International Journal of Medical, Medicine and Health Sciences
ISSN: 2517-9969
Vol:11, No:12, 2017

The Effects of Pilates and McKenzie Exercises on Quality of Life and Lumbar Spine Position Sense in Patients with Low Back Pain: A Comparative Study with a 4-Week Follow-Up

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***Abstract*—**Non-specific chronic low back pain (NSCLBP) is a common condition with no exact diagnosis and mechanism for its occurrence. Recently, different therapeutic exercises have taken into account to manage NSCLBP. So, the aim of this study has mainly been placed on comparing the effects of Pilates and Mackenzie exercises on quality of life (QOL) lumbar spine position sense (LSPS) in patients with NSCLBP. In this randomized clinical trial, 47 patients with NSCLBP were voluntarily divided into three groups of Pilates (n=16) (with mean age 37.1 ± 9.5 years, height 168.9 ± 7.4 cm, body mass 76.1 ± 5.9 k), McKenzie (n=15) (with mean age 42.7 ± 8.1 years, height 165.7 ± 6.8, body mass 74.1 ± 4.8 kg) and control (n=16) (with mean age 39.3 ± 9.8 years, height 168.1 ± 8.1 cm, body mass 74.2 ± 5.8 kg). Primary outcome included QOL and secondary was LSPS. Both variables were assessed by the WHOQOL-BREF questionnaires and electrogoniameter, respectively. The measurements were performed at baseline, following a 6-week intervention, and after a 4-week follow-up. The ANCOVA test at $P < 0.05$ was administrated to analyze the collected data using SPSS software. There was a statistically significant difference between experimental groups and the control group to improve QOL. But, no difference was seen regarding the effects of two exercises on LSPS ($p < 0.05$). Both Pilates and Mackenzie exercises demonstrated improvement in QOL after 6-week intervention and a 4-week follow-up while none of them considerably affected LSPS. Further studies are required to establish a supporting evidence for the effectiveness of two exercises on NSCLBP.

***Keywords*—**Pilates, Mackenzie, proprioception, low back pain, physical health.

I. Introduction

LOW back pain (LBP) is one of the most common leading causes of musculoskeletal disorders involving most people at least once in their lives [1]. Its recurrence rate has been estimated as high as 16% to 62% [2]. Not only is LBP a tremendous medical problem, but also a vast socioeconomic problem due to the high rate of disability. In the United States, it is estimated to reach $100 billion to $200 billion a year due to work absenteeism and exerting a large burden on the health care system because of engaging LBP [3]. Although the significant resources have been utilized to manage NSCLBP, it appears that current views have resulted in less satisfactory and profoundly affected outcomes for pain and function [4]. One reason for such poor outcomes may be a limited understanding of a clear mechanism or limited knowledge regarding the mechanism of injury; this condition is generally referred to as NSCLBP [5], [6]. As the name implies, there are no specific symptoms such as discopathy, fracture, infection or tumor in NSCLBP [7].

Although the reasons for the occurrence and etiology of NSCLBP are still unknown, it is reported to be closely correlated to bilateral Multifidus (MF) atrophy, diminishing reflex activity, and reflex inhibition caused by afferent input alternation [8], Transverse Abdominis (TA) delay contraction and its disability to contract concentrically [9], functional impairment and paraspinal muscles atrophy [10], lacking feedback from back muscles and the lumbar spine proprioception defect [11], alteration in pattern of trunk muscles function [12], loss of endurance and strength of the trunk muscles [13], increase and decrease in lumbar lordosis [14], [15]. In addition, one of the problems patients with NSCLBP encountered is patient's inability to detect the condition of a limb or joint in space that occurred with a defect in the lumbar spine proprioception [16]. Ultimately, these symptoms all contribute to the patient's inability to perform occupational, recreational or sports activities [17].

