



The Effects of Isometric Quadriceps Exercise at Different Angles in Healthy Adult Knee

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Abstract

Introduction; Strengthening exercise is routinely used to maximize muscular power and endurance and reduce muscle imbalance and joint injuries in musculoskeletal patients and athletes. Isometric exercise has been shown to rapidly increase quadriceps muscle strength.

Objective; This study compared the effects of isometric strengthening exercise on quadriceps muscle strength at different angles of the knee joint between treatment and experimental groups of healthy adult participants and examined its effectiveness at the 45-90 degree angle.

Methodology; Convenience sampling selected 40 Institute adults for the study. Participants were randomly assigned to the Control (N=20) and Treatment (N=20) groups based on inclusion criteria. The control group squatted while the treatment group did isometric strengthening for eight weeks. Before and after treatment, knee quadriceps muscle strength was measured at 45-90 degrees.

Result; This pre-to-post experimental study showed a statistically significant increase in quadriceps muscle strength at the 45-90 degree knee joint with a $P_{0.0001}$ value, while the control group showed no such effect with $P_{0.083}$ and $P_{0.055}$, respectively. The experimental group significantly strengthened quadriceps at 45 degree joints compared to the control group. ($P_{0.0001}$).

Conclusion; Isometric exercises can strengthen the quadriceps at the 45-90 degree knee angle in healthy adults. The quadriceps' 90-degree strength has increased more than 45-degree strength.

Keywords; Muscle strength, muscle imbalance, Quadriceps strength, Isometric exercise, squatting exercise, multi-angle exercise

Introduction; Although there have been many studies on strength training, it is still unknown which of the various modalities will increase strength the most effectively [1]. In patients with musculoskeletal issues or in athletes, strengthening exercises are frequently used to increase muscular power and endurance as well as have the additional benefits of reducing muscle imbalance and joint injuries. For high-strength training, eccentric, concentric, and isometric exercises—or combinations of them—have reportedly been used. Isometric exercise is reportedly effective in terms of outcomes for the rapid augmentation of quadriceps muscle strength. [2,3]. According to studies, when performed for eight weeks, isometric exercises have the potential to boost muscle strength by up to 40%. Although the effects of muscle imbalance and the quadriceps femoris' contribution to the overall strength of the quadriceps muscles have been well documented, it has been speculated that the strength of the quadriceps may vary depending on the angle of the knee joint. [4,5]. The aim of this study was to compare, between the treatment and experimental groups of healthy adult participants, the effects of isometric strengthening exercise on the strength of the quadriceps muscles at different angles of the knee joint. The effectiveness of isometric strengthening exercises on the quadriceps muscles at knee joint angles 45 to 90 was another goal of the study.

Material & methods:

Convenience sampling was used to select the N=40 participants for this comparative experimental study from the 3rd and 4th DPT batches at KMU-IPMR in Peshawar. Statistical Parameters were ;CG 30% Incidence, TG 72%, Alpha 0.05, Beta 0.2, Power 0.8 Sample Size; 40 The Inclusion criteria's a) *Age*; <20-24years, b) *Gender*; both Male & Female c) *Health status*; Participants with no history of knee injuries or surgeries or MSK disorders d) *Physical activity level*; Participants in light to moderate physical activity, without regular participation in strenuous lower limb exercise regimens e) *consent*; Participants willing to provide informed consent to participate in the study. F) *No Contradictory conditions*; Individuals without medical conditions such as Hypertension, Heart diseases or other systemic diseases that might contraindicate to participate in the isometric exercise G) *No Medications interference*; Participants taking any medications that might interfere with the muscles performance were excluded. The study's participants were split into two groups at random—the control group (N=20) and the treatment group (N=20)—based on the precise inclusion criteria. All of the enrolled students were in good health and had no recent knee injuries. The average age of the group was 20.3 + 0.79. Over an eight-week period, the treatment group engaged in isometric strengthening exercises while the control group engaged in squatting exercises. Clinical information was gathered and compared before and after regarding the quadriceps muscle strength at the 45-90 of the knee joint. The study's equipment included a multi-gym, goniometer, and free weights for the assessment and isometric quadriceps strength training. The protocol for the isometric strengthening exercise intervention is as follows: Five times a week for eight weeks, the subjects in the experimental group performed quadriceps exercises on each leg while fully extending their knees and holding three kilograms of weight. Use sand-bag resistance while sitting up straight for 10 seconds, then take 5 seconds to rest to prevent overuse fatigue in the flexed position. For eight weeks, this procedure was done five times per day, ten times per therapeutic session. The participants' seated quadriceps muscle strength was measured and evaluated using the multi-gym. When the resistance is applied, the knee joint is Isometrically extended with the hip flexed at 90 and the trunk straight and upright. The strength of the quadriceps was assessed at 45 and 90 degree angles. Clinical information was gathered and compared before and after regarding the quadriceps muscle strength at the 45-90 of the knee joint. Independent tests were used to compare the independent variables between the control and treatment groups, whereas dependent t-tests were used to compare the effects within the group. The statistical test used to analyses the data was P0.05.

