EFFECTS OF PILATES ON CORE MUSCLE STRENGTH AND ENDURANCE IN POST 6 MONTHS DELIVERED WOMEN

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ABSTRACT

Objective: To determine the effects of Pilates on core muscle strength and endurance in post 6 months delivered women.

Design: Randomized controlled study was conducted among post delivered women in PimpriChinchwad Pune, participants sample size was 52 subjects they were randomly allocated to 2 groups containing 26 samples each. In group A (Experimental Group) Pilates training was given while the group B (controlled group) conventional exercises were given on alternate days for 4 weeks. Each group was assessed pre and post of training using pressure biofeedback for core strength, plank test for core endurance, 3 minute step test for cardiorespiratory fitness and girth measurements.

Results: The results shows that there was significant difference between pre and post mean in pressure biofeedback in group A pre 30.88 and post 43.11 and in group B pre 28.96 post 33.3, there was significant difference in pre and post in plank test group A pre 23.26 post 30.69 group B pre 14.15 post 19.23, there was significant difference in pre and post in 3 minute step test group A pre 109.73 post 97.61 group B pre 104.96 and post 100.11, there was significant difference in girth measurements in pre and post in group A pre 52.19 post 51.53 and group B pre 47 and post 47.56. There was significant change seen in pre and post in group A and B of 0.05

Conclusion: Pilates mat exercises contributed to increase in the strength and endurance of core muscles in post delivered women and even improve the fitness of women by improvement in cardiorespiratory fitness and decrease in the girth measurements.

Keywords: Pilates, core, post delivered, pressure biofeedback
INTRODUCTION

The Core can be portrayed as a strong box with the abdomen in front, Para spinals and gluteal in the back, diaphragm as rooftop and pelvic floor and hip support musculature as base. Inside this crate are twenty nine sets of muscles that help to stabilize the spine, pelvis and motor chain during functional movements.\(^1,2\)

The core has been depicted as a container which is comprised of muscles including abdomen which makes up the front wall, Para spinal and gluteal muscles makes up the back wall, while the diaphragm makes up the rooftop and the pelvis floor and hip support muscles makes up the base. Inside this container are 29 sets of muscles. The core demonstrates through thoracolumbar belt. Transversus abdominals has enormous connections to the center and back layers of thoracolumbar belt. Profound lamina of back layer joins to lumbar spinous procedures. Consequently thoracolumbar belt fills in as band around the storage compartment. Pelvis and its immediate connection to spine is deciding element for the state of Diaphragm. During inhalation and exhalation pull ribcage up and there is forward tilt of pelvis encouraging spinal extension. This gives diaphragm a state of topsyturvy letter L. During exhalation inside Interco sties pull ribcage down and there is a retrogressive tilt of pelvis encouraging spinal flexion giving diaphragm a state of a topsyturvy letter J.\(^1,2\)

During pregnancy women’s body experience numerous anatomical and hormonal changes. The muscular strength will be stretched and are lengthened for a developing uterus. A brace between the two recti abdominis muscles known as diastasis will more likely than not be evidently in any women who was at term before work. This can differ between a little vertical gap of 2-3 cm wide and 12-20cm in width and expanding almost the entire length of the recti muscle accordingly, the whole abdominal corset will be debilitated with a next to no obvious mechanical control. In view of this, notwithstanding expanded flexibility to its tendon the back will be a lot of defenseless against injury coming about because of incorrect use. Core is the powerhouse for all the limb movements. Women whose pregnancies required delayed idleness or the individuals who constantly take almost no activity will surely find that their abdomen muscles are incredibly powerless. The pelvic floor will unquestionably be more vulnerable than it was preceding pregnancy.\(^6\)
PILATES

It is an exercise program that takes a shot at fortifying the core muscles which influence pose and offer help and quality of the spine. It shows body mindfulness, great posture and simple movement. Pilates improves adaptability, agility and economy of movement.

BENEFITS

Pilates advances more noteworthy trunk and pelvic security, improving and muscle control of and around the spine. Pilate's activities explicitly expect to make muscle balance in the body, more noteworthy coordination of the development and control of abdomen and breathing. This activity empowers the utilization of the body overall unit, developing strong, lean musculature instead of permitting singular muscle gathering to create confined quality and to get massive. A normal Pilate's tangle work meeting will advance the activities specifically request, so the muscles are set up for resulting practices and completely body exercise is accomplished.4

CORE STRENGTH AND PILATES

The guideline point of the activities is to make center quality, which will be the powerhouse for the remainder of the body. The abdomen and the back structures the Center of the body from which all developments in Pilates are started.

