



# Effectiveness of Structured Exercise Protocol on Muscle Imbalance of Quadriceps and Hamstrings in Postmenopausal Obese Women

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## Abstract

**Background and Objectives:** In a woman who experienced menopause, there is a decrease in the strength of the muscle due to hormonal changes and because of several changes related to the hormones that occur in the body, it affects the body's BMI which then affects to daily life. Physiotherapy is an effective way of reducing the majority of difficulties while doing daily activities and thereby improving overall health. The study aims to determine how the structured exercise protocol affects a muscle imbalance of hamstrings and quadriceps in postmenopausal obese women. **Methodology:** This research study was carried out on 50 females who experienced menopause and were between the age group 50-60 years the inclusion criteria were satisfied by them and they were divided into 2 groups randomly. Pre-interventional and post-interventional measurements were taken by Modified Sphygmomanometer, by 90-90 SLR test, Range of knee joints by goniometer also pain was assessed. Group A (the Control group) received the treatment which included hot moist therapy along with hamstrings active stretching, isometric exercises for both hamstrings and quadriceps and quadriceps strengthening and Group B received the treatment which included mulligans technique for hamstrings and for quadriceps muscle, MET technique was used. Both groups received the treatment for 6 weeks. **Results:** Statistically significant changes (with p-value <0.05) were seen in the pre and post-interventional measurements. But the value of the mean shows more progress in group B compared to group A. **Research Conclusion:** Both protocols are useful in the treatment of muscle imbalance in quadriceps and hamstrings in postmenopausal obese women but the Structured exercise protocol is more effective than the conventional protocol for muscle imbalance of quadriceps and hamstrings in postmenopausal obese women.

**Keywords:** Hamstring Tightness, Muscle Imbalance, Postmenopausal, Quadriceps Strength

## 1. Introduction

Menopause is the term stated about the phase in which a woman experiences a lot of changes in the body prior to or after the cessation, i.e., cessation of a period of reproduction. It is the term where periods stop for a year and ovarian function also stops which results in permanent amenorrhoea<sup>1</sup>. Menopause is the aging stage and it also

progresses the process of non – non-communicable conditions. Menopause generally occurs in the age of 40 and it differs from woman to woman<sup>2</sup>. Menopause is the process that includes the changes revolving around hormones as stated above. Estrogen hormone plays a big role in the maintenance of overall organs and their functions. Deficiency in the level of estrogen will affect the skeletal muscle function. Some previous research

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studies observed that, estrogen functions in maintaining muscle strength<sup>3,4</sup>. when the estrogen level reduces, the muscle strength also decreases<sup>4</sup>. The changes in the levels of these hormones will affect the activities of daily living<sup>3</sup>. One study stated that locomotor disability and frailty, falls, and fractures lead to not only compromise the quality of life but also these risk factors associated with mortality of women after menopause<sup>4</sup>. Aging is the natural decline in physiological functions which will lead to a reduction in the strength of the muscle and its mass. In some studies, strength loss occurs earlier in age for women than for men. The time period where muscle strength decreases is around 5<sup>th</sup> to 6<sup>th</sup> decades of age and that will hamper their daily life activities. Some studies showed that about 20 to 25 % of muscle strength is reduced between 25-55 years of age. The receptors of estrogen play a role in stabilizing the muscle function. So the drop in the levels of menopause is likely to affect muscle mass and strength<sup>5</sup>. Because of the change in hormone levels, the effect is often seen on the body mass index. After menopause, body mass index increases which leads to a concomitant decline in muscle function<sup>9</sup>. The strength of knee extensors has been related to the gait, ability to climb the stairs, and activity from sitting to standing. Postural stability and also the occurrence of falls. As menopause begins, estrogen level reduces which will affect obesity because of hormonal changes. A previous study stated that the women who experienced menopause suffered from loss of muscle strength. The strength reduction of the quadriceps which may related to the increase in body mass, is constantly carried by these individuals which causes prolonged levels of muscular exertion while doing the daily activities<sup>6</sup>. One previous study concluded that quadriceps strength is reduced in the obese person compared with lean subjects. Knee pain is one of the main reasons and it is prevalent in those aged over 50. Obesity is one of the causes and because of this, it may progress both structural knee osteoarthritis. Reduction in body weight can decrease knee osteoarthritis risk and exercise can help and it can lessen pain<sup>7</sup>. The major function of the knee joint depends on the quadriceps as well as the hamstrings. Evidence suggests that Higher development of the quadriceps will lead to the force of hamstrings causing muscles to imbalance. By giving the exercise protocol, the hamstrings to quadriceps ratio increased<sup>8</sup>. Accumulation of the fat in the body causes the restriction of activities which ultimately decreases the capacity to work<sup>9</sup>. A higher amount of fat

