



**EFFECTIVENESS OF NEUROMUSCULAR EXERCISES AND PILATES EXERCISES  
ON PAIN AND FUNCTION IN SUBJECTS WITH CHRONIC KNEE OSTEOARTHRITIS**

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**ABSTRACT**

**Objective:** Osteoarthritis is one of the degenerative disorders characterized by cartilage loss as well as soft tissues around the joint. It is extremely prevalent disease in society, with a worldwide distribution. There are studies showing both Neuromuscular Exercises and Pilates Exercises have been proved effective when compared to Conventional Physiotherapy on reducing pain and improving Function in Chronic Knee Osteoarthritis. But literature is limited on their comparison. Hence, the need of the study arises. **Materials And Methods:** Prospective Study design. 64 subjects with mean age of 53 years having a clinical diagnosis of Chronic Knee Osteoarthritis were randomly allocated in to two groups. In Group I (n=32) subjects were treated with Neuromuscular Exercises, where as in Group II (n=32) subjects were treated with Pilates Exercises. Participants were given intervention thrice a week for 8 weeks. The outcome measures of this intervention were measured in term of VAS for Pain and WOMAC score for Function. **Results:** Independent 't' test was used to compare the mean significance difference between continuous variables. Paired 't' test was used to assess the statistical significant difference pre and post test scores. Statistical analysis of the data revealed that within group comparison both groups showed significant improvement in all parameters. Where as in between groups comparison Neuromuscular Exercises showed better improvement compared to Pilates exercises. **Conclusion:** In this study, 8 weeks of Neuromuscular and Pilates Exercises showed significant improvement in decreasing Pain and Improving Function in subjects with Chronic Knee Osteoarthritis. However Neuromuscular Exercises were found to be more effective when compared to Pilates Exercises.

**KEYWORDS:** Chronic Knee Osteoarthritis, Pilates Exercises, Neuromuscular Exercises, WOMAC.

**INTRODUCTION**

Osteoarthritis (OA) has been defined by the American College of Rheumatology (ACR) as a heterogeneous group of conditions which lead to joint symptoms and signs associated with defective integrity of the underlying bone and joint margins<sup>[1]</sup> (Altman et al, 1996).

Worldwide the prevalence rate of OA is 20% for men and 41% for women and it causes pain or dysfunction in 20% of the elderly. In India, OA is the 2nd most common and has a prevalence rate of 22 to 39% (Tandel 2001).<sup>[2]</sup> Osteoarthritis of the knee typically affects women more than men and has prevalence between 10-15% at age 35 and 35-45% at age 65<sup>[3]</sup> (Wilson et al 1990).

Osteoarthritis is one of the major public health problems with physical disability, preventing performance of daily activities. About one third of the individuals with Chronic Knee Osteoarthritis will experience progression to more advanced diseases which is the leading indication for Knee replacement surgery.<sup>[4]</sup>

Exact cause of Knee Osteoarthritis is not known. However it could be caused by environmental, biomechanical, metabolic, genetic or degenerative changes in the joints.<sup>[5]</sup> Osteoarthritis is categorized in to two types. Primary type cause is intrinsic alteration of the articular tissues themselves. Secondary type has an underlying cause such as fractures in knee joint, obesity, arthritis, previous injury.<sup>[6]</sup> Chronic Knee Osteoarthritis results in symptoms such as a Knee joint pain, tenderness, joint stiffness, decreased muscle strength,

swelling, cracking noise with joint movement, loss of flexibility and proprioception deficits.<sup>[7,8]</sup>

Chronic Knee Osteoarthritis is characterized by repetitive inflammatory response of the articular cartilage or patho-physiological alteration of cartilage matrix, increased subchondral bone caused by hereditary and the development of hypertrophy of the osteoblast activity.<sup>[9]</sup> Risk factors for Chronic Knee Osteoarthritis includes Obesity and Overweight, Gender, Heredity, Occupational factors, Previous trauma, Physical activity, Leprosy, Biomechanical factors, Osteoporosis and Dietary exposures.<sup>[10]</sup>

