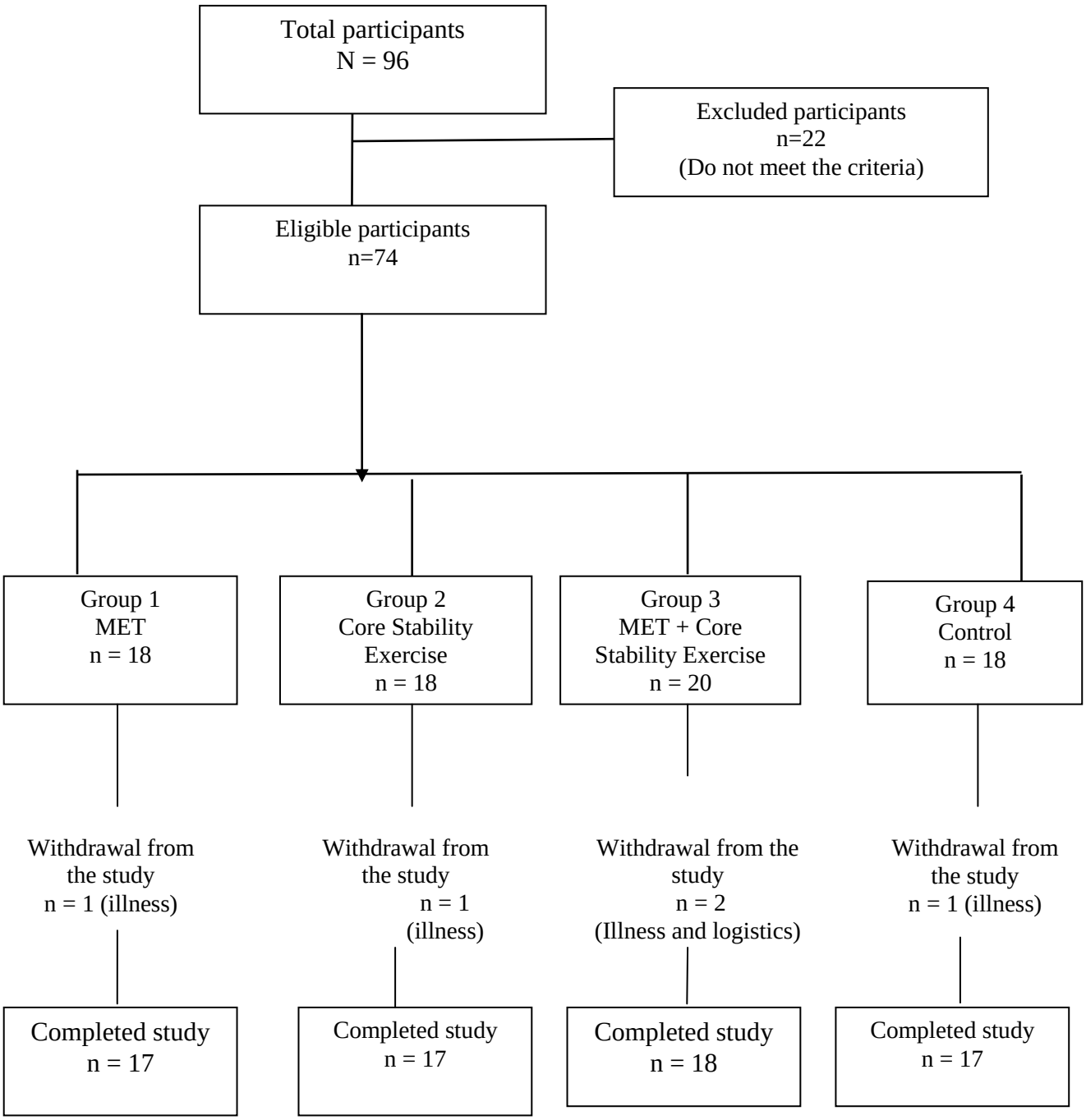

Figure 1. The flow chart of the study

They were patients who presented with non-specific chronic low back pain (NSCLBP) and were referred to Physiotherapy Clinic of two tertiary Hospitals in Nigeria. Included into the study are participants with not less than 3 months onset of Low back pain, participants with no history of previous surgery to the lumbosacral spine, participants with no burning or radiating pain or loss of sensation below the knees. Excluded from this study are participants with previous history of spinal surgery, Participants with NSCLBP who had cognitive impairment or inability to follow instructions, participants with back pain as a result of pregnancy.

