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# Effects of Core Stability Exercise Training Using Pilates on Lower Extremity Strength and Postural Stability in Sedentary Population

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## ABSTRACT

**Background:** It has been demonstrated that the Pilates method enhances the strength of the muscles, flexibility, somatosensation, and equilibrium. To achieve total control of the mind over the body, or muscle control, each workout component encompasses Pilates, control, concentration, focusing, flow, breath, and accuracy. Pilates stimulates the muscles in a way that replicates the precise kinetic chain activation patterns found in everyday activities. **Objective:** To determine the effects of core stability exercise training using Pilates on the lower extremity strength and postural stability in a sedentary population. **Methods:** A quasi-experimental study was conducted on 40 sedentary subjects aged 18 – 40 years using a non-probability convenience sampling technique. The participants included were only sedentary subjects, Adults over age 18-40 years, both males and females. The exclusion criteria were any fracture, recent surgery, pregnancy, history of any serious disease and illness, and tumors. Group 1 (n=20) received the core stability training using pilates whereas Group 2 (n=20) did not receive any training. Pilates were performed 4 days per week for 1 month with 10 repetitions. The outcome measures used were the the Medical research Council grading system for strength, the star excursion balance test for postural stability and balance, and the single-leg stance test for stability. These outcomes were assessed before and after intervention. **Results:** Using SPSS, the Shapiro-Wilks test was used to verify the normality of the data. The data is normally distributed, according to this test. According to the descriptive statistics, the participants' ages ranged from 23.28±3.09 years for the average and standard deviation. In the current study, there were 23(57.5%) women and 17 (42.5%) men. The participants' average and standard deviation of body mass index were 23.29±4.37. Distance reached on the star excursion balance test in each direction of both groups was compared. **Conclusion:** It was concluded that pilates had significant effects on improving postural stability and strength among sedentary individuals.

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## INTRODUCTION

The concept of core stability, also known as core strengthening, is becoming widely recognized in the field of sports medicine and fitness. Popular fitness regimens like Tai Chi, Pilates, and yoga are based on strengthening the core strategies. The diaphragm acts as the roof of the muscular package that is the core, with the pelvic floor and hip girdle musculature as the bottom, the paraspinal and gluteal in the back, and the abdominals in the front.[1] Using a blend of Western body conditioning techniques like P. H. Ling's medical gymnastics and Eastern ideas about philosophy and movement practices like yoga, Joseph Pilates (1880–1967) created an exercise program.[2] It has been demonstrated that the Pilates method enhances the strength of the muscles, balance, somatosensory and versatility. To achieve total control of the mind over the body, or movement control, every aspect of the workout encompasses the fundamental concepts of Pilates, control, concentration, focusing, flow, breath, and accuracy.[3] Core balance is the ability of the lumbosacral and pelvic girdle complex to keep away from buckling and go back to equilibrium after perturbation. Center balance is in particular maintained by way of muscular factors instead of static elements (bones and gentle tissues).

Pilates adds strengthening and stretching in this way to improve the strength of the body and develop a sound mind that runs a sound body. Centering is thought to be a crucial point when it comes to Pilates. From center, it means the core of the body usually is said powerhouse, Concentration is a term we use to follow the basic concepts of Pilates, Concentration in mind while doing Pilates guides the body to do accurate exercise. After completing the exercise from the center here comes "control" after concentration. Accuracy of exercise depends upon controlled movements. While doing Pilates or any kind of exercise circulation of blood towards muscles and mind is very important to accomplish a healthy exercise. "Breathing" fulfills this requirement; proper breathing technique is always in need of Pilates. Adequate oxygenated blood should be delivered to each tissue, In the end, during a Pilates session flow results in the successful transfer of one exercise into another.[4] Even though athletic trainers discuss center balance extensively, bodily therapists, and individuals immersed in studies on the musculoskeletal system, description of the expression can rely on an individualistic perspective. Trunk and hip muscle patience and power, trunk muscle strength, renovation of a specifically inclined pelvis or else of ligamentous laxity and alignment of the spine, all have been used to explain the term center balance.

