Effect of Treadmill Jogging on Core Endurance among Sedentary Individuals

Mahtab Alam Ansari [1], Sohrab Ahmed khan[2*], Tabassum Saher[3], Hina Siddiqui[4]

[1]Student, Department of Rehabilitation Sciences, Jamia Hamdard University, New Delhi, India,

[2*]Associate Professor, Department of Rehabilitation Sciences, Jamia Hamdard University, New Delhi, India,

[3]Assistant Professor, Faculty of Physiotherapy, SGT University Gurugram Haryana, India,

[4]Assistant Professor, SRMS Institute of Paramedical Sciences, Bareilly, India.

Abstract

Objective: To determine the effectiveness of treadmill jogging on core endurance among sedentary individuals.

Background: With rapid industrialization and urbanization in the developing world, the lifestyle of the people has undergone marked changes leading to a sedentary lifestyle. People work in monotonous and constrained postures for long working hours. There is shrinking of space at home, offices and around the community contributing to further immobility. Treadmill jogging is an exercise which may increase the core endurance among sedentary individuals.

Methods: A total of 24 sedentary subjects, both males & females, aged between 21-35 years were included in the study. All subjects were initially screened through musculoskeletal assessment to rule out inclusion and exclusion criteria. Treadmill jogging protocol was followed for 4 weeks, three times in a week. Prior to the treadmill jogging, a measurement of core endurance (trunk flexion, trunk extension, right side bridge, left side bridge) was done along with the measurement of the resting heart rate.

Results: The present study resulted a significant change (p<0.01) in the core endurance(trunk flexion, trunk extension, right side bridge, left side bridge)and also in the resting heart rate after 4 weeks of treadmill training.

Conclusion: The present study concluded a significant improvement in core endurance levels of trunk flexion, extension, right side & left side bridge on treadmill jogging for 4 weeks. It also signifies a decrease in resting heart rate after 4 weeks of treadmill training. The present training protocol can be further prescribed to patients with weak muscle endurance.

Key words: Treadmill jogging, core endurance, sedentary individuals.

Introduction

With rapid industrialization and urbanization in the developing world, the lifestyle of the people has undergone marked changes leading to a sedentary lifestyle. People work in monotonous and constrained postures for long working hours. Sedentary life style is a major cause of fat deposition and loss of strength and flexibility.

Physical inactivity and Sedentariness cause or aggravate physical illnesses, psychological problems, obesity, and reduce life expectancy. These reduce employee performance and increase health care costs.[1]

The core is a double walled cylinder. The abdominals make up the anterior portion, para spinals, erector spinae, latissimus dorsi, quadratus lumborum and gluteus make up the posterior portion, the diaphragm is the superior aspects and the pelvic floor and hip girdle musculature make up the inferior aspects of the core.[2] The development of core muscles endurance plays an important component for sports conditioning and musculoskeletal health to active rehabilitation for individuals with low back pain. Low back pain is associated with lack of back muscle endurance.[3] Low back pain with jogging has been found to be low.[4] Most of the studies in literature have investigated the relationship between running and core endurance. They have highlighted the ease of performing running activity and its role in stabilization of the trunk by improving the stability of the core region and thus the abdominal muscles. Running exercise is expected to train the core muscle groups in the trunk and abdomen that maintain the stability of the vertebrae. Other studies have reported an increased in abdominal muscle activity with increased running speed.[5]

Rapid growth in technology in the last couple of decades has lead to constant reduction in physical activity and increased sedentary lifestyle. Minimization of human movements and muscular activity has a dual effect on human behaviour causing the people to move less and sit more. Core weakness defined as the weakness of abdominal and back muscles, due to lack of physical inactivity and adaptation of faulty postures. Sedentary life style contributes to increased risk of musculoskeletal disorders associated with low back pain. These disorders are mainly a result of weakening of core muscles. Consequently, it can lead to excessive load on the lumbar spine, poor endurance of muscles, muscle imbalance, back injuries and instability of lower extremity which may ultimately lead to atrophy of paraspinal muscles.[6]

Core muscles not only protect the spine from excessive force, the importance function of the central core of the body for stabilization and force generation in all sports activities. Core training exercise plays an important role in fitness and in rehabilitation. Core training can relieve chronic low back pain and facilitate recovery from injury. In core training the most important component is core endurance because it supports core muscles in maintaining an efficient trunk position.[7] Endurance training results in decrease resting heart rate. Studies have shown that a sedentary individual with an initial resting heart rate of 80 beats/min can decrease resting heart rate by approximately 1 beat/min with each week. The mechanisms responsible for this decrease are not entirely understood, but training appears to increase parasympathetic activity in the heart while decreasing sympathetic activity.[8]

Jogging is not only the common movement for athletes there is an increasing trend for people to choose jogging as a form of physical activity to maintain their health. For the sedentary population, jogging is more popular than running and also produces less stress on the body. Since jogging is a natural extension of walking and walking has been shown to activate the core muscle. As jogging can be easily advised to the sedentary population & beneficial effects of the same can provide valuable insight into its significance in improving the endurance of core muscles &prevention of various ailments associated with reduced core endurance.[9] So the objective of the present study was to determine whether treadmill jogging can improve the core endurance among sedentary individuals, which in turn can prevent development of many common ailments including low back pain etc., sedentary individuals can incorporate treadmill jogging in to their life style and prevent development of WRMSD (work-related musculoskeletal disorders).