Studies in recent years commonly prescribed treatments for NSCLBP such as acupuncture, traction, transcutaneous electrical nerve stimulation, facet injections, laser therapy, massage, and lumbar supports; however, none of these management methods can truly offer a solution to improve NSCLBP [7]. Today, therapeutic exercises have a great deal of pleasure among the researchers and considered by physical therapists as a non-invasive and conservative approach to rehabilitation programs [2]. Aluko et al., in their pilot clinical trial, investigated the effect of specific exercises on MF and TA muscles compared with local and global core stability training. The results demonstrated an increase in trunk movement acceleration accompanied by pain relief and improve disability in patients with acute non-specific LBP. The authors suggested that acute state of non-specific LBP pain may induce the pain-spasm-pain model rather than the pain adaptation model [18]. Kachanathu et al. tried to investigate the effect of therapeutic exercises, including low back, Iliopsoas and Hamstring muscles flexibility along with the abdominal muscles strengthening with and without using Kinesio tape in patients with NSCLBP. The result of this study revealed that, regardless of the use of kinesio tape, exercises

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can significantly affect pain intensity reduction, improving ADL, trunk extension, and flexion ROM in post-test within each group [7].

Recently, therapeutic exercises focusing on the local and global stability of the spine are introduced as Pilates training with the aim of managing and controlling LBP. There are six concerned principals as following that must take into account. 1. Centralization: The basis of all movements as well as the need for trunk stability before limbs' movements. 2. Control: Observing movement while doing them correctly. 3. Precision: Considering doing exercise correctly. 4. Focusing: Placing the exercise in the focus of attention. 5. Respiration: Being prepared by inhaling for the performing motion and exhale operation to move, activating trunk muscle and intensify movement. 6. Movement flow: Progressing the person to the next exercises provided that she/he is thoroughly familiar with the previous one [19]. Lim et al. in a systematic review entitled" Effects of Pilates-based exercises on pain and disability in individuals with persistent nonspecific LBP", by focusing on just previous randomized control trails, tried evaluating Pilates. The results reflected the fact that Pilates-based exercises are superior to minimal intervention for reducing pain in participants with NSCLBP; however, it was not superior to other forms of exercise to reduce pain and disability. The authors also believed that to achieve a credible result, further studies are needed [20].

Conversely, being reputable among therapist and health care practitioners, the McKenzie exercises, include a comprehensive program for evaluating and treating a patient with back pain. To create a central ailment in the low back or to move it from the lower extremity to low back can be called as the main purpose of McKenzie exercises [21]. In a study conducted by Garcia et al., the effects of McKenzie and Back School exercises on 148 patients with NSCLBP during four weeks were assessed. The research conclusion demonstrated the McKenzie exercises superiority over Back school program in improving the subjects' physical disabilities, while there was no significant difference in the effectiveness of these two methods to reduce the pain variable [22].

Based on the aforementioned information and the prevalence of nonspecific LBP in different societies, especially in the Iranian population, as well as the lacking sufficient evidence to compare Pilates and McKenzie trainings, the authors attempted to conduct a study aimed at assessing the impacts and differences between these two methods on QOL and LSPS in patients with NSCLBP in order to provide valuable evidence.

II. Method

A. Study Design and Participants

This was a randomized double-blind controlled clinical trial with simple sampling, conducted in Iran during the period of February 2014-2015 under the supervision of the Department of Sports Rehabilitation at Shahid Bahonar University of Kerman, Kerman, Iran. Firstly, 154 patients with a complaint of back pain were introduced to physiotherapy centers. Those who participated in the research based on the inclusion criteria had the following conditions: 18 to 55 years old of age, diagnosed NSCLBP by an orthopedic surgeon, neurologist, persistence of symptoms for at least three months, person's willingness and satisfaction to participate in the study, suitability of the training for the individual based on clinical evaluation, and no history of lumbar spinal injury or abnormality. The criteria for exclusion also included severe injury in the lumbar or thoracic spine (at least during the last six months), spondylolysis or spondylolisthesis, history of spinal surgery, neurological defects, mental disorders such as depression, pregnancy, and finally those who had undergone, the last three months, the training for the exercises for the lumbar spine and low back [23]. After assessing an experienced physical therapist, 94 of all enrolled subjects were excluded due to lack of inclusion criteria, and 60 eligible participants voluntarily entered the study. Before randomized, blinded assessor performed the subjective and objective examinations (QOL and LSP). All stages of the study process were described with details, and the consent form was signed to them. Then, demographic data of all subjects were collected by the questionnaire designed specifically for the study. Subjects, whose number was based on previous studies, were randomly divided into three Pilates, McKenzie and control group (20 subjects for each group). The allocation was concealed by a random numerical sequence in sealed envelopes, each of which contained the name of a group. Before initiating interventions, every participant chose one envelope and opened the chosen envelope. So, the group written on the envelope and in which subject had to attend was disclosed.

