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CARDIOVASCULAR EFFECTS OF PILATES EXERCISE IN INDIVIDUALS WITH MECHANICAL LOW BACK PAIN AND HEALTHY SUBJECTS

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ABSTRACT

Background: Low back pain (LBP) is a highly prevalent musculoskeletal disorder worldwide, often leading to functional limitations and recurrent episodes. Pilates exercise, originally developed as “Contrology,” emphasizes core strengthening, postural alignment, and breathing control, and has been increasingly utilized in rehabilitation programs. Its cardiovascular effects in patients with LBP, however, remain underexplored. **Objectives:** To evaluate the cardiovascular effects of Pilates exercises in individuals with mechanical low back pain compared to healthy individuals. **Methodology:** A comparative study was conducted on 60 participants, aged 30–50 years, divided into two groups: 30 patients with mechanical LBP (experimental) and 30 healthy individuals (control). A six-week Pilates intervention program, including exercises such as knee fold, single leg stretch, spine twist, flight, and hip extension, was administered four times per week. Heart rate (HR), systolic blood pressure (SBP), and diastolic blood pressure (DBP) were measured pre- and post-exercise using manual palpation and sphygmomanometer. Data were analyzed using paired and independent t-tests at 0.01 and 0.05 significance levels. **Results:** Pilates exercise produced significant cardiovascular changes in both groups. In LBP patients, HR and BP values were significantly higher than controls across several weeks ($p<0.05$). Pre- and post-exercise comparisons revealed significant increases in HR, SBP, and DBP, with the effect becoming more pronounced as repetitions increased. **Conclusion:** Pilates exercises impose notable cardiovascular demands in individuals with LBP and healthy subjects. Incorporating cardiovascular monitoring is essential when prescribing Pilates for rehabilitation, especially in patients with existing or potential cardiovascular risk. Pilates may also contribute to cardiac rehabilitation programs.

KEYWORDS: Low back pain, Pilates, cardiovascular response, rehabilitation, exercise therapy.

INTRODUCTION

Due to anatomical and biomechanical deficiencies, the lumbosacral junction has remained weak ever since humans transitioned from their original quadrupedal state to an upright two-legged position.[1] Fortunately, this has led to mechanical LBP (low back pain) being experienced by the majority of people, as opposed to LBP caused by prolapsed intervertebral discs (PIVD) and other conditions requiring substantial treatment, which affect only approximately 1-2% of all LBP patients.[1]

While the annual prevalence in the general population ranges from 15 to 45%, the lifetime prevalence of low back pain is believed to be between 60 and 85%. Back discomfort is thought to affect 10% to 15% of the population on an annual basis. 90% of patients with low back pain are anticipated to heal in around six weeks from this self-limiting disease. However, there have been reports of high recurrence rates of 40–70%, including annual recurrence rates of 60%.[8]

The daily activity produces tensile pressures on the muscular and ligamentous components of the back as well as significant repetitive, compressive, and shearing stresses on the bony components.[1] Active trunk flexion significantly raises intradiscal pressure. Standing causes the 100 kg intradiscal pressure to increase to 280 kg. When the anterior tilt is increased, the shearing force increases, and when the back is flattened, it decreases.[1]

Joseph Pilates created the Pilates system of physical exercise in the early 20th century. The name of Pilates' technique is "Contrology." It is a widespread practise, particularly in western nations.11Pilates focuses on alignment, breathing, building a strong core, and enhancing balance and coordination. A person's core, which consists of the muscles in their belly, low back, and hips, is frequently referred to as their "powerhouse" and is considered to be the secret to their stability.

Incorrect breathing, proper spinal and pelvic alignment, and an attention on fluid, flowing movements are the main focuses of Pilates. The pilates exercise turns into a mind-body workout by combining all of these elements. Pilates movements that focus on the deep abdominal muscles and muscles lining the spine help to build a strong core and back. The exercises used in Pilates workouts lengthen and slim down the muscles, enhancing joint mobility and flexibility. This lowers the chance of muscle damage. Pilates enhances posture because of the even development of the muscles, a strong core, and the use of the back muscles as support.[13] Inhalation can help the spine extend and counteract forces that would otherwise cause it to flex. Exhaling can help the spine bend and counteract forces that would otherwise cause it to extend.[15]

This study will look at the cardiovascular effects of Pilates so that proper monitoring can be done when these activities are used to treat people with low back pain who are at risk for cardiovascular diseases.

METHODOLOGY

Participants:- This study was comparative including 60 subjects who were divided into two groups. Group A consists 30 subjects with mechanical low back pain (experimental group) and 30 subjects of normal healthy individuals (control group).