Chronic Knee Osteoarthritis can be diagnosed by several techniques including medical imaging. Radiographically X- ray has been shown to be imprecise guide for the diagnosis of Degenerative joint diseases. X- ray findings shows loss of joint cartilage, narrowing of joint space and bone spur formation. Kellgren-Lawrence (K-L) classification is typically applied specifically within the context of Chronic Knee Osteoarthritis. Each radiograph was assigned a grade from 0 to 4, which they correlated to increasing the severity of Knee Osteoarthritis; with grade "0" indicates no presence and grade "4" indicates severe.<sup>[11]</sup> Magnetic Resonance Imaging and Ultrasonography used for a detailed visualization of cartilaginous, ligamentous and soft-tissue structures to quantitatively assess the severity and other investigations are serological tests, serum uric acid, ESR (Erythrocyte Sedimentation Rate).<sup>[12,13]</sup>

Current management for Chronic Knee Osteoarthritis focus on Pain reduction, improving range of motion, increase muscle strength and decreased disability.<sup>[14]</sup> Numerous interventions are available for Chronic Knee Osteoarthritis which includes Pharmacological therapies, surgical procedures and Conservative interventions. Pharmacological treatment includes Hyaluronic, NSAIDS, Intraarticular corticosteroids injections, Acetaminophen; Glucosamine. Surgical treatment includes Arthroscopic surgery, Joint fusion, Osteotomy, Arthroplasty, Joint replacement.<sup>[15]</sup> Physiotherapy Management plays a major role in conservative Management, Chronic Pain management by use of either electro modalities ( Transcutaneous electrical nerve stimulation, Thermal modalities, Diathermy, Ultrasound, Cryotherapy, Exercise and biofeedback), manual therapy (Manipulation & mobilization) and Bracing. (Kenneth D 1995, Dr. G. P. Dureja, 2006).<sup>[16,17]</sup>

Recent trends show that exercise therapy includes balance exercises which consist of Strength training, Balance & Perturbation training, Aquatic therapy, Manual therapy, Proprioceptive Neuromuscular Facilitation technique, Retro walking, Functional task training and Aerobic exercises helps protect the joint from painful loads and helps to restore the muscle power and ligament and damaged tissues around joint,

lower extremity through coordination. Young Dae YUN 2010).<sup>[18]</sup>

Recent evidence suggests that Neuromuscular Exercises and Pilates Exercises have shown significant improvements when compared to Conventional Therapy in reducing pain and improving function in subjects with Chronic Knee Osteoarthritis.

A Neuromuscular Training aims to improve neuromuscular control, thus increasing joint stability and balance which may have a protective effect against injury. The Exercises program develop the co-activation of the muscles surrounding joints and active joint stability. Neuromuscular Exercises is an intervention that can have biomechanical effect such as decreased landing forces and adduction and abduction movements as well as physiological effect, such as decreased estrogen levels and increased Hamstring to Quadriceps ratios, in order to increase functional ability, increase the strength of the flexors and extensors muscles of the knee joint and minimize the joint shearing forces.<sup>[19]</sup>

Pilate's Training is a mind-body fitness program. Originally it was developed as mat exercises. But Pilates were used in rehabilitation for the first time in New York in late 1960. Pilates Exercises is an ideal form of exercises for people who are suffering with Chronic Knee Osteoarthritis. Pilates Exercises is based on principles: Control, Concentration, Centering, flowing movement, Precision and breathing. These exercises improve physical and mental conditioning through increasing strength, flexibility, balance and postural awareness by strengthening and stretching exercises. Pilates Exercises is a useful tool for rehabilitation programs and improve overall health status, level of pain, flexibility, and muscular endurance and Proprioception, prevention of injuries and dysfunctions of musculoskeletal system.<sup>[20]</sup>

Previous research has studied the positive effect of physical therapy in Chronic Knee Osteoarthritis. This study focused on two interventions i.e. Neuromuscular Exercises and Pilates Exercises. This comparison, to the best of my knowledge has not been studied before. So, the effort of the study was to investigate the effectiveness of Neuromuscular Exercises and Pilates Exercises on Pain reduction and improving Function in subject with Chronic Knee Osteoarthritis.

#### NEED OF THE STUDY

The physical disability arising from Chronic Knee Osteoarthritis affects the performance of daily activities and negatively affects the quality of life. The greatest increase in the elderly population worldwide is the most important change in the field of public health in the 21<sup>st</sup> century. It has being estimated that the number of people over the age of 65 years will be doubled in the first two decades.