Results; This pre-to-post experimental study's analysis revealed a statistically significant effect on the improvement of quadriceps muscle strength at the 45-90 of the knee joint with P0.0001; however, in the subjects in the control group, no statistically significant effects on the improvement of quadriceps strength were found in the pre-to-post experimental study (P0.083 & P0.055, respectively). In a study comparing the control and experimental groups, it was found that the quadriceps strength at the 45 knee joints was significantly increased, with a P value of 0.0001. Pre-post statistical analysis with a P0.0001 value showed that isometric exercise significantly increased quadriceps strength in the experimental group at knee flexions of 45 and 90. (Table-1). The quadriceps muscles' strength improvement in the control group (quadriceps pre-post score analysis) at 45 and 90 degrees of knee flexion did not differ noticeably from baseline values at P0.083

and P0.055, respectively. (Table-2). The control group outperformed the experimental group when quadriceps strength at 900 degrees of knee flexion was compared between the two groups (P = 0.001). (Table-3). When the strength of the quadriceps at 450 degrees of knee flexion was compared between the experimental and control groups, significant differences in quadriceps development were discovered. (Table-4).

Quadriceps strength analysis for the experimental group at 45⁰ and 90⁰ of the knee joint, Table 1.

Knee joint quadriceps strength prior to intervention (mean SD)		Knee joint quadriceps strength following intervention (mean± SD)	t-values	P-values
45 ⁰	20.85±0.79	20.85±0.79	df=19,7.32	P< .0001
90 ⁰	26.05 ± 0.85	26.05 ± 0.85	df=19, 7.26,	P<.0001

Table-2: Quadriceps strength analysis in the control group at 450 and 900 of the knee joint

Knee joint quadriceps strength prior to intervention (mean SD)		Knee joint quadriceps strength following intervention (mean SD)	t-values	P-values
45 ⁰	19.35±0.77	20.15±0.70	1.83, df=18	P< 0.0001
90 ⁰	23.95 ± 0.75	24.50 ± 0.10	1.05, df=18	P<0.0001

Table-3: comparative analysis of the control & experimental groups for the quadriceps strength at the 90° of the knee joints

Quadriceps strength at the knee joint; experimental group; at 90 degrees of knee flexion (mean SD)	Strength of the quadriceps at 90 degrees of knee flexion; control group ((mean SD)	t-values	P-values	
Pre-intervention	18.94±0.72	20.84±0.78	1.78, df=36	P< 0.079 (NS)
Post-intervention	19.05 ± 0.89	22.94 ± 0.89	3.62, df=36	P<0.0001 (S)

Table-4: comparative analysis of the control & experimental groups for the quadriceps strength at the 45° of the knee joints

Quadriceps strength in the experimental group at 450 degrees of knee flexion at the knee joint (mean SD)	Strength of the quadriceps at the knee joint, at 450 degrees of knee flexion, and in the control group (mean SD)	t-values	P-values	
Pre-intervention	24.15±0.70	25.05±0.77	df=38, 1.88,	P< 0.090 (NS)
Post-intervention	24.45 ± 0.70	27.90 ± 0.88	df=38, 2.62,	P<0.0001 (S)

Discussion;

