## ABSTRACT

**TITLE OF THE TOPIC:** A comparative study to evaluate hemodynamic changes in response to Pilates exercises in mechanical low back pain patients and healthy individuals.

Dr. Jyoti Mann, Assistant Professor, Geetanjali college of Physiotherapy, Udaipur, Rajasthan

**BACKGROUND:**

Pilates exercises for the lumbar spine, which are done repeatedly, have been used in the management of low back pain for over three decades. The cardiovascular effects of exercises that involve postural stabilization, core strengthening, arm exercises and of exercises performed in lying are well known, but there are seldom studies performed to assess the cardiovascular effects of these commonly used Pilates exercises. Therefore the study focused on evaluating the effects of 6 commonly used Pilates exercises on the cardiovascular system.

**METHODOLOGY:**

This study includes 60 subjects both male and female of age 30-50 years who were eligible as per the inclusion criteria were divided into two groups- Group A (Low Back Pain individuals=30 subjects) and Group B (Healthy individuals= 30 subjects). Pre- participation questionnaire along with consent form and PARQ (Physical Activity Readiness Questionnaire) was given to subjects to fulfill criteria for selection. Each subject performed six Pilates exercises such as- Knee fold, Single leg stretch, Spine twist, Flight, Single leg stretch in standing and Hip extension for six weeks ; four days in a week. With each week repetitions and bouts were increased from 5and3 to 15and 13 respectively. Heart Rate and Blood Pressure (Systolic and Diastolic BP) were recorded

pre and post intervention each day every week. Heart Rate was measured by manual palpatory method and Blood Pressure by Sphygmomanometer.

**RESULTS:**

Results showed that there was a significant difference in HR ($p<0.05$ in wk.4, $p<0.05$ in wk.5); SBP ($p<0.01$ in wk.1, $p<0.01$ in wk.2, $p<0.05$ in week 4); DBP ($p<0.05$ in wk.4, $p<0.01$ in wk.5, $p<0.01$ in wk.6) during pre exercise session and HR, SBP and DBP were significantly higher almost in all weeks during post exercise session of LBP and healthy individuals. Although, LBP individuals experienced more cardiovascular demand as number of repetitions increased but the intervention has cardiovascular effects on healthy individuals too.

**CONCLUSION:**

Pilates exercises have cardiovascular effects on low back pain patients. This effect was increased as the number of repetitions increase. Adequate cautions need to be taken while prescribing Pilates exercises complaining of low back pain with symptomatic or asymptomatic cardiovascular diseases. Proper cardiovascular monitoring will be required for low back pain as well as healthy individuals while prescribing Pilates exercises**.**

**KEY WORDS:** low back pain, pilates, heart rate, blood pressure.

## INTRODUCTION

Since the time of acquiring erect two-legged posture from the ancient quadruped state, the lumbosacral junction has remained weak due to its structural and biomechanical inadequecies.[1]

Fortunately, this has resulted into the presence of mechanical LBP (low back pain) in the majority of patients, whereas, LBP due to prolapsed intervertebral disc (PIVD) and other causes needing extensive treatment occurs only in about 1-2% cases of all the patients of LBP.[1]

The lifetime prevalence of low back pain is estimated at 60-85%, while the annual prevalence in the general population is ranging from 15-45%. The annual incidence of back pain in the general population is estimated between 10%-15% In the vast majority of patients low back pain is a self limiting condition, from which 90% are expected to recover in about six weeks.However, high recurrence rates of 40-70%, including annual recurrence rates of 60% have been reported.[8]

The daily activity puts tremendous repetitive, compressive, and shearing stresses on the bony components of the back and tensile stresses on the muscular and ligamentous components.[1]

Active trunk flexion increases intradiscal pressure tremendously. Intradiscal pressure of 100 kg during standing is raised to 280 kg. Shearing force increases if the anterior tilt is increased and diminishes when the back is flattened.[1]

Pilates is a physical fitness system developed in the early 20th century by Joseph Pilates. Pilates called his method "Contrology." It is practiced worldwide, and especially in western countries.[11]

Pilates puts emphasis on alignment, breathing, developing a strong core, and improving coordination and balance. The core, consisting of the muscles of the abdomen, low back, and hips, is often called the "powerhouse" and is thought to be the key to a person's stability.