Various types of exercises have been commonly used and are effective non pharmacological treatment modalities for patient with Chronic Knee Osteoarthritis. There are studies showing both Neuromuscular Exercises and Pilates Exercises have been proved effective when compared to Conventional Physiotherapy on reducing pain and improving function in Chronic Knee Osteoarthritis. But literature is limited on their comparison. So, the purpose of the study was to determine the effectiveness of Neuromuscular Exercises and Pilates Exercises on reducing pain and improving function in subjects with Chronic Knee Osteoarthritis.

### AIM OF THE STUDY

The aim of the study was to compare the effectiveness of Neuromuscular Exercises and Pilates Exercises on reducing pain and improving function in subjects with Chronic Knee Osteoarthritis.

### OBJECTIVES OF THE STUDY

To assess the effectiveness of Neuromuscular Exercises on pain and function in subjects with Chronic Knee Osteoarthritis.

To assess the effectiveness of Pilates Exercises on pain and function in subjects with Chronic Knee Osteoarthritis.

To determine the effectiveness of Neuromuscular Exercises when compared with Pilates Exercises on pain and function in subjects with Chronic Knee Osteoarthritis.

### HYPOTHESIS

**Research Hypothesis:** Neuromuscular Exercises will have a significant effect when compared to Pilates Exercises on reducing pain and improving function in subjects with Chronic Knee Osteoarthritis.

**Alternative Hypothesis:** Pilates Exercises will have a significant effect when compared to Neuromuscular Exercises on reducing pain and improving function in subjects with Chronic Knee Osteoarthritis.

**Null Hypothesis:** There will be no significant difference between Neuromuscular Exercises and Pilates Exercises on reducing Pain and improving function in subjects with Chronic Knee Osteoarthritis.

### MATERIALS AND METHODS

This Prospective study design was conducted in accordance with the principles of good clinical practice. Subjects were selected in to the study using a simple Random sampling technique. The study population includes 64 patients with mean age of 53 years. The study was undertaken at the Department of Physiotherapy, GSL Medical College & General Hospitals Rajamahendravaram, Andhra Pradesh, India. A total of 150 subjects were screened with through physical examination and 64 subjects who fulfilled the selective criteria were recruited to volunteer in this study. All the eligible participants were consecutively randomized in to Neuromuscular Exercises and Pilates Exercises groups.

The study obtained prior approval from the Institutional Ethical Committee of GSL Medical college and General Hospital and a written consent was obtained from each subject participating in this study.

The included participants were of age 45 to 60 years, able to ascend and descend at least a flight of stairs, No warmth to touch, Radiographic evidence of grade 3 or 4 in Kellegren and Lawrence criteria for Knee Osteoarthritis, Morning stiffness, Crepitus with active motion, Tenderness on palpation, symptoms more than 3 months, Pain and limited of ROM. The participants were excluded if they had Osteoporosis, Post traumatic stiffness of knee, Systemic inflammatory diseases, Fractures, Pregnancy, Bursitis, Scars over knee, Hypothermia, Backache, Radiating pain to legs, Fixed deformity limb, sensory loss, Extensor lag.

### OUT COME MEASURES

**VAS** is considered as the gold standard for measuring pain. This tool was first used in psychology by Freyd in 1923. A horizontal 10cm line was drawn on a sheet of paper and dividing 10 equal sections with "0" representing no pain and "10" representing unbearable pain. The patient is asked to mark his pain level on the line between two end points.<sup>[21]</sup>

The secondary outcome measure was taken Western Ontario and MC Master Universities Arthritis Index (**WOMAC**) to measure patient's perception of Symptoms, Stiffness, Pain, Function and Daily living. WOMAC index was developed in 1982. WOMAC was widely used in the evaluation of Hip and Knee Osteoarthritis. Patients were asked to score 33 items from 0 (none) to 5 (extreme) and total score recorded at baseline and end of the treatment. Here higher score indicates better situation and less pain.<sup>[22,23]</sup>

### PROTOCOL

A total of 64 participants with Chronic Knee Osteoarthritis were screened for this study. Those who are willing to voluntarily be included in the study after obtained informed consent. Participants Age, Weight, height and body mass were determined. The participants were classified in to two groups. Group-I (Neuromuscular Exercises) and Group-II (Pilates Exercises) consisting of 32 participants in each group. Baseline assessment of pain evaluation (VAS) and Functional Performance (WOMAC) scores were taken by using the questionnaires.