Subsequently, 13 subjects withdrew from continuing study due to personal issues. The final statistical analysis was achieved by only 47 subjects into three Pilates (N=16), McKenzie (N=15) and control group (N=16).

Again, the same blinded assessor repeatedly performed the outcome measurements following the 6-week interventions and after a 4-week follow-up. The subjects in experimental and control groups received no exercises and continued their daily lives during follow-up.

1) Procedures for Measuring Outcomes

WHOQOL-BREF questionnaire was utilized to assess the QOL as the primary outcome in the study. The questionnaire is a 26-item tool includes four areas: 1. physical health (seven items) 2. psychological health (six items), 3. social relationships (three items), 4. environmental QOL (eight items), and two general items include QOL and health. The first area includes general health, mobility, daily activities, functional and work capacity, energy and fatigue, pain and sleep. The second one is divided into positive and negative feeling, thinking, learning, memory and concentration, self-steam, bodily image and appearance, religion and personal belief. The third area includes personal relationship, social support and sexual relationship, and finally, the forth as the last area is related to the financial resources, physical safety and security, freedom, health and social services, physical

environment, skills and knowledge, acquisition opportunities, participation in and opportunities for recreational activities, general environment (noise, pollution, traffic, climate) and transport covers. All scores of four to 20 for each area with a higher score are converted to QOL. While there is no overall score for WHOQOL-BREF. It is possible to replace another item if one of them has been lost out of one area. Except for the third area (social relationships), in which more than one missing item is necessary to cancel the calculation when more than two items are lost, the score of that area should not be calculated. Questionnaires in which 20% of items have been missed should be removed [24], [25].

To measure the LSPS as the secondary outcome electrogoniameter was utilized. To accomplish this purpose, the subject was placed in a comfortable, stable position with no shoes and socks. He was asked to open the legs at the width of the shoulder and the eyes had to be closed so that the afferent of the vision system removed. To reduce the feedback from the lower leg and hip during bending, the subject was immobilized with a wooden frame with a belt closing around the pelvic floor under the AIISs. The electrogoniameter's electrodes were applied to L1 and S1 spinous processes. In order to control the movement and obtain a full lumbar spine ROM, the examiner's thumbs were placed on two SPISs and then the person was asked to bend forward. Then, the bending motion stopped when the pelvis began to tilt. Therefore, the full lumbar spine ROM was measured and its value was recorded as the maximum amount of bending angle in lumbar spine region. In the end, 30% and 60% of this value were determined as the two target angle reproduction in pre-, post-, and follow-up tests.

For the two angles of 30% and 60% maximum bending, at first the subject was asked to flex forward and, when they reached the target's angle, kept the situation for two seconds and remembered. Then, the subject returned to the standing position, and after 15 seconds, he again reproduced the desired angle by bending forward. Lastly, the average of the error in the reproduction of the situation was repeated three times as a regression error [26].

B. The Exercise Interventions

During six weeks, the participants in the experimental group received their own training included Pilates and McKenzie. They also were banned from receiving other treatment interventions such as medication and other exercises. However, the patients attending in control group were asked to continue their daily routines and received neither physical therapy treatment programs nor other medical cares. Considering the morality issues, after the study, the treatment process of subjects in the control group continued by the prescription of their specialist physicians. It should be noted that all participants in experimental group completed the exercises from the beginning to the end under the supervision of an experienced physical therapist with knowledge about NSCLBP and therapeutic exercise.

McKenzie exercises consisted of deep breathing in prone, passive trunk extension on elbows in prone, passive trunk extension on hands in prone, passive trunk extension in standing, knee to the chest in crook lying, and trunk flexion in sitting on a chair, that conducted from 1st to 6th week, respectively [21], [27].