particularly accumulated in the lower extremities, it predicts slower walking speed for both normal and brisk walking<sup>9</sup>. According to the Janda Approach, It was stated that muscles that adapt to tightness quickly are tonic and muscles that adapt to weakness are phasic<sup>10</sup>. So the knee flexor is hamstring and the knee extensor is quadriceps. The hamstrings are also called as antigravity muscle which functions to keep the posture erect. So it has a tendency to go into tightness more than the quadriceps. According to one previous article, in postmenopausal women along with handgrip strength, leg strength is also reduced. The quadriceps is the main weight-bearing muscle and if its functional capacity reduces it will cause loss of balance and it will result in falls<sup>11</sup>. After menopause, this muscle imbalance further leads to musculoskeletal problems, and also postmenopausal women are more prone to osteoarthritis. So knee pain is the earliest symptom along with weakness of the quadriceps. A flexible muscle is one that smoothly moves a joint. If postmenopausal women have osteoarthritis, the overall range will reduced for motion and there will be loss of muscle extensibility acting over the joint, here the hamstrings play an important role which in turn leads to loss of ability to function<sup>12</sup>. In the elderly population, the walking speed affects and leads to imbalance while walking. It is stated that the range of motion will decrease up to adult life from the birth of a child and in that women show greater declines related to the age than men. This decreased range of motion requires altered movement patterns and these will compromise balance and related activities such as ambulation<sup>13</sup>. So the effect of an increase in BMI on these muscles will lead to an increase in the stress on the knee joint and the lower limb and it will cause gait-related problems in the postmenopausal women. In this study, to rule out the effectiveness of muscle imbalance between quadriceps and hamstrings in postmenopausal obese women, a structured exercise protocol will be given which can help to improve the quality of life and it can lead to better health outcomes.

## 2. Study Method

Design of the Study: Experimental type

Type: Comparison between pre and post-of each group

Population included: Postmenopausal females - age 50-60 years

Sample size: 50

### 3. Eligibility Criteria

#### Inclusion criteria

- Women with Group 3 BMI (overweight)
- Age: 50-60 years
- Post menopause duration: 2 years
- Women wanted to take part in the study.

#### Women who didn't satisfy the study criteria:

- Women with Diabetes Mellitus.
- Women with Hypertension
- Any unstable medical conditions
- Any Recent surgeries.
- Any recent lower limb injuries.
- Any known deformity of lower limbs

### 4. Materials Used

Modified Sphygmomanometer, Goniometer

### 5. Outcome Measures

#### 5.1 Quadriceps Strength

Quadriceps strength will be measured by a modified sphygmomanometer.

It will be measured as a pre and post-test outcome measure.

Position of patient

The subject is seated on the table in a high sitting position. Modified sphygmomanometer placement needs to be done in the following way: knee flexors – Back part - leg Extensors – front part - leg

Modified sphygmomanometer should keep parallel to resist the movement of the muscle group which has to be tested. During testing, the Subject was asked to show muscle contraction of that particular group, and an average reading was taken. 3 trials were taken and the rest period in between was 10-15 secs.

#### 5.2 Hamstring Tightness

Hamstring tightness will be measured by 90-90 SLR test. Position of the subject should be supine and hip and knees flexed to 90 degrees and the therapist should check that the patient is in a comfortable position. The subject should stabilize by placing their hands on the back part

of the thighs. The side that has to be tested should be actively extended by the subject, and the lumbar spine should not move while doing this movement. Then use the goniometer for measurement and if the angle is less than 125°, then the hamstrings are considered to be tight.