A therapist considers the crucial component of any general motor demand to be stability. Core stability is also described as the level of energy or persistence in a special muscle's organization of the lumbopelvic complex.[5] Core stability is an essential issue for the health and rehabilitation domain. It is characterized by trunk and pelvic girdle muscle strength, endurance and ability to maintain pelvic inclination. Recent studies suggest that a decrease in core stability may lead to injury because, for every day gross motor tasks, core stability is crucial. Proper stability of core training may help to reduce the injury.[6] Pilates constructively improves the strength and flexibility of the muscles of the pelvis, hip and abdomen.[7] It is frequently believed that the zones of the body that are in motion throughout an exercise are the zones in which the concentration should be attentive; this is acknowledged as "isolating" a specific group of muscles. The problem with this thought is that it disregards the other zones of the body that are not in motion. it is most actual to think of concentrating on anchoring, or stabilizing, the zone of the body that is not in motion. This zone that is not in motion that the Pilates technique concentrations upon is the powerhouse. This concept is very vital if one is

to appreciate and gain what is trendy during a Pilates training.[8] Integration activities that stimulate a wide variety of muscles in the core increase core performance. Examples of these exercises comprise The practice of yoga, the Pilates method, the practice of Tai Chi, Swiss Ball education, and other dynamic exercises. Pilates uses intricate movements that call for stabilizing the LPH complex while executing deliberate extremity movements, which have been demonstrated to increase the activity of the muscles in the core. Pilates produces muscle contractions that closely resemble certain kinetic chain patterns of activation seen in practical movements.[9] Core stability exercise training using Pilates helps improve posture, balance and overall body strength.

Pilates targets the deep muscles of the core including the abdominals, back and pelvic floor which can lead to increased stability and reduced risk of injuries. So, incorporating pilates into a fitness routine can be a great way to improve overall fitness and well-being. There is limited literature available on this topic. Previous literature explains the effects of Pilates on core stability and overall body strength in healthy subjects. There is a lack of research on its impact on lower extremities in sedentary individuals. So, the purpose of the study was to determine the effects of core stability exercise training using Pilates on lower extremity strength and postural stability in a sedentary population.

## METHODS

A quasi-experimental study was conducted on 40 sedentary subjects in the Faisalabad community. The study was completed three months after the approval of the synopsis. This study included only sedentary adults without any kind of present or past obvious illness or deformity. Data was collected through convenient sampling from Faisalabad. It used the Medical research Council (MRC) grading system for strength, star excursion balance test for postural stability and single leg stance test to measure balance. The participants included were only sedentary subjects, Adults over age 18-40 years, both males and females. The exclusion criteria were any fracture, recent surgery, pregnancy, history of any serious disease and illness, and tumors. About 40 Participants were allocated to two groups, group 1 (n=20) and group 2 (n=20) in which group 1 (core stability training group) performed Pilates. Pilates were performed 4 days per week for 1 month by participants with 10 repetitions.

The overall duration of Pilates was 30 minutes with 10 seconds of rest between each Pilates. Pilates were performed under supervision with a proper breathing pattern. Whereas Group 2 (control group) did not receive any training. Pre and post-training postural stability and lower extremity strength were measured. MRC grading system to measure the strength of muscles[10], star excursion balance test for postural stability and balance. In this test 8 guidelines were made to move each limb in all instructions, guidelines were anterior, anteromedial, medial, posteromedial, posterior, posterior lateral, lateral and anterolateral[11] and the single leg stance test, was used to evaluate stability. This test was performed by standing on a single leg without footwear or socks on the foot and with the hands placed on the iliac spines to avoid the use of arms for stability. The degree of time the subject can maintain their balance was calculated.[12] The pilates used in this study were One-leg circles, rolls up, one-leg stretches, lifts the leg supine, one-leg stretches, and one-leg stretches.