Based on the previous studies done by the authors of the current study, the Pilates exercises were carefully planned for participants in the experimental group during the 6 weeks.

The 1st week exercises included shoulder bridge, sidekick, and one leg stretch. The 1st week's exercises pulse hundred were executed in 2nd week. Progression of the two previous weeks' exercises was considered for the 3rd week, and roll up, swine dive, swimming, one leg circle, double arm stretch, spine twist as well as the exercises of week three in the 3rd week were recommended for last three weeks [28]-[30].

C. Statistical Analysis

The Shapiro-Wilk test was set to measure the normal distribution of data. In terms of demographic characteristics, one-way analysis of variance (ANOVA) was used to compare the three groups' data. However, to compare the results in both post-test and follow-up between the three groups, Analysis of Covariance (ANCOVA) test was used; then Bonferroni Post-hoc test was done for comparison of inter-group dependent variables ($P<0.05$). All statistical analysis was performed using SPSS software version 20.

III. Result

The data were analyzed for 47 individuals who finished the prescribed exercises for six weeks, and a four-week follow-up. According to the results in Table I, all demographic data including age, height, body mass, body mass index, and duration of back pain were normally distributed with no significant difference between the three groups ($P>0.05$).

The obtained measurements related to the QOL and the LSPS in the three pre- and post-test and follow-up in two groups are shown in Table II.

The results of ANCOVA showed that there was a significant difference in physical health ($F(2,43)= 87.0$; $P < 0.001$), psychological health ($F(2,43)= 86.7$; $P<0.001$), social relationships ($F(2,43)= 134.6$; $P<0.001$), and environmental QOL ($F(2,43)= 78.1$; $P<0.001$) between the two experimental groups compared with control group. The results of Bonferroni Post-hoc test indicated Pilates and McKenzie exercise significantly improved physical health, psychological health, social relationships, and environmental QOL ($P < 0.001$). Although the Pilates exercises were effective than McKenzie on improving physical health ($p <0.05$).

Furthermore, there was a significant improvement in physical health ($F(2,43)= 89.3$; $P<0.001$), psychological health ($F(2,43)= 96.9$; $P<0.001$), social relationships ($F(2,43)= 150.6$; $P<0.001$), and environmental QOL ($F(2,43)= 56.5$; $P<0.001$) in the experimental groups compared with the control group during a four-week follow-up. Based on Bonferroni Post-hoc test, after a four-week follow-up, the effects of Pilates and McKenzie training remained longer in experimental groups in comparison with control group ($P<0.001$). Like the post-test results, the effect of Pilates

exercises on increasing physical health was significantly higher than the McKenzie exercises ($p < 0.05$) (Table III).

TABLE I
DEMOGRAPHIC DATA (MAIN±SD) (N=47)

Variable	Group	Pre-test	Post-test	Effect size	Exercise duration
	Pilates	12.1±61.51	15.1±25.45	1.78	15.1±49.53
PH	McKenzie	12.1±00.37	13.1±71.45	1.21	13.1±69.63
	Control	12.1±32.82	12.2±09.02	0.11	11.2±93.02
	Pilates	12.1±13.25	14.1±32.47	1.60	14.1±53.48
PsH	McKenzie	12.1±48.40	14.1±08.08	1.27	14.1±12.06
	Control	12.1±60.45	12.1±43.64	-0.10	12.1±21.65
	Pilates	13.1±35.30	14.1±99.12	1.35	15.1±13.13
SR	McKenzie	13.1±50.16	15.1±03.07	1.37	15.1±75.29
	Control	12.1±94.32	12.1±79.28	-0.11	12.1±75.29
	Pilates	12.1±88.30	13.1±66.45	0.56	13.1±68.39
EQOL	McKenzie	12.1±75.23	13.1±34.25	0.47	13.1±37.28
	Control	13.1±10.01	12.0±71.9	-0.40	12.0±70.9
	Pilates	3.05±3.43	3.0±53.46	0.00	3.0±55.42
30% TRR	McKenzie	3.0±40.50	3.0±40.65	0.00	3.0±53.61
	Control	3.0±71.56	3.0±70.58	0.01	3.0±78.58
	Pilates	4.0±26.50	4.0±25.50	0.01	4.0±24.52
60% TRR	McKenzie	4.0±04.45	3.0±96.47	0.17	4.0±10.47
	Control	4.0±29.47	4.0±33.50	-0.08	4.0±38.54