### THERAPEUTIC INTERVENTIONS

Group-I performed Neuromuscular Exercises and Group-II performed Pilates Exercises for thrice a day for 8 weeks. The exercises consisted of 40 min and remaining 20 min for warm up & cool down.

**GROUP-I: NEUROMUSCULAR EXERCISES.<sup>[24]</sup>**

EXERCISES	DESCRIPTION
<b>Wedding March</b>	Step forward and slightly to one side with leading foot, bring trailing foot together with leading foot; alternate leading foot
<b>Backward wedding March</b>	As above, stepping backward
<b>Side stepping</b>	Stand with feet together, step to side with leading foot, bring trailing foot back to leading foot: repeat for prescribed number of steps, then repeat in opposite direction.
<b>Semi-tandem</b>	Walk heel to toe with heel landing just in front of and medial to great toe of opposite foot.
<b>Tandem walk</b>	Advanced version of above; heel lands directly in front of opposite foot.
<b>Cross –over walk</b>	Walk forward bringing each foot across midline of body.
<b>Modified grapevine</b>	Step to side with right foot, bring left foot behind right, step to side with right, bring left in front of right; repeat for prescribed number of steps; change leading foot and repeat in opposite direction

**GROUP II: PILATES EXERCISES.<sup>[25]</sup>**

Duration	Exercises	Duration	Frequency
WEEK 1	HUNDRED	5 repetitions	Thrice weekly
WEEK 2	(WEEK 1)+ ONE LEG STRETCH, DOUBLE LEG STRETCH	6 repetitions	Thrice weekly
WEEK 3	(WEEK 2)+ CLAMS	7 repetitions	Thrice weekly
WEEK 4	(WEEK 3)+ ONE LEG KICK	7 repetitions	Thrice weekly
WEEK 5	(WEEK 4) + SIDE LEG KICK	8 repetitions	Thrice weekly
WEEK 6-8	(WEEK 5)+ ONE LEG CIRCLE	10 repetitions	Thrice weekly

**HUNDRED**

Lie on your back with your hip and knee in 90-90 position and your shin parallel to the floor. Relax breathe in and pull your abdomen in. Exhales bring your head up and using abs, curl upper spine off the floor, stay at this position and engaged in the back and inhale. Exhale at the same time, pull your abdomen in tightly and extend your arms and legs. Hold your position breathe in and out. Keep your spine curved and bring your knee toward your chest. Hold your both the knees and lower down the upper spine. Take a deep breath in and out. Repeat it for 5 times.

**ONE LEG STRETCH**

As you inhale, begin to fold your left knee in and stretch you right leg out. Take hold of your left shin and bring it to your chest, left hand above the ankle and right hand below the knee. As you can change from one leg to the other keep your pelvis and spine stable and maintain your abdominal support, keep your shoulder open and your elbow high and wide as you bring your leg to your chest. Continue inhaling as you switch legs, folding your left knee to your chest and extending your right leg. Repeat it for 3 times and hold for 30sec.

**DOUBLE LEG STRETCH**

Lie on your back with your hip and knee in 90-90 position, parallel to the floor inhale. Exhales pull your abdominal in to curve your upper body up of the floor. Bring your head towards the knee. Inhale shoulders should be away from ears, and abs should be pulled in, as

you simultaneously reach your arms and legs in opposite directions. Extend as far as possible while your abs should be kept pulled in and the lower back on the couch. Exhale as you sweep your hands and legs in opposite direction extending as far as possible, hold for 30 sec, repeat it for 3 times.

**CLAMS**

Lie on your side with your feet and hip stacked, shoulder and hip stacked, your knees bent 90 degrees, and head resting on left arm. Draw your knees in toward your body until your feet are in line with your buttock. Place your right hand on your right hip to ensure it doesn't tilt backward. Ensure your back is in neutral and your centre is engaged. Bent your hips to approximately 45<sup>0</sup> and bent your knees to 90<sup>0</sup> inhales to prepare, exhale lift the top knee upwards keeping the feet together as far as you can without rotating hip Hold for 1 second. Repeat it for 7 times.

**ONE LEG KICK**

Participant is in prone position with your legs straight and together and brings the elbow underneath the shoulder. Inhale and bends on knee upward. Push the heel on your bent leg close to your buttocks twice while flexing the foot. Exhale and return it starting position. Repeat it 7 times.