In Pilates by balancing out the middle, there is co-appointment between the abdomen muscles and the back muscles. This implies every one of these muscles is cooperating to make a steady element. In many people they frail in the back can be strained or tight. Right now spine might be pulled crooked, causing inappropriate stance and danger of injury. At the point when the back muscles and abdomen are solid and adaptable it gets simpler to keep upright stance. Pilates fortifies and extends the core muscles, assisting with revising uneven characters and possibility of enduring back pain5

MATERIAL AND METHODOLOGY

This is a randomized control trial in which 52 subjects were included. In this study inclusion criteria was the subjects should have delivered at least one time, age group between 20-40 years, participants who have not taken any previous physiotherapy treatment for core, participants who had normal delivery and were willing to participate. Exclusion criteria consisted of any orthopedic,
neurological, cardiovascular problems and psychological issues. Outcome measures used in the study are pressure biofeedback, plank test, 3 minutes step test, girth measurement.

A written informed consent was taken from the subjects before the commencement. Subjects were then randomly allocated into 2 groups by chit method. Control group consisted of 26 subjects. 26 subjects were included in the Experimental group. Pre – assessment was done. For control group conventional exercise were given for experimental group Pilates exercise were given, both were given for 4 weeks on alternate days and post – assessment was taken.

OUTCOME MEASURES

Plank test
Purpose of the test is to hold a raised position for as long as possible. The upper body should be reinforced off the ground by the elbow and forearm and legs should be straight with the weight mainly taken by the toes. Hips are elevated from the floor creating a straight line from head to toe. As soon as the participant is in the correct position, the stopwatch is started. The test is over when the participant is not able to maintain the back straight.7

Pressure Biofeedback
Participant in prone position and place the pressure biofeedback under the abdomen and then the biofeedback was inflated up to 70mmHg and now participants were asked to breath in and out once and asked participants to hold this position for 10 seconds the difference between 2-4 mmHg is normal. Then in crook lying position pressure biofeedback was place at L3 level and the pressure biofeedback was inflate up to 40 mmHg, the participant was ask to pull the naval towards the spine and hold it for 15 seconds for 2 times and in this 40-42 mmHg.9

3- Minute step test
First of all starting to this test for the heart rate of the person were checked, and first therapist demonstrated how to perform this test, subject were ask to first steps up with one foot on beat 1 and steps up with the second foot on beat 2, then steps down with the first foot on beat 3 and down with the second foot on beat 4.continue it for 3 minute and after that immediately asked participant to sit and check for her heart rate.10

Girth measurement
Arm: with the subject standing erect and feet together, an even measure is taken at halfway between the acromion and olecranon process.

Forearm: with the subject standing, arms hanging descending however marginally away from the storage compartment and palms face anteriorly.

Abdomen area: with the subject standing upstanding and loose, a flat measure is taken at the best front expansion of the mid-region, for the most part at the degree of the umbilicus.

Midsection: with the subject standing, arms along the edges, feet together, and stomach area loose, a flat measure is taken at the tightest piece of the middle.

Hips: with the subject standing erect and feet together, a flat measure is taken at the maximal boundary of bottom.

Thigh: with the subject standing, legs somewhat separated (~10cm), a flat measure is taken at the maximal boundary of the hip/proximal thigh, just beneath the gluteal overlay.

Midthigh: with the subject standing and one foot on a seat so the knee is flexed at 90 degree, a measure is taken halfway between the inguinal wrinkle and the proximal fringe of the patella, opposite to the long hub.

Calf: with the subject standing erect an even measure is taken at the degree of the most extreme periphery between the knee and the lower leg.¹⁰

Conventional exercises for control group were given as follows:

1. Static Back

Participants were asked to lie in a supine position in a relaxed position, and ask to press her head, shoulders, hips and ankles at the same time on the ground surface and hold it for 10 seconds repeating it for 10 times, this is one seat. And they were ask to do 3 seats in a day.