Pilates focuses largely on correct breathing, spinal, and pelvic alignment, and a concentration of smooth flowing movements. By connecting all of these aspects, the pilates exercise becomes a mind-body workout. Pilates creates a strong core and strong back with exercises concentrating on the deep abdominal muscles and muscles lining the spine. The moves incorporated in Pilates workouts elongate the muscles and make them leaner, improving joint mobility and flexibility. This decreases risk of muscle injury. Due to the even development of the muscles, Pilates improves posture due to a strong core and back muscles for support.[13]

Inhalation can facilitate spine extension and resist forces of spinal flexion. Exhalation can facilitate spine flexion and resist forces of spine extension.[15]

This study is to examine the cardiovascular effects of Pilates so that when these exercises are incorporated in treatment of individuals with low back pain who are prone to cardiovascular diseases, proper monitoring can be done.

## METHODOLOGY:

60 samples were divided into two groups. Group A consists 30 samples with mechanical low back pain and 30 samples of normal healthy individuals.

Subjects were given detailed information about the study and its importance and were requested to fill the questionnaires voluntarily. Informed Consent was taken from all the subjects. Subjects were selected by convenient sampling method based on inclusion and exclusion criteria along

with a written consent signed by them for participation in this study. First the pre-participation data was collected from the subjects, which included personal details name, age, sex, occupation, medications etc were collected and documented. Approval for this study was obtained from the ethical committee of the Geetanjali University, Udaipur.

All the respondents completed the questionnaires anonymously. No expenditure was inflicted on the cases, and all the personal records were considered confidential.

Exercise intervention program consists of:- Pilates exercises (knee fold, single leg stretch, spine twist, flight, single leg stretch in standing, hip extension); four days in a week. With each week repetitions and bouts were increased from 5and3 to 15and 13 respectively. Heart Rate and Blood Pressure (Systolic and Diastolic BP) were recorded pre and post intervention each day every week. Heart Rate was measured by manual palpatory method and Blood Pressure by Sphygmomanometer.

| **Week 1** | **5 repetitions and 3 bouts of each exercise pattern /day** |
|---|---|
| Week 2 | 5 repetitions and 5 bouts of each exercise pattern/day |
| Week 3 | 10 repetitions and 7 bouts of each exercise pattern /day |
| Week 4 | 10 repetitions and 9 bouts of each exercise pattern/day |
| Week 5 | 15 repetitions and 11 bouts of each exercise pattern/day |
| Week 6 | 15 repetitions and 13 bouts sets of each exercise pattern/day |

The resting HR and BP were recorded in a relaxed sitting position in an armchair.

The client should rest 5 to 10 minutes in seated position before assessing the resting heart rate.

Heart rate was measured by palpatory method; left side radial artery. Use the middle and index finger, palpate radial artery. Start stop watch simultaneously with the pulse beat, count the first beat as zero. Count HR for 15 seconds, count time 4, multiply to convert the count to beats per minute (bpm). (15*4=60 bpm).[44]

Blood Pressure was measured by Gold Standards. Guide the patient to the desired position. The sitting position is recommended with the back supported, legs uncrossed and feet flat on floor midpoint of the arm should be at heart level with the elbow slightly flexed and the palm up.[45]

Wrap the deflated cuff snugly and evenly around the patient's bare arm approximately one inch above the antecubital fossa ; the center of cuff should be in the line with the brachial artery. Place the bell of the stethoscope firmly over the brachial pulse point at the lower border of the BP cuff. Close the valve of the BP cuff and rapidly inflate the cuff to approximately 30 mm Hg above the estimated SBP. Release the thumb valve, air should be released at a rate of 2 mm Hg per heart beat. Note the point at which the first rhythmic tapping sound is heard represents the systolic pressure. Note when the sounds become muffled there after the sound will disappear represents the diastolic pressure. [45]

**Warm up exercises:-** for (5-10 minutes)

Include brisk walking, jumping, stretching of upper and lower limbs like neck stretch, hamstring stretch etc. repetitive motions at slow speeds, gradually increasing the effort.

**Cool down period:-** for (5-10 minutes)

Include slow total body repetitive motions and stretching for exercised muscle group same as warm up period.