Ethical approval for this research was sought and obtained from the Health Research and Ethics Committee of Lagos University Teaching Hospital Idi-Araba, Lagos with registration number: ADM/DCST/HREC/APP/315. Informed written consent was sought and obtained from the participants prior to commencement of the study. The research design was a randomized controlled study.

Demographic and anthropometric information such as name, age, gender, height, body weight and occupation were recorded for each participant. Pain, disability and lumbar spine AROM were measured using visual analogue scale, Oswestry disability questionnaire and modified Scrober method.

The participants were randomly assigned to four different groups via a computer-generated random number sequence. Each group except group 3 had 18 patients from the 74 eligible patients.

Group 1. Participants in this group were treated with muscle energy technique only with a frequency of two treatment sessions per week for 8 consecutive weeks. The movement was sustained for 10 seconds against the therapist resistance (14).

Group 2. Participants in this group were treated with core stability exercise only for 30 minutes duration with a frequency of two treatment sessions per week for 8 consecutive weeks, as adopted from the protocol of Hick et al (15) and Akodu et al (16).

Group 3. Participants in this group were treated with muscle energy technique combined with core stability exercise for 30 minutes duration with a frequency of two treatment sessions per week for 8 consecutive weeks.

Group 4. Participants in this group were treated with back care education and stretching exercises of lower limbs and served as the control group for 15 to 20 seconds duration on each group of muscles with a frequency of two treatment sessions per week for 8 consecutive weeks as adopted from protocol of Odebiyi (17). Subject went through the protocol twice weekly for 8 consecutive weeks. Assessment of pain intensity, functional disability, and Lumbar range of motion was done at baseline, end 4th week and 8th week respectively.

Data Analysis. Statistical Package for Social Sciences (SPSS Inc., Chicago, Illinois, USA) 20.0 version for Windows package programme was used to analyse the data. Demographic and quantitative data were expressed as mean ± standard deviation (SD). Pre and post intervention were analysed using Wilcoxon sign rank test for non-parametric variables and paired t test for parametric variables. Analysis of variance (ANOVA) for normally distributed variables and Kruskal Wallis test for variables that are not normally distributed at baseline, end of 4th and 8th week post intervention. A Post hoc analysis using the least significant difference (LSD) was carried out to compare the mean changes between the four groups in order to detect where statistical difference lies and which treatment protocol was statistically more effective. Level of significance was set at $p \leq 0.05$.

Results

A total of ninety six (96) participants were recruited for the study but only sixty nine (69) participants completed the study. Seventeen (17) participants (24.6%) were in group 1, group 2 also had seventeen (17) participants (24.6%), group 3 had eighteen (18) participants (26.1%), while seventeen (17) participants (24.6) were in group 4. The results showed that the distributions of the social and physical characteristics of the four groups are homogenous. The age range of the participants was between 28 years and 60 years with a mean of 49.67$\pm$8.63 years. The body mass index (BMI) of the participants ranged from 18.70 - 40.40 kg/m^2 with mean of 27.68±4.44kg/m^2. The BMI of nineteen (19) of the participants was within the normal range (18.5kg/m^2-24.9kg/m^2), thirty (30) were overweight (25kg/m^2-29.9kg/m^2), while twenty (20) were obese ($\geq$ 30kg/m^2).

Fifty-one (53%) of the participants were males and 45 (47%) were females; the four groups did not differ significantly in age, height and body mass index (Table I).