**SIDE LEG KICK**

Lie on right side in a straight line from shoulder to ankles. Prop your head on your right hand and place your

left palm flat on the couch in front of your chest. Move both legs in front of your hips on a slight. Lift the top leg off the bottom leg, and kick it forward. Lengthening the leg as you sweep it to kick back. Only move the leg so far forward or back as you can without moving the pelvis or crunching the lower back. Perform 8 repetitions, and then repeat on other side.

**ONE LEG CIRCLE**

Lie flat on back with arm by side, one leg straight on the couch and other leg straight up to the ceiling. Circle the top leg across the body down and around, while keeping the pelvis stable for 10 circles. Reverse the circle in other direction, circling the leg away from the body down and around. Ensure the pelvis is level and stable and avoid tipping to one side as the leg extends out. Repeat it 10 times.

**STATISTICAL ANALYSIS**

Data were Analyzed using the SPSS version 21.0 and Microsoft Excel 2007. Data were expressed as Mean and Deviation ( $\pm$ SD). The differences between pre-test and

post-test were calculated and expressed as percentages. The level of significance was set at  $P < 0.05$ .

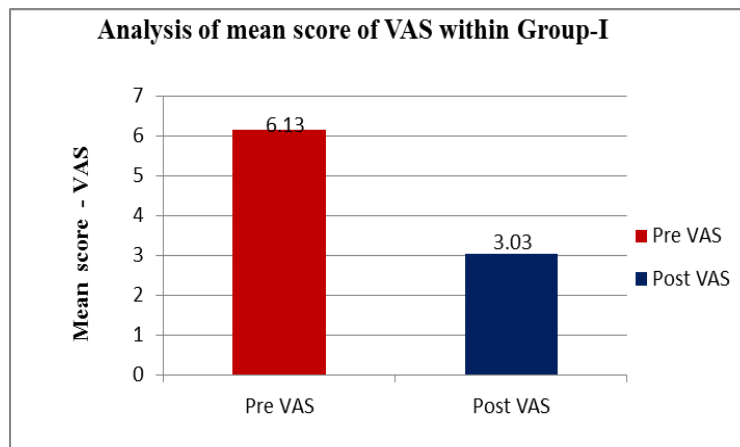
A total of 150 subjects were screened for eligibility, amongst 64 subjects were included in the study trail. All the 64 subjects who met inclusion criteria have undergone baseline assessment and included subjects were randomized into two equal groups consisting 32 subjects.

In this study 30 subjects completed training in Group-I and 30 subjects completed training in Group-II.

**RESULTS**

**Analysis of Mean scores of VAS from pre test to post test within Group-I.**

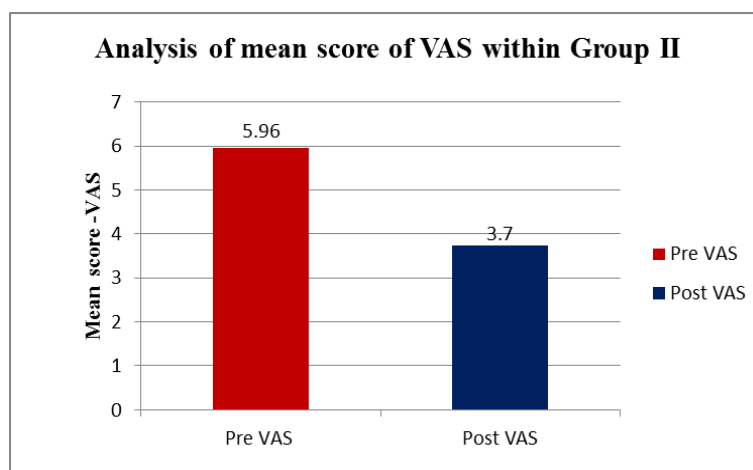
GROUP -I	Mean	SD	P- value	Inference
Pre VAS	6.13	1.7	0.0001	Highly Significant
Post VAS	3.03	0.9		



**Results:** The above Table and Graph shows that mean score of VAS changes from pre-test to post-test values within Group-I were found to be statistically significant ( $P < 0.05$ ).