**One leg circle:** Place both legs outstretched on the mat and lie supine with your arms by your sides and your palms facing downward. Once one knee is bent to the chest, raise it straight up toward the ceiling. Point the foot gently. Flex your foot on the mat. Breathe out. One side of the pelvis can lift off the mat by circling the

elevated leg across the body's midline. View the illustration of the main muscle. As the back of the pelvis comes back to rest evenly on the mat, keep moving the leg down and across the other leg. Breathe in. To go back to the beginning position, keep circling the leg out to the same side as it was raised. Alternate the legs with each circle, repeating the same sequence with the second leg.

**Roll-Up:** Lay down flat with your feet slightly pointed and your legs straight and together. With the palms facing up, the arms are directly overhead and parallel to the shoulders. Breathe in. Draw the wall of the abdomen inward toward the spine. Then, raise the head and scapulae off the mat, lift the arms toward the ceiling, and bring the chin toward the chest. Dorsiflexion of the ankle and foot occurs simultaneously. Breathe out. Keep curling up, moving through a sitting position until the upper body is above the legs and the fingers are pointing toward the toes. The palms can rest on the mat as indicated, or they can touch the sides of the feet if flexibility permits. Take a breath. Till the back of the sacrum makes contact with the mat, start rolling downward. Breathe out. Once you've finished rolling down, raise your arms overhead and take a step back to the beginning.

**One-Leg Stretch (Single-Leg Stretch):** Place your head, scapulae, and one knee into your chest while lying supine in the chest lift position. The shin is held just above the ankle by the hand on the side of the bent knee. With the hand on the knee, the other arm is bowed. The height of the straight leg allows the lower back to stay in contact with the mat. Each foot has a slight point. Breathe in. Start bending the leg that is extended and then extend the bent leg. Breathe out. Exhale as your leg fully straightens out and the hand transfers to the other knee, accomplishing the switch as demonstrated in the main muscle illustration. The shin near the ankle is grasped by the hand on the side of the bent knee, while the knee that is being pulled toward the chest and is held by the other hand.

**Single Straight-Leg Stretch (Hamstring Pull):** Place your head and shoulders off the mat in the Chest Lift position while lying supine. Both hands are placed around the ankle of one leg, which is raised toward the forehead. At a height where the lower back can still make contact with the mat, the opposing leg is suspended above it. Both feet are softly pointed, and both knees are straight. Breathe out. With two slow pulses in time with two percussion exhalations, draw the upper leg closer to the forehead and draw the wall of the abdomen slightly toward the spine. Breathe in. Alternate your legs while maintaining a straight posture, reaching your hands toward the ankle of the other leg. Let out a breath. Once more, bring this leg in closer to your forehead.

**Leg lift supine:** Place yourself in a supine position, knees bent so that your lower legs are roughly 90 degrees from your thighs, and place your feet flat on the mat, hip-width apart. With the palms of the hands facing downward, the arms are by the sides of the body. Breathe out. Lift one leg so that the thigh is perpendicular to the mat and the knee is slightly above the hip joint, keeping the knee joint at the 90-degree angle as demonstrated in step 2. Breathe in. Keeping the knee joint at a 90-degree angle, lower the leg till the toes make contact with the mat.

**Double leg stretches:** Place a single hand on each shin while bending both knees and drawing them toward the chest while lying supine in the Chest Lift position with your head and scapulae over the mat. Breathe in. Stretch both legs to a height where the lower back stays in contact with the mat, and at the same time, extend the arms downward to the sides of the legs. Breathe out. With your hands on the shins, the arms should be back in the starting position

as you bend your legs back toward the chest. Data was first collected and then analyzed by IBM SPSS STATISTICS 26. The histogram, range, mean, and standard deviation were the quantitative variables displayed. Normality was checked by Kolmogorov and Shapiro-Wilk test. The percentages (%), frequencies, cross tabulation, bar chart and pie chart were used to assess the categorical variables. A significance limit of 0.05 was selected for the alpha. The parametric test, paired sample t-test, and independent sample t-test were used for analyzing the data.