#### 5.3 Knee Range of Motion

The measurement was taken with the help of a Goniometer. Knee Flexion

Patient position: Supine

The middle part of the goniometer called the fulcrum over the femur-lateral condyle

The stationary arm is placed over the midpoint of the femur and the moving arm is according to the fibula midline. Normal ROM: 135°

#### 5.4 Pain

Muscle imbalance can cause pain in the lower extremities while walking, sitting standing, and performing daily life activities. The numerical pain rating scale is used.

### 6. Procedure

Ethical approval was taken before beginning the study. The women who experienced menopause were included in the study. The subjects explained the purpose of the study. Subjects approached who fulfilled the criteria of the study and the Consent form was given in the local language of the subjects. And then form was taken after filling. Samples were taken according to convenient sampling. 50 females were divided among 2 groups by random sampling method. Subject's demographic data was taken and by taking height and weight, BMI was calculated. Then pre and post-protocol, assessments were taken. Participants underwent 5 days per week 25 mins of protocol for 1 and half months. Group A underwent conventional treatment which includes hot moist therapy for 5-7 mins along with active stretching of hamstrings, isometrics of quadriceps and hamstrings, and quadriceps strengthening consisting of dynamic quadriceps, single leg raises, and prone knee bending. Each exercise will be repeated 5 times in the first week then 10 times for the next 2 weeks and then for the rest three weeks, the frequency of sets will be increased up to 3 sets with 60 secs rest in between the sets. Group B underwent a Structured exercise protocol which includes Mulligan's protocol for

hamstrings and for quadriceps muscle MET was given. Bent leg raise technique by Mulligan: The Therapist stood on one side of the subject took her flexed knee to the shoulder and then pushed the leg towards the shoulder and relaxation. Stretch hold for 30 secs by taking the leg in a downward direction and 3 times repetitions and 60 secs rest between each stretch. Similar to be done on the other side. Muscle energy technique for quadriceps: Ask the subject to be in the prone position. Then ask the patient to take her heel towards her hips actively and then relax it. So now therapist should passively grasp just below the heel and take it towards the hip. Now therapist should pay attention that while taking the leg towards the hip, the hip should not be lifted. So, the therapist will get that end range So after getting that first barrier point, count to 10 and ask the subject to push down the heel that is to resist the movement. Then ask the patient to relax and move to the next barrier point and again the same procedure to be

followed. 3 sets are to be performed with 60 secs rest in between.

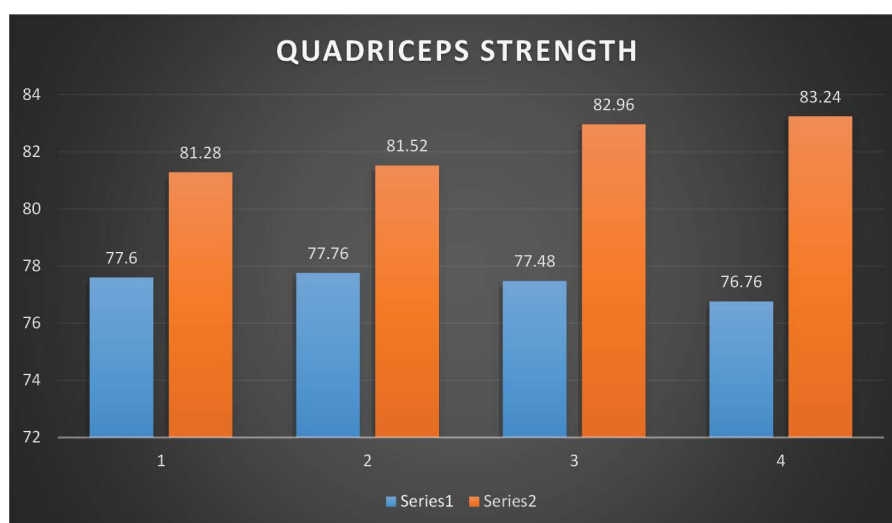
## 7. Results

According to the mentioned values in Table 1, In group A, p value for both the left and right limb is less than 0.0001 and it is considered as extremely significant. In group B, p value for both the left and right limb is less than 0.0001 and it is considered as extremely significant. But group B is more significant and has strength more than group A.