Procedure

Subjects were provided with comprehensive information about the study and its significance, and they were asked to freely complete the surveys. Each individual gave their informed consent. Based on inclusion and exclusion criteria and a signed written consent form, subjects were chosen for the study using a practical sampling technique. Patients needed to be in the 30- to 50-year-old age range, perform independent gaits without assistance, be medically healthy to engage in physical activity, be both male and female, and engage in typical ADL activities to meet the inclusion criteria. Patients with cardiovascular conditions, tumours, infections, fractures, neurological and muscle problems, any ongoing surgeries, and head injury histories were excluded from the study.

The questionnaires were filled out by each and every respondent privately. The lawsuits did not incur any costs, and all personal information was treated as private.

The fitness intervention program's warm-up exercises include brisk walking, hopping, extending the neck and hamstrings, as well as repeating slow-moving motions for 5 to 10 minutes while gradually increasing the effort. Pilates exercises are performed on all four days of the week (knee fold, single leg stretch, spine twist, flight, single leg stretch while standing, hip extension). The number of repetitions and bouts increased every week, going from 5 and 3 to 15 and 13, respectively. Pre and post intervention measurements of heart rate and blood pressure (systolic and diastolic BP) were taken every day of the week. Manual palpation was used to determine heart rate, and a sphygmomanometer was used to determine blood pressure. Stretching for the worked-out muscle area and gradual, repetitive motions of the entire body were included in the 5- to 10-minute cool-down session.

Intervention

Table 1: Exercise intervention four days a week.

S.No.	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6
1.	Knee Fold	Knee Fold	Knee Fold	Knee Fold	Knee Fold	Knee Fold
2.	Single Leg Stretch	Single Leg Stretch	Single Leg Stretch	Single Leg Stretch	Single Leg Stretch	Single Leg Stretch
3.	Spine Twist	Spine Twist	Spine Twist	Spine Twist	Spine Twist	Spine Twist
4.	Flight	Flight	Flight	Flight	Flight	Flight
5.	Single Leg Stretch in Standing	Single Leg Stretch in Standing	Single Leg Stretch in Standing	Single Leg Stretch in Standing	Single Leg Stretch in Standing	Single Leg Stretch in Standing
6.	Hip Extension	Hip Extension	Hip Extension	Hip Extension	Hip Extension	Hip Extension
REPS/BOUTS	5/3	5/5	10/7	10/9	15/11	15/13

STATISTICAL ANALYSIS

Descriptive statistics for comparison between pre and post operative scores including means and standard deviations were calculated. Statistically the characteristics of the scores and the results were compared using independent sample t test and paired t tests. A level of probability at 0.01 and 0.05 levels was assumed to draw significance.

RESULTS

Results showed that there was a significant difference in HR ($p<0.05$ in wk.4, $p<0.05$ in wk.5); SBP ($p<0.05$ in wk.1, $p<0.05$ 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.

Tables showed 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. Graph depicts correlation between pre and post exercise which was significant for HR in week5, SBP in week 2,3 and DBP in week 3,4,5,6 in case of all the subjects and correlation was significant for HR in week1,3,4,5; SBP in week3 and DBP in week3.

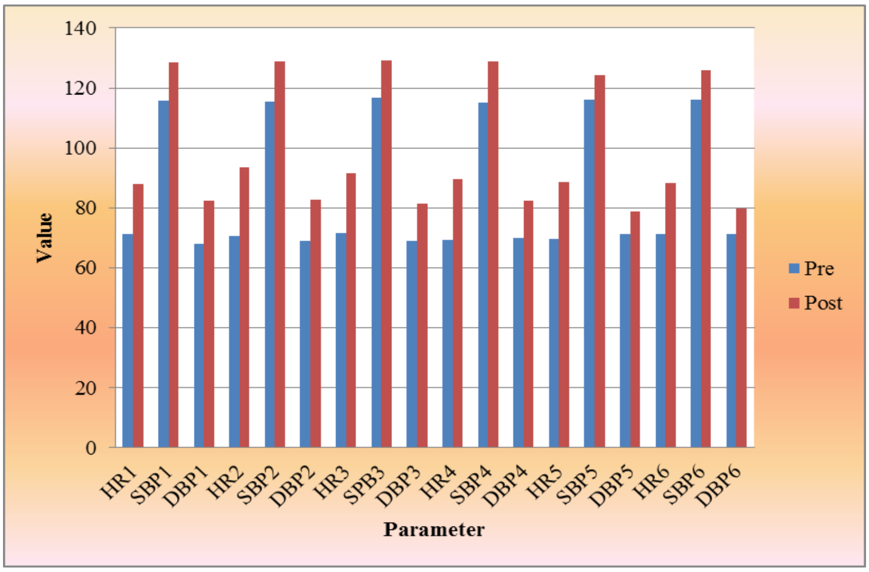
Although, LBP individuals experienced more cardiovascular demand as number of repetitions increased but the intervention has cardiovascular effects on healthy individuals too.