## RESULTS:

**Table 6.1 : Descriptive statistics of mean between pre and post exercise scores of all subjects**

| | Group | Mean | SD | Difference | SEd | t | df | P |
|---|---|---|---|---|---|---|---|---|
| HR pre exercise in first week | M | 73.27 | 8.145 | 4.067 | 1.901 | 2.139 | 58 | 0.037 |
| | F | 69.20 | 6.488 | | | | | |
| SBP pre exercise in first week | M | 113.87 | 4.265 | -3.667 | 1.104 | -3.320 | 58 | 0.002 |
| | F | 117.53 | 4.289 | | | | | |
| DBP pre exercise in first week | M | 68.93 | 5.192 | 1.800 | 1.252 | 1.438 | 58 | 0.156 |
| | F | 67.13 | 4.478 | | | | | |
| HR pre exercise in second week | M | 71.40 | 6.563 | 1.500 | 1.515 | 0.990 | 58 | 0.326 |
| | F | 69.90 | 5.081 | | | | | |
| SBP pre exercise in second week | M | 114.00 | 4.983 | -3.000 | 1.109 | -2.705 | 58 | 0.009 |
| | F | 117.00 | 3.474 | | | | | |
| DBP pre exercise in | M | 67.73 | 4.891 | -2.133 | 1.348 | -1.582 | 58 | 0.119 |
| | F | 69.87 | 5.532 | | | | | |

| | Group | Mean | SD | Difference | SEd | t | df | P |
|---|---|---|---|---|---|---|---|---|
| second week | | | | | | | | |
| HR pre exercise in third week | M | 72.13 | 6.827 | 1.133 | 1.643 | 0.690 | 58 | 0.493 |
| | F | 71.00 | 5.866 | | | | | |
| SBP pre exercise in third week | M | 116.60 | 4.583 | -0.067 | 1.048 | -0.064 | 58 | 0.950 |
| | F | 116.67 | 3.457 | | | | | |
| DBP pre exercise in third week | M | 68.33 | 4.334 | -1.333 | 1.410 | -0.946 | 58 | 0.348 |
| | F | 69.67 | 6.391 | | | | | |
| HR pre exercise in fourth week | M | 70.73 | 5.953 | 2.667 | 1.403 | 1.901 | 58 | 0.062 |
| | F | 68.07 | 4.856 | | | | | |
| SBP pre exercise in fourth week | M | 113.87 | 4.754 | -2.467 | 1.085 | -2.273 | 58 | 0.027 |
| | F | 116.33 | 3.565 | | | | | |
| DBP pre exercise in fourth week | M | 68.40 | 4.116 | -3.000 | 1.285 | -2.335 | 58 | 0.023 |
| | F | 71.40 | 5.709 | | | | | |
| HR pre exercise in fifth week | M | 68.07 | 4.941 | -3.000 | 1.374 | -2.184 | 58 | 0.033 |
| | F | 71.07 | 5.675 | | | | | |
| SBP pre exercise in fifth week | M | 115.67 | 4.205 | -0.933 | 0.970 | -0.963 | 58 | 0.340 |
| | F | 116.60 | 3.244 | | | | | |
| DBP pre exercise in fifth week | M | 68.73 | 5.265 | -5.067 | 1.321 | -3.835 | 58 | 0.000 |
| | F | 73.80 | 4.965 | | | | | |
| HR pre | M | 70.53 | 5.482 | -1.733 | 1.533 | -1.130 | 58 | 0.263 |