Table I. Demographic characteristics of the participants (n=69)

Variables	Group 1 (X±SD)	Group 2 (X±SD)	Group 3 (X±SD)	Group 4 (X±SD)	F-value	p-value
Age (years)	48.06 ±10.13	45.12±10.95	49.67±8.63	47.53 ±9.00	0 .66	0.58
Height (m)	1.64±0 .09	1.65±.07	1.63± 0 .08	1.64± 0.08	0.28	0.84
Weight (kg)	72.17± 12.57	75.47 ±11.82	76.33±17.65	72.41±11.24	0.42	0.74
BMI(kg/m^2)	27.02±4.30	27.83±4.36	28.84± 5.80	26.95 ±2.80	0.68	0.57

*Significance level p ≤ 0.05. Key: Mean± Standard Deviation -X±SD; BMI - Body Mass Index; Group 1 - Muscle energy techniques; Group 2 - Core stability exercises; Group 3 – Muscle energy technique and core stability exercises; Group 4 – Control (stretching exercise and back care education); F-value - One-way ANOVA

Comparison of Pre-treatment and post-treatment intervention of the participants with Wilcoxon sign rank Test. The comparison of the mean score of all the outcome measure parameters at pre-intervention (baseline) and post-intervention (end of 8th week) of each group. Wilcoxon sign rank test showed that there was significant difference between pre- and post- treatment intervention assessment for the entire outcome measures assessed in all the groups except in group 4 (Table II).

Table II. Outcome measure parameters at Pre-treatment and Post-treatment

	Outcome Measure	PRE-Rx (Baseline) (X±SD)	POST-Rx (End of 8th week) (X±SD)	z-Value	p-value
GRP 1	Pain	7.00±0.97	1.50±0.62	3.76	0.01*
	FD	46.11±10.88	19.33±5.72	3.73	0.01*
	ROM	2.86±0.36	4.93±0.20	3.74	0.01*
GRP 2	Pain	6.94±1.25	1.53±0.62	3.69	0.01*
	FD	43.82±13.46	16.12 ±4.83	3.62	0.01*
	ROM	3.00±0.38	4.99±0.13	3.63	0.01*
GRP 3	Pain	6.65±1.00	1.12± 0 .70	3.70	0.01*
	FD	40.35± 12.63	17.94±6.31	3.62	0.01*
	ROM	2.78±0.43	4.98±0.12	3.63	0.01*
GRP 4	Pain	6.59 ±1.23	4.24±0.97	1.67	0.80
	FD	30.00±10.64	26.29±8.45	1.30	1.00
	ROM	2.89±0.43	3.08±0.32	1.02	0.20

**Significant difference at p≤0.05. Key: GRP 1 - Group 1 - Muscle energy technique; GRP2 - Group 2 - Core stability exercise; GRP3 - Group 3 - Muscle energy technique and Core stability exercise; GRP 4 - Group 4 – Control; FD - Functional Disability; Rx – Treatment; z - Wilcoxon sign rank test.*

Comparison of the four groups using post hoc analysis on pain, functional disability and range of motion at the end of the 8th week post treatment intervention (Table III).

Table 3. Outcome Measure parameters at baseline end of 4th week and 8th week between groups

	Outcome Measure	GRP1 (X±SD)	GRP2 (X±SD)	GRP3 (X±SD)	GRP4 (X±SD)	H-Value	p-value
(Pre-Rx) Baseline	Pain	7.00±1.00	6.94±1.25	6.67 ±0.97	6.59± 1.23	0.56	0.64
	FD	46.47±11.11	43.82±13.46	40.33±12.25	30.00 ±10.64	6.24	0.10
	ROM	2.85±0.37	3.00±0.38	2.79±0.42	2.89±0.44	0.84	0.48
(Mid-Rx) End of 4th wk	Pain	2.76±1.03	3.47± 0.87	3.67±0.77	5.71± 1.36	25.65	0.01*
	FD	30.82±9.29	27.47± 7.93	29.83±9.04	28.65 ± 10.01	0.44	0.73
	ROM	4.79±0.32	4.65±0.36	4.39±0.43	2.96±0.39	83.38	0.01*
(Post-Rx) End of 8th wk	Pain	1.53±0.62	1.53±0.62	1.11±0.68	0.68±0.97	65.15	0.01*****
	FD	19.29±5.89	16.12±4.83	18.06 ±6.14	15.29 ± 8.45	8.03	0.01*
	ROM	4.93±0.20	4.98±0.13	4.98±0.12	3.08±0.32	34.96	0.01*