RESULTS

Table 2: 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 second week	M	67.73	4.891	-2.133	1.348	-1.582	58	0.119
	F	69.87	5.532					
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 exercise in sixth week	M	70.53	5.482	-1.733	1.533	-1.130	58	0.263
	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					

	Group	Mean	SD	Difference	SEd	t	df	P
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					
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					

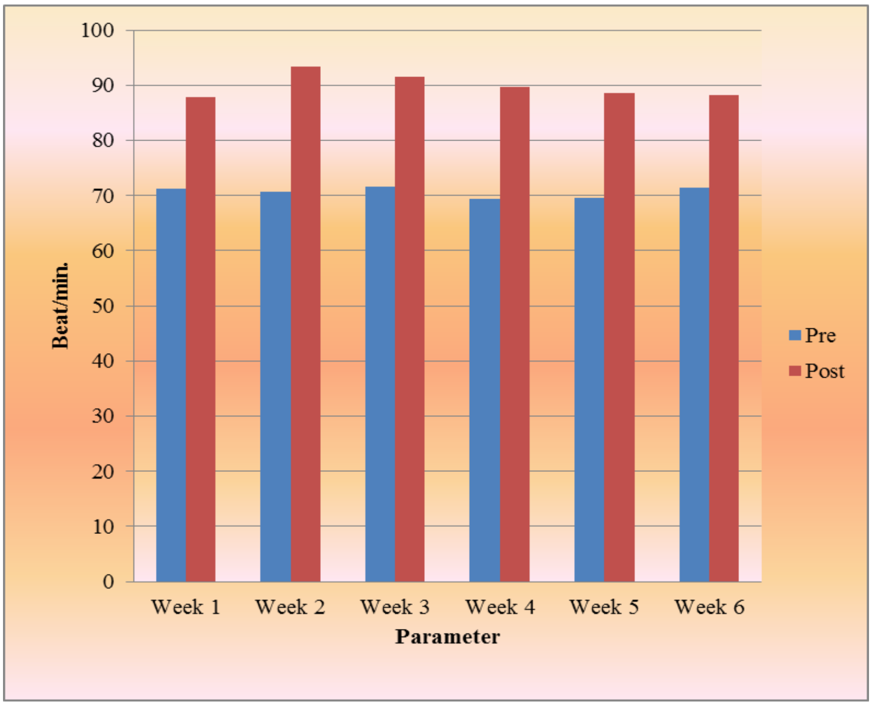


Graph No. 2: Difference between pre and post exercise of all subjects.

Table 3: Paired correlation between variables for each week.

Pair	Correlation	P
Pre HR & post HR for first week	0.092	0.486
Pre SBP & Post SBP for first week	0.174	0.183
Pre DBP & Post DBP for first week	0.162	0.215
Pre HR& Post HR for second week	-0.030	0.818
Pre SBP & Post SBP for second week	0.260	0.045
Pre DBP & Post DBP for second week	-0.030	0.822
Pre HR & Post HR in third week	0.212	0.103
Pre SBP & Post SBP in third week	0.262	0.044