| | Group | Mean | SD | Difference | SEd | t | df | P |
|---|---|---|---|---|---|---|---|---|
| exercise in sixth week | F | 72.27 | 6.362 | | | | | |
| SBP pre exercise in sixth week | M | 115.20 | 4.916 | -1.800 | 1.065 | -1.690 | 58 | 0.096 |
| | F | 117.00 | 3.140 | | | | | |
| DBP pre exercise in sixth week | M | 68.67 | 5.287 | -5.267 | 1.457 | -3.615 | 58 | 0.001 |
| | F | 73.93 | 5.977 | | | | | |
| HR post exercise in first week | M | 81.63 | 11.693 | -12.433 | 2.398 | -5.186 | 58 | 0.000 |
| | F | 94.07 | 5.977 | | | | | |
| SBP post exercise in first week | M | 126.13 | 4.066 | -4.800 | 1.285 | -3.734 | 58 | 0.000 |
| | F | 130.93 | 5.747 | | | | | |
| DBP post exercise in first week | M | 80.80 | 3.916 | -3.333 | 1.112 | -2.997 | 58 | 0.004 |
| | F | 84.13 | 4.666 | | | | | |
| HR post exercise in second week | M | 91.33 | 4.936 | -4.267 | 1.246 | -3.425 | 58 | 0.001 |
| | F | 95.60 | 4.709 | | | | | |
| SBP post exercise in second week | M | 125.80 | 5.416 | -6.333 | 1.291 | -4.905 | 58 | 0.000 |
| | F | 132.13 | 4.547 | | | | | |
| DBP post exercise in second week | M | 80.80 | 4.859 | -4.067 | 1.240 | -3.279 | 58 | 0.002 |
| | F | 84.87 | 4.747 | | | | | |
| HR post exercise in third week | M | 88.33 | 9.189 | -6.400 | 1.780 | -3.595 | 58 | 0.001 |
| | F | 94.73 | 3.258 | | | | | |

| | Group | Mean | SD | Difference | SEd | t | df | P |
|---|---|---|---|---|---|---|---|---|
| SBP post exercise in third week | M | 126.87 | 4.416 | -4.733 | 1.251 | -3.785 | 58 | 0.000 |
| | F | 131.60 | 5.236 | | | | | |
| DBP post exercise in third week | M | 78.20 | 4.278 | -6.667 | 0.983 | -6.784 | 58 | 0.000 |
| | F | 84.87 | 3.267 | | | | | |
| HR post exercise in fourth week | M | 84.60 | 7.775 | -10.067 | 1.562 | -6.443 | 58 | 0.000 |
| | F | 94.67 | 3.575 | | | | | |
| SBP post exercise in fourth week | M | 125.07 | 4.571 | -7.867 | 1.199 | -6.558 | 58 | 0.000 |
| | F | 132.93 | 4.719 | | | | | |
| DBP post exercise in fourth week | M | 79.20 | 4.859 | -6.533 | 1.078 | -6.062 | 58 | 0.000 |
| | F | 85.73 | 3.352 | | | | | |
| HR post exercise in fifth week | M | 83.13 | 7.785 | -10.800 | 1.705 | -6.334 | 58 | 0.000 |
| | F | 93.93 | 5.159 | | | | | |
| SBP post exercise in fifth week | M | 122.13 | 3.521 | -4.267 | 0.896 | -4.761 | 58 | 0.000 |
| | F | 126.40 | 3.420 | | | | | |
| DBP post exercise in fifth week | M | 74.80 | 4.318 | -8.267 | 1.195 | -6.917 | 58 | 0.000 |
| | F | 83.07 | 4.920 | | | | | |
| HR post exercise in sixth week | M | 82.60 | 7.468 | -11.267 | 1.535 | -7.342 | 58 | 0.000 |
| | F | 93.87 | 3.857 | | | | | |
| SBP post exercise in sixth week | M | 125.27 | 4.653 | -1.133 | 1.105 | -1.025 | 58 | 0.309 |
| | F | 126.40 | 3.874 | | | | | |
| DBP post exercise in sixth week | M | 75.13 | 5.056 | -9.533 | 1.178 | -8.090 | 58 | 0.000 |
| | F | 84.67 | 4.011 | | | | | |