With permission from the ethics committee of Government College University Faisalabad, this study was carried out. When gathering data, due consideration was given to cultural and religious factors. For the sake of ethical consideration first of all a consent form was given to all the participants of the research to seek their permission. Then confidential information of each subject including their identity, contact number, personal information, and address was kept secret by the researcher. Data was collected from the subjects by keeping in mind that their self-esteem and comfort zone should not be disturbed. According to ethical standards allotment of subjects was performed without any age, gender, or occupation discrimination.

## RESULTS

Using SPSS, the Shapiro-Wilks test was used to verify the normality of the data. The data is normally distributed, according to this test. According to the descriptive statistics, the participants' ages ranged from 23.28±3.094 years for the average and standard deviation. In the current study, there were 23 (57.5%) women and 17 (42.5%) men. The participants' average and standard deviation of BMI were 23.29±4.37 as shown in Table 1. Distance reached on the star excursion balance test in each direction of both groups was compared.

## DISCUSSION

This study investigated the effect of Pilates, core stability exercise training, on the lower extremities to improve postural stability and strength among the sedentary population.

**Table 1: Participant's Demographics**

| Variables | Mean±SD |
|---|---|
| **Age** | 23.28±3.094 |
| **Gender** | M= 17, F=23 |
| **BMI** | 23.29±4.37 |

**Table 2: Summary of participant's time taken by each limb in single leg stance test; descriptive statistics, intra-group and inter-group comparison**

| Limb/group | Pre-value Mean±SD | Post-value Mean±SD | p-value Intra-group | p-value Inter-group | Mean Diff. |
|---|---|---|---|---|---|
| **Right Pilates group** | 82.75±27.08 | 112.30±29.71 | .000 | .000 | 35.70 |
| **Control group** | 74.80±27.94 | 76.60±27.37 | .214 | | |
| **Left Pilate group** | 70.20±24.20 | 99.70±23.28 | .000 | .000 | 30.15 |
| **Control group** | 68.45±24.61 | 69.55±23.28 | .443 | | |

**Table 3:** Summary of participant's Distance reached on star excursion balance test in each direction; Descriptive statistics, intra-group and inter-group comparison