**Analysis of Mean scores of VAS from pre test to post test within Group-II.**

GROUP II	Mean	SD	P- value	Inference
Pre VAS	5.96	1.6	0.0007	Significant
Post VAS	3.7	0.9		

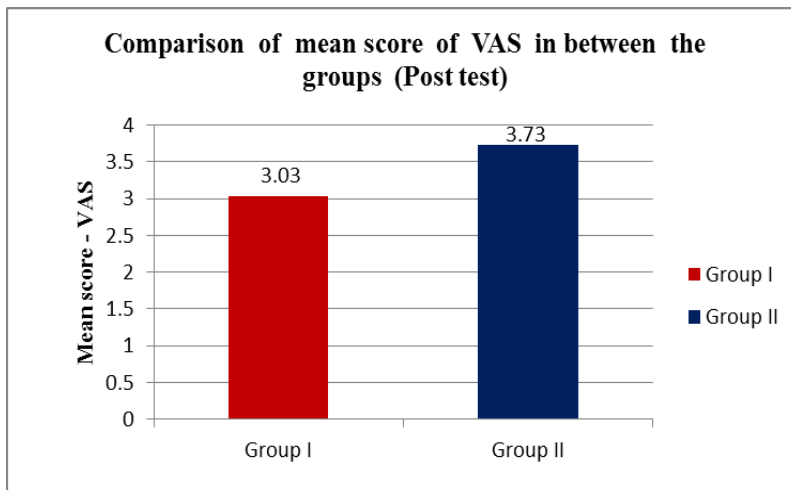




**Results:** The above Table and Graph shows that mean score of VAS changes from pre-test to post-test values within Group-II were found to be statistically significant ( $P < 0.05$ ).

**Comparison of Mean scores of VAS in between the Groups (Post test)**

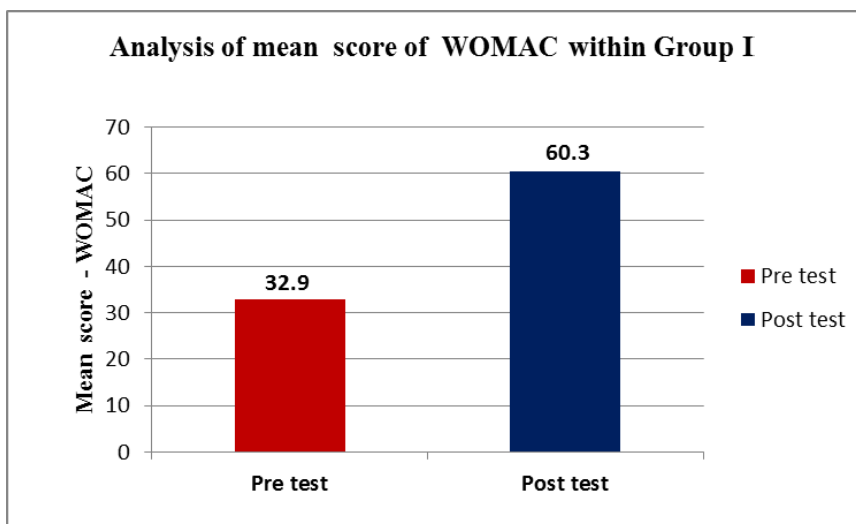
GROUPS	Post VAS Mean	SD	P-value	Inference
Group -I	3.03	0.99	0.008	Significant
Group -II	3.7	0.96		



**Results:** The above Table and Graph shows the Post test measurement of mean score of VAS changes between the Group I ( 3.03 ) and Group II ( 3.7 ) were found to be statistically significant ( $P < 0.05$ ).

**Analysis of Mean scores of WOMAC from pretest to post test within Group-I**

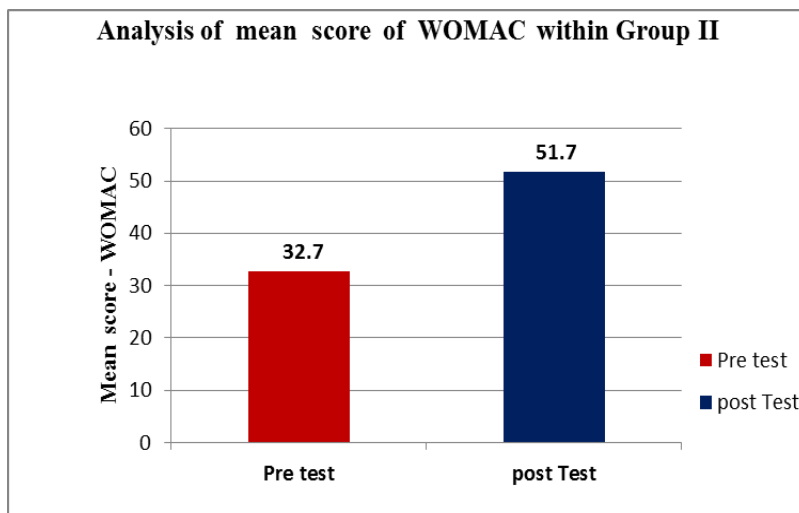
Group -I	Mean	SD	P-value	Inference
Pre WOMAC	32.9	10.5	0.0001	Highly Significant
Post WOMAC	60.3	11.3		