**Significant difference at p≤0.05. Key: GRP 1 - Group 1 - Muscle energy technique; GRP2 - Group 2 - Core stability exercise; GRP3 - Group 3 - Muscle energy technique and Core stability exercise; GRP 4 - Group 4 – Control; FD - Functional Disability; Rx – Treatment; H- Kruskal Wallis; ROM - Lumbar flexion ROM .*

The four groups that were significantly different using Kruskal Wallis test were further analysed with the least significant difference (LSD) post hoc analysis. The significant difference lies between group 1 and 2, group 1 and 3 for pain. The least significant difference (LSD) post hoc analysis showed that there is significance difference between group 3 and 2, 4 and 1, 4 and3 for functional disability. The least significant difference (LSD) post hoc analysis showed that there is significant difference between group 1 and 3, group 1 and 4 for the range of motion.

Discussion

This study was designed to compare the effects of muscle energy technique and core stability exercise in the management of chronic low back pain. There was a marked improvement in clinical outcomes (pain intensity, functional disability and lumbar ROM in muscle energy technique group, core stability exercise group and combination of both muscle energy technique and core stability exercise group. All outcome measures of the study improved significantly post-intervention.

The result of this study reveals that muscle energy technique and core stability exercises are effective in the management of pain associated with patients with non-specific low back pain. This was supported by the findings of Rasmussen-Barr et al (18). They conducted a study on the comparative effect of Stabilisation Training (ST) with Manual Treatment (MT) in sub-acute and chronic low-back pain. After the treatment period, there was a significant difference between the groups in pain severity ($P<0.05$). This finding agrees with the result of the study of Suresh et al. (19) who studied the effects of core stabilisation programme and conventional exercises in the management of patients with chronic mechanical low back pain and found that there was a significant reduction in pain on experimental group who received core stability exercise. Another study by Shivalika et al. (20) also supports the finding of this study. They compared the effect of muscle energy technique and core stability exercises on pain and range of motion (ROM) and reported that there was a statistically significant improvement in pain level especially in Core stability group. This finding was also supported by the report of the study of Akodu et al. (9). Who carried out a study on the effect of stabilisation exercise on muscle thickness of lumbar multifidus (LM) in patient with chronic low back pain. The finding showed that there was improvement in lumbar multifidus muscle thickness and this implies that increased contracted LM muscle was associated with greater improvement in CLBP patients. The reduction in pain by core stability exercises can be attributed to the strengthening of the deep muscles of the back, lumbar multifidus and transversus abdominals muscles and trunk stabilisation from the spine and subsequently reduce low back pain (21, 8). This result supports the result of the study by Akodu et al. (16), who reported that core stability exercise alone, is effective for reducing pain in non-specific chronic low-back pain patients. This is however contrary to the finding of Mindy et al. (22) who in their study of randomized controlled trial of specific spinal stabilization exercises and conventional physiotherapy for recurrent low back pain do not support the use of stabilization exercise in the treatment of NSCLBP. It also disagrees with the study by Koumantakis et al. (23) who compared stabilization exercise with general exercise and reported that stabilization exercise do not provide additional benefit to patients with subacute and chronic low back pain. One possible reason for the difference in the result of Koumantakis et al. (23) and the present study may be due to the age group of the patient that were recruited for their own study.