Using isometric exercise to increase quadriceps strength at knee angles of 15 and 60, respectively, the maximum torque in both positions before & after training in the ten healthy females was assessed. Therefore, a number of studies have suggested that isometric exercise carried out at various angles might ultimately be the most successful at increasing muscle strength. [6,7]. Clinical data, such as quadriceps torque and strength, were recorded before and after the intervention. Health participants underwent isometric exercise three times per week for a total of six weeks. According to reports, the quadriceps strength and pain levels of study participants decreased over time and were consistent across all of the studies. [8,9]. A study that should be looked into further suggested that the quadriceps muscle could gain the most strength through mid-range isometric training. [10,11]. In a study with 17 volunteers, unilateral strength training with low repetition and high resistance on the quadriceps was carried out three times per week for five weeks. Quadriceps strength and circumference measurements were taken before and after the exercise for both legs, and the results were analyzed. The trained quadriceps demonstrated an increase in isometric strength greater than their cross sectional areas, while the untrained thigh showed no discernible difference or change [10,12,13]. The maximum isometric torque was assessed for six weeks, a year, and sixteen months at different knee angles, including 90, 60, and 30. These findings showed a gradual increase in torque at the entire angle over a 16-month period. These findings showed that, as opposed to specificity training, mid-range isometric exercise training had a positive impact on the patient's rehabilitation [14–17]. We looked at quadriceps bilateral strength training at 45° and 90° knee angles in this study. The participants' findings corroborated those of a different study [13,18,19] with a sample size of 40 females, which discovered that they could generate more force or torque at an angle of 90° than at 45°. The maximum torque in both positions was measured before and after

training in the ten healthy females using isometric exercise to increase quadriceps strength at knee angles of 15 and 60, respectively. Therefore, a number of studies have suggested that isometric exercise carried out at various angles may ultimately be the most successful at increasing muscle strength [6,7]. Quadriceps torque and strength were measured clinically both before and after the intervention. Health participants underwent isometric exercise three times per week for a total of six weeks. According to reports, the quadriceps strength and pain levels of study participants decreased over time and were consistent across all of the studies. 8,9 A study that should be further investigated suggested that the quadriceps muscle could gain the most strength from mid-range isometric training [10,11]. In a study with 17 volunteers, unilateral strength training with low repetition and high resistance on the quadriceps was carried out three times per week for five weeks. Quadriceps strength and circumference measurements were taken before and after the exercise for both legs, and the results were analyzed. The trained quadriceps demonstrated an increase in isometric strength greater than their cross sectional areas, while the untrained thigh showed no discernible difference or change [10,12,13]. The maximum isometric torque was assessed for six weeks, a year, and sixteen months at different knee angles, including 90, 60, and 30. These findings showed a gradual increase in torque at the entire angle over a 16-month period. These findings showed that, as opposed to specificity training, mid-range isometric exercise training was advantageous for the patient's rehabilitation [14–17]. We looked at quadriceps bilateral strength training at 45° and 90° knee angles in this study. Participants' results revealed that they could produce more force or torque at an angle of 90° than at 45°, which was consistent with conclusions from a different study [13,18,19] on females with a sample size of 40. Both aerobic walking and home-based quadriceps strengthening exercises were found to be effective in reducing pain and self-reported disability in patients with knee osteoarthritis, according to the findings of a study that looked at the results of 35 randomized controlled trials (RCTs). The combined data did not reveal a statistically significant difference between the two types of exercise. However, additional research is required to evaluate their relative efficacy and investigate the possibility of interactions between the two. [21-23]

The results of this study provide valuable insights into the potential benefits of Isometric quadriceps exercise for promoting knee joint health in the healthy adults. These findings have implications for both preventive & rehabilitative strategies, incorporating isometric exercises into exercise routines may offer an effective way to enhance knee joint stability & peri-articular muscles strength. However, further research is needed to determine the optimal protocols, duration & its long term effects. Moreover, investigating the applicability of these findings to specific populations, such as individuals with knee-related injuries would contribute to a more comprehensive understanding of the broader clinical implications of isometric quadriceps exercises.

Conclusion; The strength of the quadriceps muscles at the 45-90° angle of the knee joint can be increased by isometric strengthening exercises in healthy adults. The quadriceps' strength at 90 degrees has been shown to have increased more than its strength at 45 degrees.

Limitations; The uncontrollable confounding factors are as follows: (a) the isometric exercise was not overseen by the researcher; and (b) other activities performed during the study period. C) a modest, homogeneous sample size.

Recommendations: A sizable sample size and participation from numerous centers are included. b) To investigate the effects of isometric quadriceps strength on the movements of the right and left legs. B) Supervised interventional studies in settings with suitable equipment must be carried out under the supervision of an experienced researcher in order to further authenticate its results.

References:

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