| Direction/limb/group | Pre-value Mean±SD | Post-value Mean±SD | p-value Intra-Group | p-value Inter-group | MeanDiff. |
|---|---|---|---|---|---|
| Anterior/righPilate group Control group | 28.37±5.082<br>28.53±5.511 | 35.93±4.632<br>28.56±5.427 | .000<br>.617 | .000 | 7.37 |
| Anterior/left Pilate group<br>Control group | 26.38±5.752<br>27.21±5.289 | 34.31±5.849<br>27.33±5.871 | .000<br>.449 | .001 | 6.98 |
| Ant. Medial/rightPilate group Control group | 27.67±5.957<br>28.06±5.837 | 38.11±5.237<br>27.66±6.717 | .000<br>.126 | .000 | 10.45 |
| Ant. Medial/left Pilate group<br>Control group | 27.13±6.550<br>27.77±5.922 | 36.75±8.562<br>28.53±5.783 | .000<br>.003 | .001 | 8.22 |
| Medial/right Pilate group Control group | 23.34±4.811<br>23.72±4.581 | 33.55±4.240<br>23.23±3.968 | .000<br>.157 | .000 | 10.31 |
| Medial/left Pilate group<br><br>Control group | 24.14±4.003<br><br>24.11±3.432 | 31.19±6.986<br><br>25.51±3.353 | .000<br><br>.053 | .002 | 5.68 |
| Post. medial/rightPilate group Control group | 22.81±5.793<br>22.16±4.774 | 34.92±5.876<br>22.62±4.619 | .000<br>.037 | .000 | 12.29 |
| Post. medial/left Pilate group<br>Control group | 22.68±2.715<br>23.23±3.324 | 27.84±2.690<br>23.43±3.422 | .000<br>.003 | .000 | 4.405 |
| Posterior/rightPilate group Control group | 24.45±4.835<br>24.11±4.388 | 28.18±5.992<br>24.88±5.897 | .000<br>.149 | .087 | 3.30 |
| Posterior/left Pilate group<br>Control group | 22.10±1.987<br>21.73±2.103 | 28.57±5.017<br>21.79±1.987 | .000<br>.083 | .000 | 6.78 |
| Post.Lateral/rightPilate group Control group | 28.46±5.487<br>29.14±4.373 | 30.90±6.591<br>29.48±4.145 | .039<br>.154 | .419 | 1.42 |
| Post. Lateral/left Pilate group<br>Control group | 22.78±2.797<br>22.99±1.987 | 31.44±4.562<br>23.30±1.857 | .000<br>.005 | .000 | 8.14 |
| Lateral/right Pilate group Control group | 27.54±4.777<br>28.03±4.827 | 29.11±5.349<br>28.62±5.073 | .003<br>.004 | .770 | .485 |
| Lateral/left Pilate group<br>Control group | 24.14±4.408<br>23.77±3.717 | 30.66±5.286<br>23.90±3.417 | .000<br>.296 | .000 | 6.75 |
| Ant. Lateral/rightPilate group Control group | 26.86±5.231<br>27.20±5.151 | 31.30±5.665<br>27.28±5.055 | .000<br>.053 | .023 | 4.02 |
| Ant. Lateral/left Pilate group<br>Control group | 25.84±5.044<br>26.38±5.050 | 32.09±6.296<br>26.58±4.910 | .000<br>.134 | .001 | 9.92 |

**Table 4: Summary of participant's MRC Muscle grading; descriptive statistics, intra-group and inter-group comparison**

| Muscle/group | Pre-value Mean±SD | Post-value Mean±SD | p-value Intra-group | p-value Inter-group | Mean Diff. |
|---|---|---|---|---|---|
| Quadriceps Pilates group | 3.95±0.68 | 5.00±0.00 | .000 | .000 | 0.95 |
| Control group | 4.00±0.64 | 4.05±0.60 | .330 | | |
| Hamstrings Pilate group | 3.65±0.74 | 5.00±0.00 | .000 | .000 | 0.85 |
| Control group | 4.10±0.55 | 4.15±0.58 | .330 | | |
| Quadratus lumborum Pilate group | 3.45±0.51 | 5.00±0.00 | .000 | .000 | 1.50 |
| Control group | 3.20±0.41 | 3.50±0.60 | .010 | | |
| Internal oblique Pilate group | 3.50±0.68 | 4.95±0.22 | .000 | .000 | 1.00 |
| Control group | 3.90±0.71 | 3.95±0.75 | .577 | | |
| External oblique Pilate group | 3.60±0.50 | 5.00±0.00 | .000 | .000 | 1.05 |
| Control group | 3.90±0.30 | 3.95±0.39 | .330 | | |

were collected through convenient sampling from the general population. In our study, we took 40 subjects and allocated them equally to treatment and control groups. Participants of the treatment group received training in Pilates. And control group didn't receive any training. The participants included were only sedentary subjects, Adults over age 18-40 years, both males and females. The exclusion criteria were any fracture, Recent Surgery, Pregnancy, History of any serious disease and illness, and tumors.