The result from this study reveals that muscle energy technique improved pain in patients with non-specific chronic low back pain. This finding corroborates previous studies by Mullai et al. (24), Noelle et al. (25). Deepali and Sihddharhan (26), Ajay and Deepinder (27). Who in their own studies reported that muscle energy technique was effective in reducing pain in low back pain patients. The reduction in pain due to muscle energy technique can be based on neurophysiology as described by Chaitow (28) who stated that post isometric relaxation (PIR) refers to the subsequent reduction in tone of the agonist muscle after isometric contraction. This occurs due to stretch receptors called Golgi tendon of the agonist muscle.

These receptors react to overstretching of the muscle by inhibiting further muscle contraction. A strong muscle contraction against equal counterforce triggers the Golgi tendon organ. The afferent nerve impulse from the Golgi tendon enters the dorsal root of the spinal cord and meets with an inhibitory motor neuron (29). The increase in tension of the affected muscles and resulting pain and dysfunction are both relieved by restoring the full stretch length of the muscles.

The result of this study shows significant reduction in functional disability with core stability exercise and muscle energy technique. This result was supported by the findings of a study conducted by Igsoo et al (30) who studied the effects of lumbar stabilisation exercise on functional disability and lumbar lordosis angle in

patient with chronic low back pain. The result also corroborate the report of the study by Sung (31), who applied stabilization exercises to low back pain patients for 4 weeks and it was revealed that there was a significant decrease in the functional disability level of the patients. This result also support the findings of the study of Niemistö et al, (32) who reported that the functional disability level was significantly lower in 204 patients who performed trunk stabilization exercises for 3–12 months than the control group. This assertion was also buttressed by the result of the study of Hicks et al. (15) and Akodu et al. (16) which revealed that functional disability decreased significantly after lumbar stabilization exercises. This study also agreed with result of the study by Eric et al. (33) who conducted a study on Muscle energy technique on patient with acute low back pain and discovered that there was a significant reduction in functional disability level of the patient compared to the control group.

This study also shows that there was a significant improvement in the Lumbar Range of Motion (LROM) post treatment after muscle energy technique, core stability exercises and the combination of the two interventions. This finding agreed with result of the study by Hwi-Young et al (34) that investigated the effects of core exercise programme on active range of motion (AROM) in patients with chronic low back pain and concluded that core stability exercise programme is effective in increasing active range of motion (AROM) in patients with chronic low back pain. This also supports the result of the study of Suresh et al. (35) who in their study found that core stability exercises increase lumbar range of motion. This is similar to the study done by Sekendiz et al. (36) who reported that lumbar stabilisation exercises help mobilise motor units coordinated by the global muscle system and local muscle systems, this exercise helped restore the function of the stabilizers that contribute to the postural control of the trunk and deep abdominal muscles, increasing the range of motion of the joint. This study equally demonstrated an improvement in lumbar range of motion with muscle energy technique and this agreed with the study done by Shivalika et al (20) who compared the effect of core stability exercises and muscle energy techniques on low back pain patients. They concluded that the muscle energy technique and core stability exercises improve LROM of patient with chronic low back pain. Many researchers have proven the efficacy of MET and core stability exercises, but only a few compared both (20). Both exercises have been found to significantly reduce pain, increase lumbar range of motion and functional ability in patients with NSCLBP.

Conclusion

It was therefore concluded that Muscle Energy Technique (MET), Core Stability Exercises (CSE) and combination of the two exercises were all effective in the reduction of pain, functional disability and increase in lumbar range of motion in patients with non-specific chronic low back pain (NSCLBP).

This study established that combination of MET and CSE is better than MET and CSE alone. However the use of both MET and CSE is clinically more beneficial compared to MET alone and CSE alone.

It is therefore recommended that Physiotherapists can conveniently use either of the exercises (Muscle Energy Technique and Core Stability Exercise) in the management of Patients with NSCLBP, since the study showed that both are effective in the treatment of NSCLBP.