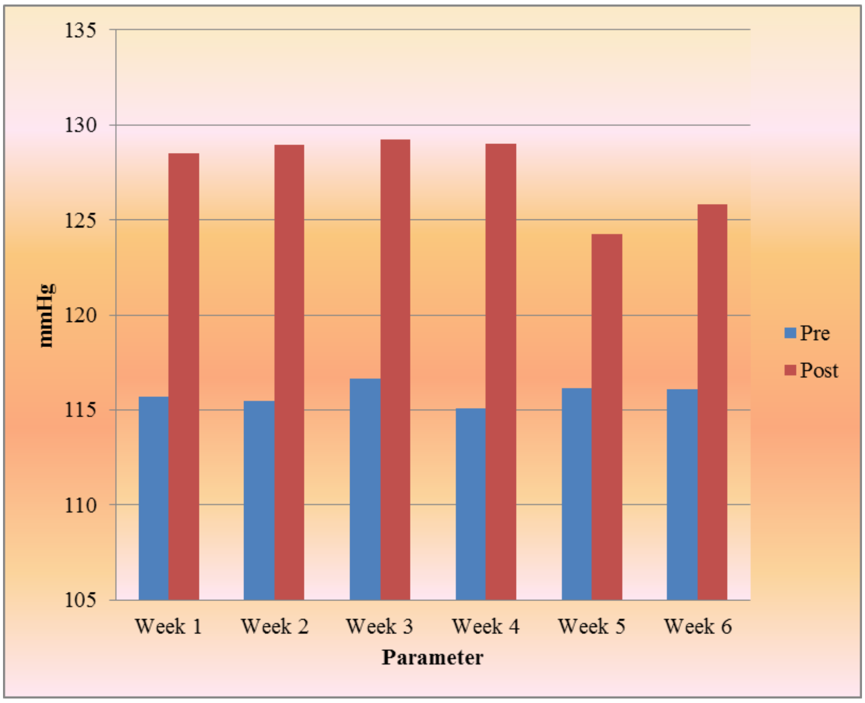
Pre DBP & Post DBP in third week	0.263	0.042
Pre HR & Post HR in fourth week	0.132	0.316
Pre SBP & Post SBP in fourth week	0.204	0.118
Pre DBP & Post DBP in fourth week	0.402	0.001
Pre HR & Post HR in fifth week	0.479	0.000
Pre SBP & Post SBP in fifth week	0.038	0.775
Pre DBP & Post DBP in fifth week	0.459	0.000
Pre HR & Post HR in sixth week	0.195	0.136
Pre SBP & Post SBP in sixth week	0.080	0.542
Pre DBP & Post DBP in sixth week	0.411	0.001



Graph No. 3: Pre and post exercise heart rate at different intervals.

Table 4: Paired correlation between variables for healthy individuals.

Pair	Correlation	P
Pre HR & Post HR in first week	0.437	0.016
Pre SBP & Post SBP in first week	0.049	0.798
Pre DBP & Post DBP in first week	0.186	0.325
Pre HR & Post HR in second week	-0.021	0.911
Pre SBP & Post SBP in second week	0.302	0.105
Pre DBP & Post DBP in second week	-0.159	0.401
Pre HR & Post HR in third week	0.448	0.013
Pre SBP & Post SBP in third week	0.403	0.027
Pre DBP & Post DBP in third week	0.547	0.002
Pre HR & Post HR in fourth week	0.631	0.000
Pre SBP & Post SBP in fourth week	-0.038	0.843
DBP4 & PDBP4	.334	.071
Pre HR & Post HR in fifth week	0.539	0.002
Pre SBP & Post SBP in fifth week	0.227	0.228
Pre DBP & Post DBP in fifth week	0.301	0.106
Pre HR & Post HR in sixth week	0.245	0.193
Pre SBP & Post SBP in sixth week	0.118	0.534
Pre DBP & Post DBP in sixth week	0.151	0.425



Graph No. 4: Pre and post exercise Systolic blood pressure at different intervals.

DISCUSSION

According to data analysis, both people with low back pain and those in good health experience significant hemodynamic stress during recurrent Pilates movements for the lumbar spine. In persons without documented spinal abnormalities, cardiovascular disease, or cardiopulmonary insufficiency, these exercises make the heart work harder. It was discovered that when the quantity of repetitions for a certain type of exercise grew, so did the cardiovascular demand. According to Richardson D, blood flow is also impacted by the strength and regularity of vigorous muscle contractions. Voluntary muscular contractions cause an increase in muscle metabolism and blood flow to the active muscles.

In their research, Christensen EH and Astrand PO came to the conclusion that the amount of oxygen consumed during physical activity is inevitably influenced by the stress on the muscles as well as the mass of the working muscles. Exercise involving the legs has a greater potential to increase metabolism than exercises involving the arms. All of these studies support the idea that muscles in motion require more oxygen, which raises heart rate, blood pressure, cardiac output, and stroke volume.

The study suggests that every patient with a spinal condition should have their cardiovascular health assessed before receiving Pilates workouts. According to this study, a simple history-taking approach is insufficient to rule out cardiovascular and pulmonary disease, and a cardiac and pulmonary risk factor evaluation should be conducted before recommending Pilates activities. The study's findings advise routine baseline blood pressure and heart rate recording. In order to do cardiovascular monitoring when Pilates exercises for the lumbar spine are performed as a home exercise programme, the patient themself should also be taught how to perform cardiovascular monitoring.

CONCLUSION

Patients with low back discomfort benefit from the cardiovascular benefits of pilates. As the number of repeats rose, this effect grew stronger. Pilates exercises need to be prescribed with the appropriate precautions when patients with symptomatic or asymptomatic cardiovascular problems complain of low back discomfort. While recommending Pilates activities, proper cardiovascular monitoring will be necessary for patients with low back pain as well as healthy people. Pilates exercises ought to be included in a programme for cardiac rehabilitation.

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