Abbreviation: PH: Physical health, PsH: Psychological health, SR: Social relationships, EQOL: Environmental quality of life, TRR: Target angle reproduction

TABLE II
MEAN CHANGES IN THE QOL AND THE LSPS SCORES IN THE THREE GROUPS (MAIN±SD)

Variable	Group			Sig. level
	Pilates (n=16)	McKenzie (n=15)	Control (n=15)	
Age (years)	37.9±1.5	42.8±7.1	39.9±3.8	F=1.401 P=0.257
Height (cm)	168.7±9.4	165.6±7.8	168.8±0.1	F= 0.745 P=0.481
Body mass (kg)	76.5±1.9	74.5±1.8	74.5±2.8	F= 0.687 P=0.508
BMI	26.1±6.3	27.1±0.4	26.1±3.7	F=0.781 P=0.646
Symptom duration (month)	32.18±3.3	30.15±8.3	32.16±4.4	F= 0.042 P= 0.959

IV. DISCUSSION

The aim of current study was to try two kinds of therapeutic methods called Pilates and McKenzie training, for patients with NSCLBP. The statistical analysis revealed that both types of training can considerably improve QOL, based on the WHOQOL-BREF questionnaire, and remain the improvement after one-month follow-up ($P<0.001$). Conversely, the authors detected no significant effect of Pilates and McKenzie exercises on LSPS, based on 30% and 60% angle of reproduction in lumbar spine ROM ($P>0.05$).

QOL is an important part of public health and is a multidimensional concept encompassing the physical, psychological and social aspects of life. QOL in patients with LBP lies in their functional and psychological aspects. Therefore, the importance of therapeutic interventions is to improve the functional aspects and psychological stress in patients [31]. There are evidence-based studies emphasizing on the effects of different therapeutic exercises on QOL in patients suffering from NSCLBP. Khauv and John reported four weeks low-force chiropractic care can significantly improve general health in people with chronic LBP [32]. In another study, Zamani et al. applied Pilates training for women with chronic LBP. They pointed that the Pilates exercises effectively fulfill the improvement of general health in NSCLBP sufferers [33]. The results of the two mentioned studies are consistent with our study's findings. It is clear that MF, TA, trunk extensors, Rectus abdominis, Internal and external oblique abdominis muscles will be activated with regular progressive exercises in patients with NSCLBP [8], [9], [11]. Connecting to the lumbar spine, these muscles lead to an increase in the stability of the spine and ultimately control the inter-vertebrae movements with their activation. In addition, therapeutic exercises can offer others advantages include reducing fatigue thresholds, improving neuromuscular control, improving static and dynamic stability, facilitating motor pattern and righting the wrong one, and increasing muscle strength and flexibility. Under this circumstance, the patient's fear and uncertainty of returning to previous and daily activities are noticeably diminished leading to enhance QOL [34], [11]. Accessing Electromyography could have helped us to distinguish the mentioned muscles activation; however, inaccessibility of it can be considered as one of the study limitations. Moreover, it has been said that performing low load physical activity (three times a week) will reduce anxiety and depression, improve the function of the endocrine, improves blood circulation in the brain as well as increasing self-esteem [35]. It is a commonly held belief that the reason why physical activities can improve psychological health and because relaxation is to increase the level of Noradrenaline in the brain. Those who are happier have high levels of Norepinephrine in the circulatory system, while depressed

people tend to have low levels of this substance. According to evidence-based studies, the more participating in physical activities, the lower the obtained scores for anxiety [36], as well, the association between depression and anxiety with chronic LBP has also been observed [37]. The interaction between the patient and the therapist and other patients during Pilates exercises is emphasized by many researchers. It is said that communication and many people-team training may result in better life-satisfaction and individual responses [38].