2. Static abdominal

Participant were ask to lie in crook lying position, were ask to pull the naval towards the spine without holding the breath for 10 seconds repeat it for 10 times, this was one seat. were asked to do it 3 seat in a day

3. Pelvic contraction

Participant were asked to lie in crook lying position, were ask to pull the naval towards the spine without holding the breath for 10 seconds and do pelvic bridging along with it, again come back
to the crook lying position and repeat it for 10 times, this was one seat were ask to do it for 3 seat in a day

4. Core stability exercise (abdominal pull in I with heel slides)
Participant were ask to lie on the back on mat and to draw the heel toward buttocks while maintaining the abdominal drawing while returning back to the starting position10 to 20 times

5. Kegal’s exercise
Participant were ask to empty the bladder first then lie down, and to tighten the pelvic floor muscles and ask to hold it for 8 sec, then relax the muscles and count to 10 , repeat I for 10 times

6. Cat and Camel exercise
Were requested – exhale as they sit back onto heels , lower head, chin tuck and reach the arms out. Cat – Inhale as they curve the back up and hollow the abdominals while the head remains tucked. Camel – exhale and lower abdominal and reach chin towards ceiling do the chin tuck

7. Pelvic Bridging
The patient lies down with the back, knees in full extension and feet flat on the floor and close to the buttock. Then the person lifts the hip off the floor towards the ceiling as high as possible.

Pilate’s exercises for experimental group were given as follows:

Mat group exercises were performed in groups for 30 minutes each day for 3 days a week. The no. of repetition for each exercise was from 5-6 repetitions. Basic commands about the positing, activation and engagement of core along with breathing control were given to the subjects.

1. Pelvic tilt
Participants were asking to lie on the mat with the knee bent. Compress the back against the mat by asking to tighten the abdominal muscles and tilt the pelvis up slightly, hold it up for 10 seconds and repeat

2. Supine leg circles
Participant was asking to get supine on the ground, hands under butt. Bend one leg and ask to raise the other leg off the floor and bring them above the hip, tuck the chin to the chest. Bring the leg up and repeat.

3. Side lying circles
Participants were asked to side lie, shoulders and hips loaded and to lift the top leg to hip height, inhale and bring the top leg forward. Keep the shoulders, torso and hips still as the top leg circles; continue to circle the leg up to the highest point without lifting the top hip up or shortening the waist. Repeat time and execute on the other side.

4. Side lying clamps

Participants were asked to lie in side lying, knees together and bent forwards, heels together in line with hips and shoulder. Head relaxed on shoulders. Create a small space under the waist. Roll the top hip slightly forwards and keep it forwards. Exhale: squash the top buttock and gradually raise the top knee keeping the feet close to each other. Make sure the hips are still and do not rock backwards. Inhale: bring the knees together.

5. Quadruped superman

Participant was asking to get down on her hands and knees with her hands shoulder width apart and flat on the Mat. Her knees and hips should be apart and bent to 90°. And to tighten her core and extend one leg completely behind it to hip height, using the abdominal to maintain stability. Lower the leg to return to the starting.

6. Seated twist

Participants were asked to sit in long sitting, and to extend the arms in T shape and ask to side rotate the upper body.

7. Prone lying stretch

At the end of the session Participants were asked to lie down prone lying with legs parallel to each other, with her shoulder and elbow in one line near to the chest and hold it for 30 seconds.

DATA ANALYSIS AND INTERPRETATION

Statistical analysis was done using the statistical package: Winpepi (version 11.65), and primer of biostatistics (version 7). Initially the normality of the data was analyzed using Shapiro wilk test in Winpepi software. Then the differences between pre and post readings of all outcomes were
compared. The intra-group (within) comparison was done using t test and inter group (between) comparison was done using paired t test.

Table- shows comparison of PRE –Treatment and POST –Treatment mean scoring using pressure biofeedback, plank test, 3 minutes step test, girth measurement.