According to the mentioned values in Table 2, In group A, the p-value for both limbs is less than 0.0001 considered extremely significant. In group B, the p-value for both limbs is less than 0.0001 considered as extremely significant. But the mean difference of group B is more significant than group A.

**Table 1.** Quadriceps strength

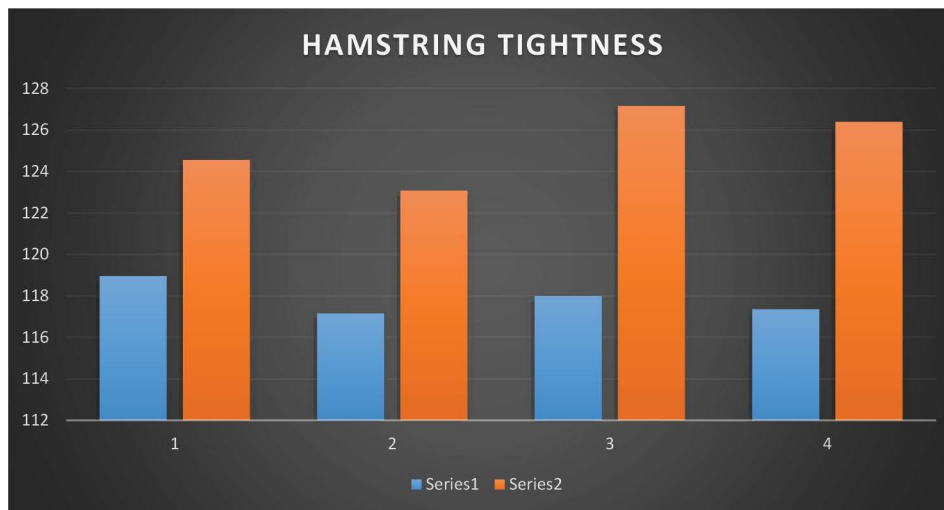
Quadriceps Strength								
	GROUP A				GROUP B			
	Lower Limb Left		Lower Limb Right		Lower Limb Left		Lower Limb Right	
	Before the Test	After the Test	Before the Test	After the Test	Before the Test	After the Test	Before the Test	After the Test
MEAN	77.60	81.28	77.76	81.52	77.48	82.96	76.76	83.24
S.D	1.658	1.429	1.832	1.584	1.686	1.485	2.241	2.185
P- VALUE	< 0.0001		< 0.0001		< 0.0001		< 0.0001	



**Graph 1.** On X axis, 1 and 2 symbolize the control group, and 3 and 4 symbolize the experimental group. The mean difference for quadriceps strength in the experimental group is greater than the control group as seen in Graph 1.