References

1. Ehrlich GE (2003). Back pain. *Journal of Rheumatology.* 67:26-31.
2. Frost H, Lamb SE, Doll HA, Carver PT, Stewart-Brown S (2004). Randomised controlled trial of physiotherapy compared with advice for low back pain. *British Medical Journal* 329(7468): 708.
3. Walker BF (2000). The prevalence of low back pain: a systematic review of the literature from 1966 to 1998. *Journal of Spinal Disord;* 13: 205–17.
4. Driscoll E (2011). Cost associated with low back pain treatment, *Asia-Pac Journal of Public Health.* 4:135.
5. Hides JA, Jull GA, Richardson CA (2001). Long-term effects of specific stabilizing exercises for first-episode low back pain. *Spine;* 26: 243-8.
6. Odebiyi DO, Ogunwezi DC, Adegoke BOA (2007). The prevalence of low back pain in commercial motor drivers and private automobile drivers. *Nigeria Journal of Medical Rehabilitation;* 12(1&2)20: 21-24.
7. Panjabi, MM (2003). Clinical spinal instability and low back pain. *Journal of electromyography and Kinesiology;* 13(4): 371-9.
8. Akodu AK, Akinbo SRA, Odebiyi DO (2015a). Effect of stabilisation exercise on pain and disability in patients with chronic low back pain. *Indian Journal of Physiotherapy and Occupational Therapy;* 9(2):175-180.