**Results:** The above Table and Graph shows that mean score of WOMAC changes from pre test to post test values within Group-I were found to be statistically significant ( $P < 0.05$ ).

**Analysis of Mean scores of WOMAC from pretest to post test within Group-II**

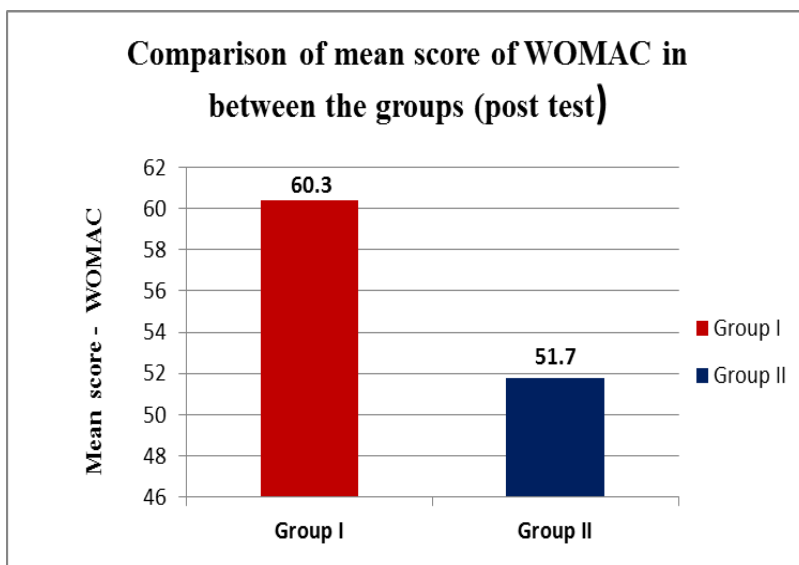
Group -II	Mean	SD	P-value	Inference
Pre WOMAC	32.7	7.40	0.0002	Highly Significant
Post WOMAC	51.76	7.76		



**Results:** The above Table and Graph shows that mean score of WOMAC changes from pre test to post test values within Group-I were found to be statistically significant ( $P < 0.05$ ).

**Comparison of Mean scores of WOMAC in between the Groups (Post test)**

Group	Post WOMAC Mean	SD	P-value	Inference
Group – I	60.3	11.3	0.0001	Highly Significant
Group-II	51.76	7.7		



**Results:** The above Table and Graph shows the post test measurement of mean score of WOMAC changes between the Group- I (60.3) and Group-II (51.7) were found to be statistically significant ( $P < 0.05$ ).

**DISCUSSION**

This study aim to compare the effectiveness of Neuromuscular Exercises and Pilates Exercises on reducing pain and improving function in subjects with Chronic Knee Osteoarthritis. In this study subjects were assessed for knee pain and function using VAS and WOMAC. The results of study indicate that 8 weeks of treatment consisting of Neuromuscular Exercises and Pilates Exercises led to reduce pain and improve function in both the groups. Where as in between groups

comparison Neuromuscular Exercises showed better improvement compared to Pilates exercises.

Chronic Knee Osteoarthritis mostly effects the medial Tibiofemoral compartment of the joint. There is a clear prevalence pattern emerging from most epidemiological studies of this degenerative disease and increases with age and sex differences are evident.