**Table 2.** Hamstring tightness

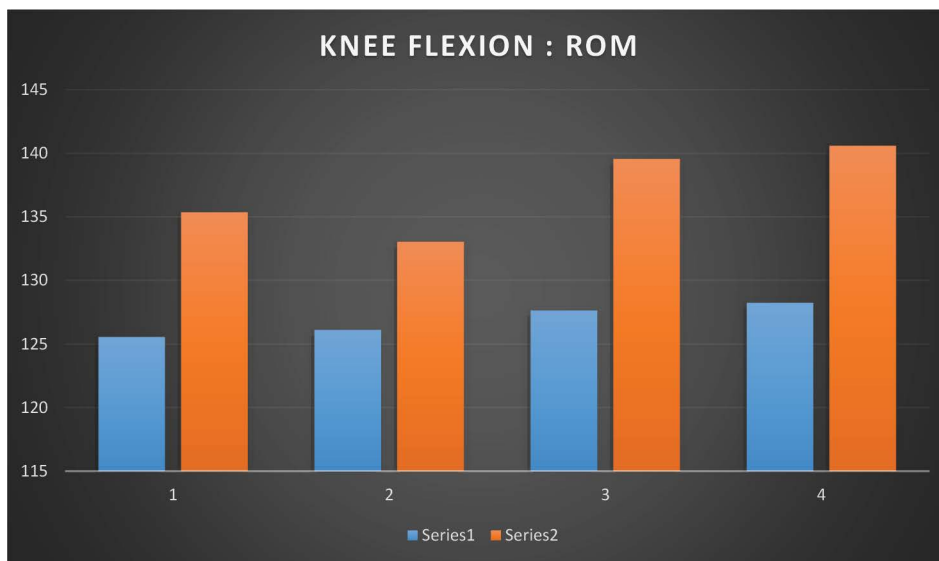
Hamstring Tightness								
	GROUP A				GROUP B			
	Lower Limb Left		Lower Limb Right		Lower Limb Left		Lower Limb Right	
	Before the Test	After the Test	Before the Test	After the Test	Before the Test	After the Test	Before the Test	After the Test
MEAN	118.96	124.56	117.16	123.08	118	127.16	117.36	126.4
S.D	1.767	1.710	1.599	1.320	1.658	1.463	1.604	1.443
P- VALUE	< 0.0001		< 0.0001		< 0.0001		< 0.0001	

**Graph 2.** It shows, that X-axis 1 and 2 symbolize the control group, and 3 and 4 symbolize the experimental group. The mean difference for Hamstring Tightness before and after the test of Group B is greater than the control group as seen in Graph 2.**Table 3.** Knee joint range of motion

Joint Range For Knee								
	Group A				Group B			
	Lower Limb Left		Lower Limb Right		Lower Limb Left		Lower Limb Right	
	Before the Test	After the Test	Before the Test	After the Test	Before the Test	After the Test	Before the Test	After the Test
MEAN	125.56	135.36	126.12	133.04	127.64	139.56	128.24	140.6
S.D	2.9022	2.447	2.906	2.850	2.984	2.468	3.443	3.028
P VALUE	0.0160	< 0.0001	0.0228	< 0.0001	< 0.0001		< 0.0001	

According to the values mentioned in Table 3, In group A, P value is stated as significant. For Group B, P value is considered extremely significant. But the mean difference was more for group B than A.

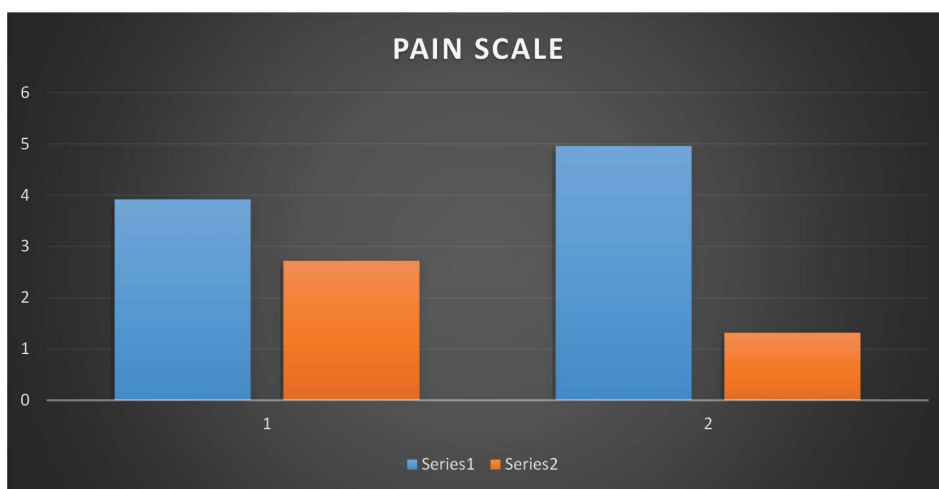
According to Table 4, the post-measurements taken by NPRS and the pain rate reduced more significantly in group B than A. Both groups show extremely significant results.



**Graph 3.** It shows, on X-axis 1 and 2 symbolize the control group, and 3 and 4 symbolize the experimental group. The mean difference for knee joint flexion ROM between before and after test values of group B is larger than the control group as seen in Graph 3.