<table>
<thead>
<tr>
<th>Table</th>
<th>Experimental Group Mean / S.D</th>
<th>Control Group Mean / S.D</th>
<th>‘t’ value (Experimental Group)</th>
<th>‘P’ value (Experimental Group)</th>
<th>‘t’ value (Control Group)</th>
<th>‘P’ value (Control Group)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-test Pressure Biofeedback Mean/S.D</td>
<td>30.88 (13.47)</td>
<td>26.96 (10.34)</td>
<td>19.16</td>
<td>.000</td>
<td>14.78</td>
<td>.000</td>
</tr>
<tr>
<td>Post-test Pressure Biofeedback Mean/S.D</td>
<td>43.11 (11.91)</td>
<td>33.03 (10.48)</td>
<td>12.82</td>
<td>.000</td>
<td>12.82</td>
<td>.000</td>
</tr>
<tr>
<td>Pre-test Plank Test Mean/S.D</td>
<td>23.26 (47.52)</td>
<td>14.15 (7.06)</td>
<td>0.80</td>
<td>.430</td>
<td>12.82</td>
<td>.000</td>
</tr>
<tr>
<td>Post test Plank Test Mean/S.D</td>
<td>30.69 (3.97)</td>
<td>19.23 (17)</td>
<td>0.00</td>
<td>.000</td>
<td>12.82</td>
<td>.000</td>
</tr>
<tr>
<td>Pre-test 3 minute step-test Mean / S.D</td>
<td>109.73 (6.18)</td>
<td>104.96 (17.45)</td>
<td>12.26</td>
<td>.000</td>
<td>1.38</td>
<td>.179</td>
</tr>
<tr>
<td>Post-test 3 minute step-test Mean / S.D</td>
<td>97.61 (3.91)</td>
<td>100.11 (5.07)</td>
<td>0.42</td>
<td>.677</td>
<td>1.38</td>
<td>.179</td>
</tr>
<tr>
<td>Pre-test Girth measure-Arm Mean/S.D</td>
<td>20.50 (5.97)</td>
<td>25.55 (16.02)</td>
<td>5.67</td>
<td>.000</td>
<td>1.17</td>
<td>.252</td>
</tr>
<tr>
<td>Post-test Girth measure-Arm Mean/ S.D</td>
<td>18.93 (5.14)</td>
<td>21.93 (4.03)</td>
<td>0.42</td>
<td>.677</td>
<td>1.17</td>
<td>.252</td>
</tr>
<tr>
<td>Pre-test Girth measure-Abdomen Mean/ S.D</td>
<td>52.19 (16.42)</td>
<td>47.00 (11.76)</td>
<td>0.90</td>
<td>.379</td>
<td>0.42</td>
<td>.677</td>
</tr>
</tbody>
</table>
The above table shows that in pressure biofeedback pre-test the mean is 30.88 post-test which is 43.11 in the experimental group and pre and post for control group 26.96 and 33.03 which shows that there was a significant difference in experimental group of 0.01.

The above table shows that in the plank test pre and post mean was 23.26 and 30.69 in the experimental group and pre and post for control group 14.15 and 19.23 which shows that there was no significant difference in the experimental group of 0.4. In 3 minutes step test pre and post mean difference in the experimental group was 109.73 and 97.61 and control group 104.96 and 100.11 which shows there was significant difference in experimental group of 0.01. Whereas in girth measurement of arm, abdomen and thigh in the experimental group a significant difference of 0.01 was found.

**DISCUSSION**

The Pilates method has a main objective to strengthen the abdominals and pelvic floor muscles. The iliopsoas, pelvic floor and quadriceps muscles are responsible for stabilization which consequently decreases pain and maintains posture thereby preventing an overall damage to the lumbosacral region. The mat Pilates exercises involved the use of gravity and participants own body weight as resistance. In Pilates one of the main techniques is to align, lengthen, and protect the spine is to scoup the umbilicus to the spine. One of the known benefits of abdominal tuckin is in the order to reduce the sacroiliac joint laxity than the abdominal bracing. Pilates focuses through whole body activity through emphasized posture. Movement patterns of each muscle are not involved primarily in alignment of each exercise. In the movement pattern the weaker muscles are promoted by the stronger muscles and the total strengthening of leg, arm and core are based on the radiation concept. The torso of the feet maintains the body weight slightly forward in the Pilates stance phase. With the core already engaged and with alignment optimal, the spine is prepared and protected for performing more skilled tasks. The TrA and multifidi get activated at a rate of about 100 milliseconds before the
movement of the limb, irrespective of direction of movement. With single leg standing and activities on any unstable surface, core muscle activity increases.\textsuperscript{3}

After analysis of data it was found that there was significant change in the value of pressure biofeedback, plank test, muscle circumference and the step test after the 4 weeks of Pilates.