Neuromuscular Exercises program includes strengthening, stretching, plyometric and balance training. This exercises decreased peak landing forces, reduced valgus and varus torques at the knee and increased hamstring function. The results of the study are in accordance with the findings of Hewett et al

demonstrated that, this exercises focus on corrections of dynamic movement pattern, increased hamstring muscle power and strength, increased Hamstring to Quadriceps peak torque ratios and decreased side to side hamstring muscle strength balance.<sup>[26,27]</sup>

The result shows the difference in VAS scoring pre and post treatment. Pre VAS scoring was 6.13 and post treatment the VAS scoring decreased to 3.03 respectively, which indicates that there was highly significant difference between the VAS scores in the subjects in group -I ( $p < 0.0001$ ). The post treatment reduction of pain, stimulates mechanoreceptor within the tendon and muscle (A beta fibers) are activated faster and effective manner and reduction in time between the neural stimuli and muscle response which leads to suppression of impulses through pain gait mechanism.<sup>[28]</sup> O' Sullivan et al demonstrated that, these Exercises improves the proprioceptive mechanism of joint leads to more normal excursion of the joint and contributes to increased range of motion by inhibiting pain through continued A – beta firing during these activities and help in controlling pain.

In this study while evaluating the baseline measurement of pre WOMAC 32.9 and post with the intervention of WOMAC of 60.3 which P value was 0.0001. Due to improvement of function, Neuromuscular Exercises are to improve the ability of the nervous system to generate a fast and optimal muscle –firing pattern, to increase joint stability, to decrease joint forces and to relearn movement pattern and skills. Neuromuscular Exercises improves dynamic stability using a series of physical activities such as balance exercises to activate and adapt the nervous system's proprioceptors to maintain balance and to improve activities of daily living function. It was reported in a study by Roos et al found that 4 months of Neuromuscular Exercises were associated with increased proteoglycan content of the cartilage matrix translates in to a greater cartilage stiffness and greater ability to withstand load.<sup>[29]</sup>

Finding of our study, since significant improvement were reported in Pilates Exercises. Pilates exercises is one of the comprehensive method of both stretching and strengthening exercises aim to create resistance of muscles and to tone up. This exercises increasing body energy, concentration, attention, relaxation of muscles and breathing effect.<sup>[30]</sup>

An improvement was recorded statistically. The result shows the difference in VAS scoring pre and post treatment. Pre VAS scoring was 5.96 and post treatment the VAS scoring decreased to 3.7 respectively. The result shows that there is highly significant difference between the VAS scores in the subjects in group A ( $p < 0.0007$ ). In this study while evaluating the baseline measurement of pre WOMAC 32.7 and post with the intervention of WOMAC of 51.76 which P value was  $< 0.0002$ . Stimulation of these mechanoreceptors such as release of

endorphins can be associated with Pain modulation central mechanisms, acting on its perception. Regarding function, while performing the Pilates postures, there is an increase in the number of sarcomeres and connective tissue remodeling provide a gain ROM, increasing muscle strength and decrease disability.<sup>[31]</sup>

When compared between the groups Neuromuscular exercises and Pilates exercises shows statistically significant in post values. Neuromuscular Exercises mediated through proprioception of joint takes in to three distinct levels of motor activation within the CNS. The first level, reflexes at the spinal level mediate movement pattern that are received from higher level, this action provides for reflex joint stabilization during conditions of abnormal stress about the articulation. The second level of motor control, located at brainstem, receives input from joint mechanoreceptors, vestibular centers and visual input from the eyes to maintain posture and balance of the body. The third level, CNS function provides cognitive awareness of body positions and movement in which motor commands are initiated for voluntary movements.<sup>[22]</sup> The intensity and volume of the Neuromuscular Exercises was progressively increased to constantly challenge the body to adapt to the stress given and this leads to the adaptation of different neural and muscular adaptation.<sup>[32]</sup>

The result of the study shows that Neuromuscular exercises is more effective than Pilates exercises to improve the Pain and Function in subjects with Chronic Knee Osteoarthritis. Hence we can conclude that patients with Chronic Knee Osteoarthritis can achieve significant benefits using Neuromuscular exercises in addition to Conventional Physiotherapy.

## CONCLUSION

The results of the study showed both Group-I (Neuromuscular Exercises) and Group-II (Pilates Exercises) are statistically significant in reducing Pain and improving Function in subjects with Chronic Knee Osteoarthritis. However Group-I (Neuromuscular Exercises) showed more percentage of improvement when compared to Pilates Exercises (Group -II) in reducing Pain and improving Function in subjects with Chronic Knee Osteoarthritis.

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**Conflict of interest:** Nill.

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