**Table 4.** Pain assessment (Numerical Pain Rating Scale)

Group	Mean	S.D	P Value
Group A (Pre)	3.92	1.038	Comparison between post values: <0.0001
Group A (Post)	2.72	0.9798	
Group B (Pre)	4.96	1.172	
Group B (Post)	1.32	0.9883	



**Graph 4.** It shows, on the X-axis 1 symbolizes the control group, 2 symbolizes the experimental group. Pain is reduced more significantly in the experimental group is greater than control group as seen in Graph 4.



## 8. Discussion

The study aim was to study about effectiveness of structured exercise protocol for muscle imbalance of quadriceps as well as hamstrings in postmenopausal obese women. The study was conducted on 50 postmenopausal women who experienced menopause for more than 2 years. The study included 50-60 years of postmenopausal females. According to one previous study, the decline in the strength of the muscle is a part of aging. Due to the reduced function of the ovary and hormones, leg strength also reduces. The quadriceps is the main weight-bearing muscle and if it weakens then it will result in loss of balance and also falls<sup>21</sup>. Another study concluded that Menopause is related to the decline in hormonal function and thereby has an effect on the BMI, which increases the load on the muscle and deteriorates the function the result of the study was that obese menopausal women have a decrease in the strength than the others<sup>6</sup>. In the above present study, Participants were checked for quadriceps strength by a modified sphygmomanometer, hamstring tightness by 90°-90° SLR test, knee joint range of motion by a goniometer, and the pain was assessed by visual analog scale and then all the subjects performed intervention for 6 weeks. Participants split into 2 groups, A Group (Control group) given the conventional treatment which includes active stretching of hamstrings, isometrics of quadriceps and hamstrings muscles, and quadriceps strengthening which includes dynamic quadriceps, single leg raise, and prone knee bending. Group B received a structured exercise protocol which includes Mulligan's technique for hamstrings and MET for quadriceps. P value (>0.05) for before the test values of both the groups with no significant difference. Data collected was analyzed by software InStat and a parametric test was used. less than 0.05 value of P is significant statistically. In total, four outcome measures assessed results of both the groups was significant but the mean of Group B was more effective in all the outcome measures than Group A in post assessment test with the p-value <0.0001 and the mean value was greater in the group B than group A. For Mulligans technique, the muscle is taken to the level of elongation to its tolerated strength. Improvement in the range of motion after the hamstring tightness test was significant. One study previously concluded that Mulligan's technique showed improvement in hamstring flexibility thereby reducing the non-specific low back pain<sup>17</sup>. Another study stated that, if there is difficulty with the knee, it will cause gait-

related problems. The hamstring-to-quadriceps ratio is important for lower limb function. Exercises including strengthening of quadriceps and hamstrings is useful in treating these types of conditions<sup>14</sup>. In one of the previous studies where subjects with knee osteoarthritis were taken, it was concluded that muscle energy technique showed a significant effect in active knee extension test and quadriceps strength. It also stated that conventional treatment can also improve the condition of patients with OA knee and it was effective but when MET was compared to it the latter was effective<sup>12</sup>. The study involving neurological mechanisms stated the reflex that will be initiated when the contraction occurs and then the effect of Golgi will be initiated and at the end, the relaxation of muscle will occur<sup>15</sup>. In the present study, both groups showed improvement but the group that had given a structured exercise protocol showed more effective results than Group A. Also, it has worked significantly on pain which is caused by muscle imbalance and causes difficulty in activities of daily living. So the study added more evidence that the structured exercise protocol can be more effective and have a significant effect on muscle imbalance of quadriceps and hamstrings in postmenopausal obese women. The limitation of the study is the sample size was small so the results were not generalized. Also, the study duration was short with one geographical location limitation. In the future, the study could be done with a larger sample size including different areas so the results can be generalized.

## 9. Conclusion

The effectiveness of both exercise protocols in treating the muscle imbalance of quadriceps and hamstrings in postmenopausal obese women is concluded in the study. But the Structured exercise protocol is more effective than the conventional treatment protocol on muscle imbalance of quadriceps and hamstrings in postmenopausal obese women.

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