Following Pilates training and conventional training there has been change in the strength of the core muscles within the group and between the group but the experimental group i.e. Pilates shows more increase in the strength than the controlled group, because the “Scoup” performed during Pilates focuses on in drawing of the abdominal muscles and contraction of the pelvic floor muscles. As the scoup was performed with every exercise and contraction had to be maintain throughout the exercise, this may be the reason for the increase in the strength post 4 weeks of exercise.

Drysdale et al. reported that when subjects performed an abdominal hollowing exercise inducing contraction of the local deep muscles, the transverse abdominis was contracted, while rectus abdominis, obliquusinternusabdominis, obliqueseexternusabdominis, which are the global muscles contracted less. They concluded that the characteristics and thickness of transverse abdominis muscle increased after the exercise.\textsuperscript{3,7}

The Pilates group included exercise which involved the activation of multifidus, like leg pull prone and similar exercise in the strength training in multifidus and transeveabdominas strength may have increased due to continuous and sustained contractions during exercise.

Nidhi Agarwal et al. reported that there is significant difference in pre and post reading in plank test after the 4 weeks of Pilates exercise, but in this With regard to the results of this study, Pilates exercises has found to be efficient training method for the improvement in the endurance of core muscles, but there is no statistical difference in pre and post reading in plank test but there is clinical difference in it, this may be due to small sample size and Pilates was given on alternate day for 4 weeks.\textsuperscript{7,11}

In the present study the subjects showed significant reduction in girth and skin fold measurement. Mainly the subjects showed the difference in the abdomen, waist, and thigh circumference. Dr Shamla Pazare et al. reported that this could be because strengthened abdominal muscle would have firmed the waist line, improved posture and resulted in trimmer appearance. Due to gravity
there is anterior pelvic tilt, so to maintain the spine neutral, it is required to strengthen the abdominal
and toning of the abdominal muscles. So after toning of the abdominal muscles, the pelvic position
is corrected thereby decreasing abdominal belly in size. Thus reduction in the girth is seen.
According to the results of this study it was determined that one can bring about positive changes in
body composition (e.g., reduction in total fat percentage and increase in lean body mass).\(^{11}\) with
regular physical exercise

In this study there is statistical difference in pre and post readings of step test i.e. in the resting heart
rate as Hee Sung LIM et al reported that the resting heart rate is the heart rates under stable
conditions; which inversely is related to exercise tolerance. As an increase in strength with physical
exercise is achieved, there is a reduction in resting heart rate. Thus, the heart rate is normalized more
quickly post an exercise session. The resting heart rate of the Pilates group of this study reduced as
observed both clinically and statistically, compared to the control group, in whom the resting heart
rate remained the same.

In this study samples also showed improvement in their regular activity like speed of walking; doing
any activity for more time in standing or sitting, maintaining balance for more time on the Scotty
etc.

According to the article published in the 2017 says that because the core muscle strengthening
allows the local stabilizers to get recruited first to stabilize the trunk, hips and ribs allowing for the
accurate and purposeful firing of global mobilizers thus allowing perfect movement over stable
framework. Through this study it is found that females suffer from low back pain because of their
involvement at work and home, their lack of exercise hampers the core stability and is associated
with back pain. Thus improving their local stability by strengthening of core had also produced
effect in their endurance and benefited them in their ADL’S.\(^7\)

Therefore, we can accept the alternative hypothesis that there is a significant effect of Pilates on
strength, endurance, fitness and muscle circumference in the post delivered women.

Conclusion
In conclusion, this study showed that Pilates mat exercises contributed to increase in the strength and endurance of core muscles in post delivered women and even improved the fitness of women by improvement in cardiorespiratory fitness and decrease in the girth measurements. In the future which may lead to better quality of life and lower the risk of back pain through improvements in abdominal and lower back strength, and abdominal muscular endurance.

FUTURE SCOPE OF STUDY

This study can be used or compared with various upcoming strategies to improve strength and endurance of core muscles in women which can reduce low back pain improve their daily activities. This study had low sample size which can be increased to improve the results. The duration of study was four weeks which can be increased in order to achieve greater results. And in this study only FTND samples were taken in future studies LSCS samples can also be used to see the difference.

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