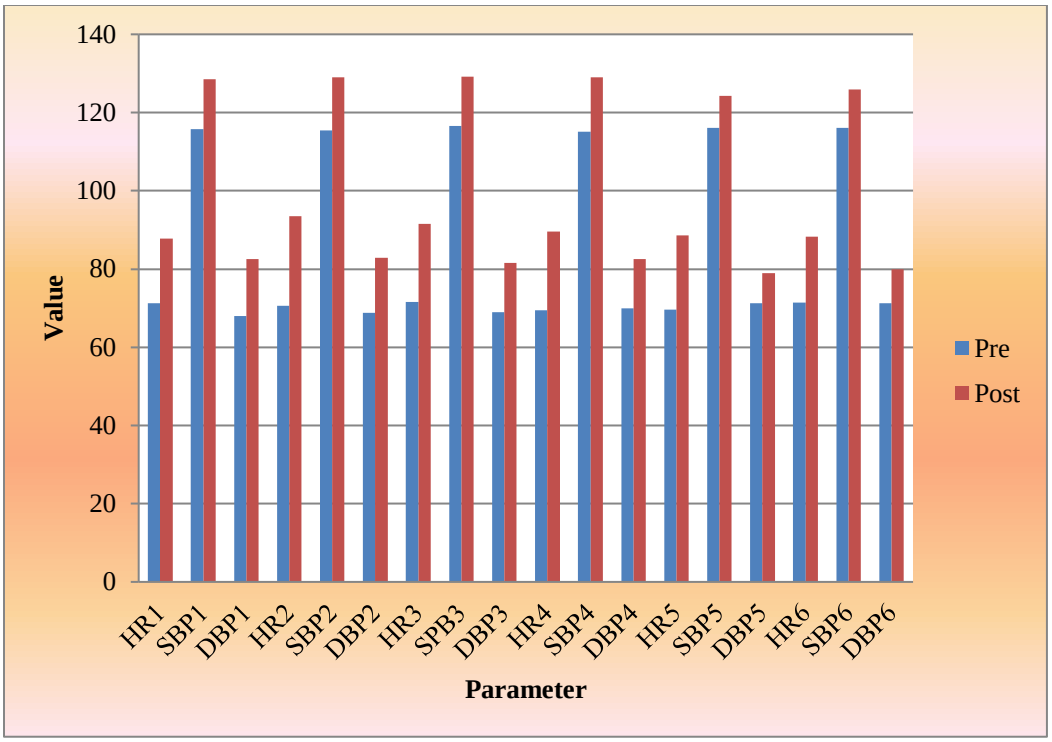


Table1 shows that there is a significant difference between HR of healthy and LBP patients in week 1 ($p<0.05$) and week 5 ($p<0.05$) pre exercise whereas post exercise HR was significantly higher in case of LBP patients in comparison to healthy individuals. The SBP was significantly higher in LBP patients pre exercise in week1 ($p<0.01$), week2 ($p<0.01$) and week4 ($p<0.05$). in case of post exercise, SBP was higher in LBP patients in week 1-5. The DBP of LBP patients was significantly higher in week4 ($p<0.05$), week5 ($p<0.01$) and week6 ($p<0.01$) whereas post exercise DBP was higher in all weeks in LBP patients.

As a result of data analysis repetitive Pilates exercises for the lumbar spine elicit significant hemodynamic stress in healthy and low back pain individuals. These exercises increase the work of the heart in people with no known spinal impairments and no cardiovascular or cardiopulmonary insufficiencies. It was found that the cardiovascular demand increased as the number of repetitions for a given type of exercise increased. Richardson D, stated that the magnitude and frequency of active muscular contractions also affect the blood flow. The muscle

metabolism increases in response to voluntary contractions, and therefore blood flow to the active musculature.

Christensen EH, Astrand PO, in their work concluded that volume of oxygen consumed during physical exercise is necessarily dependent upon the load on the muscles and also on the mass of the muscles at work. Work with legs can bring the metabolism to a higher level than can exercise performed by the arms. All these researches confirm that there is increased oxygen demand by the contracting muscles which in turn increases the HR, BP, cardiac output and stroke volume.

## DISCUSSION:

The study indicates that before administering Pilates exercises to any patient having spinal problem cardiovascular status should be examined. This study recommends that, ruling out cardiovascular and pulmonary disease by history taking alone is not sufficient and cardiac and pulmonary risk factor assessment should be done before prescribing Pilates exercises. The results of the study suggest that baseline heart rate and blood pressure should be recorded routinely. Cardiovascular monitoring should also be taught to the patient themselves so that cardiovascular monitoring can be performed when Pilates exercises for the lumbar spine are performed as a home exercise program.

## CONCLUSION:

Pilates exercises have cardiovascular effects on low back pain patients. This effect was increased as the number of repetitions increase. Adequate cautions need to be taken while prescribing Pilates exercises complaining of low back pain with symptomatic or asymptomatic cardiovascular diseases. Proper cardiovascular monitoring will be required for low back pain as

well as healthy individuals while prescribing Pilates exercises. Pilates exercises should be incorporated into cardiac rehabilitation program.

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