Data was collected through the MRC grading system for strength, Star Excursion balance test for postural stability, measuring tape for measuring distance in Star excursion balance test, and Single leg stance test for strength. In the current study, there were 47.5% female participants and 42.5% male participants. The normality of data was assessed by the Shapiro-Wilks test. Following the use of the independent and paired sample t-tests it was found that there was a statistically noteworthy difference between pre and post-values of the treatment group receiving pilates, Intergroup comparison of the star excursion balance test, single leg stance test and MRC muscle grading system showed statistically significant variation with a p-value less than 0.05. A study was conducted in 2002 by J.H Perk, & Hwang, to evaluate the consequences of Pilates schooling on hamstring-to-quadriceps ratio, shoulder electricity, trunk power, and frame composition in adolescent baseball gamers. Eight adolescent baseball gamers, who were 15 years of age had participated in the Pilates program 3 instances per week for 8 weeks. Their conclusion was following our study. They concluded that Pilates training helps in increasing muscle mass, hamstring-to-quadriceps ratio and strength of the shoulder

and trunk. A recent study has been done by Suna & Isildak. They calculate the usefulness of reformer Pilates training on sedentary women's heart rate, glucose levels, and flexibility over eight weeks. 30 subjects of age from 30 to 36 years were included in the study.

It concluded that regular reformer Pilates exercises can help in accelerating women who are sedentary losing weight. It also has a positive impact in improving measurements of glucose, heart rate, and flexibility. In our study, Pilates had significant effects on improving flexibility.[13] Ramos-Campo & Rubio-Arias in 2019 conducted a study to evaluate whether or not Pilates or resistance schooling is beneficial in improving center isokinetic and isometric muscular energy and improving dynamic and static stability in older ladies. 60 Subjects aged 60 to 80 years were randomly allocated to Pilates, muscular and control corporations. The Pilates group received Pilates sporting events for 18 weeks of slight to full-of-life intensity. In this study, pilates was done using the lower extremities to strengthen the core muscles and improve balance. They concluded that Pilates is effective for the improvement of isometric hip and trunk extension strength compared to muscular organization.[14] Kalara Yadav advert Pawaria in 2019 researched to assess the performance of Pilates for improving players' lower limb strength, dynamic balance, agility, and coordination. Forty badminton participants aged 17 to 28 were randomly allotted to experimental institutions and managed institutions. The experimental organization acquired Pilates training on the side of conventional training whereas the managed group obtained the simplest conventional schooling. In the long run, they concluded that The Pilates method works well to enhance decreased limb energy, competencies in dynamic balance, agility, and coordination among badminton players.[15]

In our study, Pilates showed effectiveness in improving postural stability and strength of lower extremity muscles. Nashar, Wishy, Helmy & Rwainy 2019 conducted research on core balance sporting activities on upper limb characteristics and trunk balance in patients with hemiparesis. They concluded that middle muscle training is similar to traditional bodily remedies in improving upper limb characteristics within the sufferers with hemiparesis, but it has a more beneficial effect in improving trunk balancing. So as per this study, Pilates had a more significant effect on trunk balance.[16] Erdem, Akbas, and Unver in 2019 conducted a study to examine whether Pilates training helps in the improvement of stability of posture in individuals with or without schizophrenia. It was concluded that Pilates training helps in the development of postural stability in schizophrenia. Pilates training exercises can be added to the treatment of schizophrenia as a safe and effective method.[17] This research has certain limitations. Primarily, due to limited financial resources data was collected from Faisalabad and the sample size was small. Secondly, due to limited time, the long-term effects of Pilates were not evaluated. So it is recommended to take samples from other cities as well and future researchers are advised to extrapolate the findings, a larger sample size should be studied.

## CONCLUSION

This study investigated the effect of Pilates, core stability exercise training, on the lower extremities to improve postural stability and strength among the sedentary population. After applying the statistical test and measuring pre and post values it was concluded that Pilates had significant effects on improving postural stability and strength among sedentary population.

## DECLARATIONS

**Consent to participate:** All methods were performed following the relevant guidelines and regulations.

**Availability of data and materials**: Data will be available on request. The corresponding author will submit all dataset files. **Competing interests:** None
**Funding:** No funding source is involved.
**Authors' contributions:** All authors read and approved the final manuscript.
**CONSORT Guidelines:** All methods were performed following the relevant guidelines and regulations.

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