TABLE III
RESULTS OF THE COVARIANCE ANALYSIS OF THE QOL IN THE POST-TEST AND FOLLOW-UP (MAIN±SD)

Variable	Period	Source	*F*	*P*
PH	Post -test	Pre-test	269.6	0.000*
		Group	87.0	0.000*
		Error		
	Follow-up	Pre-test	232.8	0.000*
		Group	89.3	0.000*
		Error		
PsH	Post -test	Pre-test	293.4	0.000*
		Group	86.7	0.000*
		Error		
	Follow-up	Pre-test	229.3	0.000*
		Group	96.9	0.000*
		Error		
SR	Post -test	Pre-test	447.1	0.000*
		Group	134.6	0.000*
		Error		
	Follow-up	Pre-test	421.3	0.000*
		Group	150.6	0.000*
		Error		
EQOL	Post -test	Pre-test	806.0	0.000*
		Group	78.1	0.000*
		Error		
	Follow-up	Pre-test	532.2	0.000*
		Group	56.5	0.000*
		Error		

Abbreviation: PH: Physical health, PsH: Psychological health, SR: Social relationships, EQOL: Environmental quality of life, TRR: Target angle reproduction

TABLE IV
RESULTS OF THE COVARIANCE ANALYSIS OF THE LSSP IN THE POST-TEST AND FOLLOW-UP (MAIN±SD)

Variable	Period	Source	*F*	*P*
30% target angle reproduction	Post -test	Pre-test	259.7	0.000*
		Group	0.08	0.920
		Error		
	Follow-up	Pre-test	219.1	0.000*
		Group	0.975	0.385
		Error		
60% target angle reproduction	Post -test	Pre-test	247.5	0.000*
		Group	1.6	0.211
		Error		
	Follow-up	Pre-test	136.9	0.000*
		Group	0.80	0.453
		Error		

Although the emphasizing on the relationship between severity of pain and QOL score was far beyond the scope of the present study, it is likely possible that the reason for the superiority of Pilates training to increase physical health compared with McKenzie exercises is related to the greater improvement in the mean scores of pain and the level of physical disability.

Proprioception is a technical term describing the complex interaction between afferent sensory inputs and efferent motor outputs to control body movement and condition. Many researchers have pointed sensory-motor defects existed in patients with LBP so that these defects can affect spinal segmental stability and ultimately lead to the articular surface injuries, and consequently, cause chronic pain [39]. Studies on individuals' postural stability have shown that any defect in the proprioceptive system leads to a perturbation in some crucial factors such as reaction time, postural control, and balance. Although in this study, as another limitation, the factors and their relationship with QOL and LSPS were not evaluated. In addition, recent studies have stated reducing proprioception, neuromuscular coordination and balance relevant with NSCLBP [40]. Leading to an inaccurate movement and movement pattern, and decreasing motor efficiency this defect can also increase pressure on the lumbar spine in patients with NSCLBP [40]. In addition, due to decreased proprioceptive system function in SI joint, poor neuromuscular function and segmental instability have been observed, in patients with NSCLBP [41]. There are limited studies conducting the effect of training interventions on proprioception and error of target angle reproduction in patients with NSCLBP. The main studies in this field have investigated the effects of the interventions on the balance in NSCLBP sufferers. Deh-bozorgi et al. tried to investigate the effect of sensorimotor training on proprioception and neuromuscular coordination. Based on the results of the study, sensorimotor training can improve proprioception in patients with NSCLBP [42]. These researchers benefited from Huber device which increases neuromuscular coordination and corrects postural condition as well as strengthening spinal deep muscles. Regarding Pilates and McKenzie exercises used in our research, different applied exercises can be considered as the contradiction between these two studies.

V. CONCLUSION

It can be concluded that Pilates and Mackenzie exercises during six weeks can lead to improving QOL, although these two types of training interventions have no significant effect on LSPS and reducing the absolute error of target 30% and 60% angle reproduction.

ACKNOWLEDGMENT

We should like to express our gratitude to all participants who accompanied us favorably.

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