9. Akodu AK, Akinbo SRA, Odebiyi DO (2014). Effect of stabilisation exercise on muscle thickness of lumbar multifidus in patient with chronic low back pain. *Iranian Rehabilitation Journal;* 12(20):6-10.
10. Danneels W, Vanderstraeten GG, Cambrier DC, Witrouw EE, Bougois J, Dankaert W, De Cyper HJ (2000). Effects of three training modalities on the cross sectional areas of the lumbar multifidus muscle in patients with low back pain. *British Journal of Sport Medicine;* 35:186-191.
11. Vasseljen O, Monica U, Christian W, Paul J (2012). Effect of Core Stability Exercises on Feed-Forward Activation of Deep Abdominal Muscles in Chronic Low Back Pain. *Spine;* 37(13): 1101–1108.
12. Venkata NP, Karnati SKR (2015). Core stabilization programme and conventional exercises in the patients with low back pain: A comparative study. *International Journal of Physiotherapy;* 2(1):352-360.
13. Shiby V (2012). A study on the effectiveness of muscle energy technique (met) as compared to manipulation therapy in chronic low back pain. *International Journal of Latest Research in Science and Technology*; 1(2): 2278-5299.
14. Wilson E, Payton O, Donegan-Shoaf L, Dec K. (2003). Muscle energy technique in patients with acute low back pain: a pilot clinical trial. *Journal of Orthopaedic Sports Physical Therapy;* 33:502-512.
15. Hicks GE, Fritz JM, Delitto (2005). Preliminary development of a clinical prediction rule for determining which patients with low back pain will respond to a stabilization exercise program. Archive Physical Medicine and Rehabilitation; 86: 1753–1762.
16. Akodu AK, Tella BA, Olujobi OD (2015b). Effect of stabilisation on pain and quality of life of patients with non-specific chronic low back pain. *African Journal of Physiotherapy and Rehabilitation Sciences;* 7(1&2): 7-11.
17. Odebiyi DO (2004). *How to avoid back pain at work and rest: A handbook of the Nigerian Back School* (1st edition). Lagos: Crowntex Printing Press Publishers.
18. Rasmussen-Barr E, Nilsson-Wikmar L, Arvidsson I (2003). Stabilizing training compared with manual treatment in sub-acute and chronic low-back pain. *Journal of Manual Therapy;* 8(4): 233–241.
19. Suresh BRA, Einstein J, Sai KN (2015). Effect of core stabilization programme and conventional exercises in the management of patient with chronic mechanical low back pain. *International Journal Physiotherapy;* 2(2): 441-447.
20. Shivalika, Apoorv N Jagmohan S, Sabyasachi B (2013). To Compare The Effect Of Core Stability Exercises And Muscle Energy Techniques On Low Back Pain Patients. *Journal of Sports and Physical Education;* 1:2 9-15.
21. Heiman E, Ramin B, Rasoul E, Mehdi S (2014). Effect of 8-week core stabilization exercises on low back Pain, Abdominal and back muscle endurance in patients with low back pain due to herniation. *Physical Treatment*; 4:25-32.
22. Mindy C,Cairns, Nadine EF, Chris W (2006). Randomised controlled trial of specific spinal stabilization exercises and conventional physiotherapy for recurrent low back pain. *Spine;* 31(19): 670-681.
23. Koumantakis GA,Watson PJ, Oldham JA (2005). Supplementation of general endurance exercise with stabilization training versus general exercise only physiological and functional outcome of a randomized controlled trial of patient with recurrent low back pain. *Cli. Biomech;*. 20: 474-482.
24. Mullai D, Aarti S Tanu A (2011). Comparative Analysis of Muscle Energy Technique and Conventional Physiotherapy in Treatment of Sacroiliac Joint Dysfunction. *Indian Journal of Physiotherapy and Occupational Therapy;* 5(4): 131-134.
25. Noelle MS, Terry L.G, Kevin MC, Kelli P, Jay H, Susan S (2013). Short-Term Effect of Muscle Energy Technique on Pain in Individuals with Non-Specific Lumbopelvic Pain: A Pilot Study. *Journal of Manual and Manipulative Therapy;* 17(1):14-18.
26. Deepali S, Siddhartha S (2014). Effects of muscle energy technique on pain and disability in subjects with SIJ dysfunction. *International Journal of Physiotherapy and Research;* 2(1):305-11.
27. Ajay K and Deepinder S (2015). Effects of Muscle energy Technique on pain and disability in patients with Non-specific low back pain. *Indian Journal of Physiotherapy*; 3:128-131.
28. Chaitow L (2001). Muscle Energy Technique. (2nd Edition) London: Churchill Livingston.
29. Ward RC (2003). *Foundation of Osteopathic Medicine* (2nd edition.) Philadelphia, United State of America: Lippincolt Williams and Wilkins.
30. Igsoo C, Chunbae J, Sangyong L, Daehee L, Gak H (2015). Effects of lumbar stabilization exercise on functional disability and lumbar lordosis angle in patients with chronic low back pain. *Journal of Physical Therapy Science*; 27: 1983–1985.
31. Sung PS (2003). Multifidi muscles median frequency before and after spinal stabilization exercises. *Archive of Physical Medicine Rehabilitation;* 84: 1313–1318.
32. Niemistö L, Lahtinen ST, Rissanen P (2003). A randomized trial of combined manipulation, stabilizing exercises, and physician consultation compared to physician consultation alone for chronic low back pain. *Spine*; 28: 2185–2191.

33. Eric W, Otto, Lisa Donegan-Shoaf, Katherine (2003). Muscle Energy Technique in Patients with Acute Low Back Pain: A Pilot Clinical Trial. *Journal of Orthopaedic and Sports Physical Therapy;* 33:9.
34. Hwi-young C Eun-hye K, and Junesun K (2014). Effects of the Core Exercise Program on Pain and Active Range of Motion in Patients with Chronic Low Back Pain. *J Phys Ther Sci*; 26(8): 1237–1240.
35. Suresh BRA, Einstein J, Sai KN (2015). Effect of core stabilization programme and conventional exercises in the management of patient with chronic mechanical back pain low back pain. *International Journal Physiotherapy;* 2(2): 441-447.
36. Sekendiz B, Cuğ M, Korkusuz F (2010). Effects of Swiss-ball core strength training on strength, endurance, flexibility, and balance in sedentary women. *J Strength Cond Res*; 24: 3032–3040.

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Received: March 2, 2017
Accepted: May 15, 2017