Methods

Subjects and procedure

A total of 24 sedentary subjects, both males & females, aged between 21-35 years were included in the study. All the subjects were initially assessed to rule out inclusion and exclusion criteria and an informed consent was taken from the selected subjects prior to the study. The individuals having history of any systemic disorder, any trauma or fracture to the lower limb or spine in the last one year, back pain (radiating and non-radiating), impaired balance/proprioception, any cardiac abnormalities, irregular blood pressure and those involving in any kind of physical activities and sports in last 3 months were excluded from the study. The ethical consideration was taken from Jamia Hamdard institutional ethical committee. Treadmill jogging protocol was followed for four weeks, three times a week. Subjects were directed to undergo a trial and familiarization session to determine the exercise heart rate and speed for jogging for testing. Prior to the treadmill jogging, the pre intervention measurements of the core endurance of trunk flexion, trunk extension, right side bridge, left side bridge were recorded. The core endurance measurements were again documented after 2 weeks and 4 weeks of intervention. The resting heart rate was also measured prior to and after 4 weeks of intervention.

Core endurance measurement:

This includes the performance of core muscles (Rectus abdominis, Erector spinae, Multifidus, External and Internal abdominal obliques, Quadratus lumborum, Transverse abdominis) endurance tests. The tests were performed on plinths. For each test, the subject was given a verbal explanation of the test, correct and incorrect position was explained, and a demonstration of the testing position was provided if found to be necessary. The subjects were instructed to hold the position for as long as possible without deviating from the test position. Each test was timed using a stopwatch and ended when the subject can no longer hold the test position or there is a deviation from the starting position. The endurance test was the trunk flexion test, trunk extensor test, and bilateral side bridge tests.[10]

The trunk flexor test:

This began with the subjects in the sit-up position with the trunk supported at 60degree of trunk flexion. Knees and hips were flexed at 90 degree, arms crossed over chest with the hands placed on the opposite shoulder and toes were placed under the toe strap. The support of the trunk was then removed, and the subjects held the position for as long as possible. The test was terminated when the subject was no longer able to hold the position. The hold time was for which the flexed position of the trunk was held was recorded using stopwatch.

Figure 1.Trunk flexor test.

The trunk extensor test:

In this test, the subjects were instructed to lie prone off the edge of a plinth with all body parts above their anterior superior iliac spines hanging off the plinth. The three straps were used to hold lower extremities on to the plinth, one at gluteal fold, one just above the knee joints, and one just above the ankles. Subjects were allowed to rest their upper extremities on a chair prior to start. They were then instructed to cross their arms in front of their chest and to lift their upper body up until their trunk was horizontal to the ground. The time was started when the subject achieves the starting position. This position was held until fatigue or until their body deviated from the horizontal, ending the test.

Figure 2. Trunk extensor test.

3. The right and left side bridge tests:

In this test, subjects were in the side- lying position on a plinth. Subjects were instructed to prop their body up while weight bearing only on their elbow and their feet, which was stacked on top of one another. Subjects were instructed that their body has to maintain in a straight line in all planes. Subjects were timed on both sides, with the order of left and right self-selected by the subjects. The time was started when the subject achieves the correct starting position. Time was stopped when the subject was no longer able to hold the position, if their body dropped out of alignment in the frontal plane, or if the pelvis rotated in the transverse plane.


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Figure 3. The right and left side bridge test.

Determination of speed using heart rate for jogging- (Testing Phase)

The maximum heart rate was calculated by using the Karvonen formula: 206.9 – 0.67 x age. Determination of 65% of the maximum heart rate and the corresponding speed at which this was achieved was noted.

Treadmill jogging phases:

In first week, subjects were involved in treadmill jogging for a total of 15 minutes which included 5 minutes of warm-up, 5 minutes of jogging and 5 minutes of cool down. The maximum heart rate of not more than 65% of heart rate maximum was taken. The subject was made to start jogging from initial till the speed at which 65% of maximum heart rate was achieved in the testing phase. This was followed by 5 minutes of jogging at the same speed. At the end of the 5 minutes of jogging, a slow reduction in speed was started with a return to the initial speed by the end of the 5 minute cool down period.

During the second week, subjects were involved in treadmill jogging for a total of 17 minutes which included 5 minutes of warm-up, 7 minutes of jogging and five minutes of cool down. An increment to 70% of the maximum heart rate was done.

Further during the third and fourth week of the study subjects were involved in treadmill jogging for a total of 20 minutes which included 5 minutes of warm-up, 10 minutes of jogging and 5 minutes of cool down. An increment to 75% of the maximum heart rate was done.

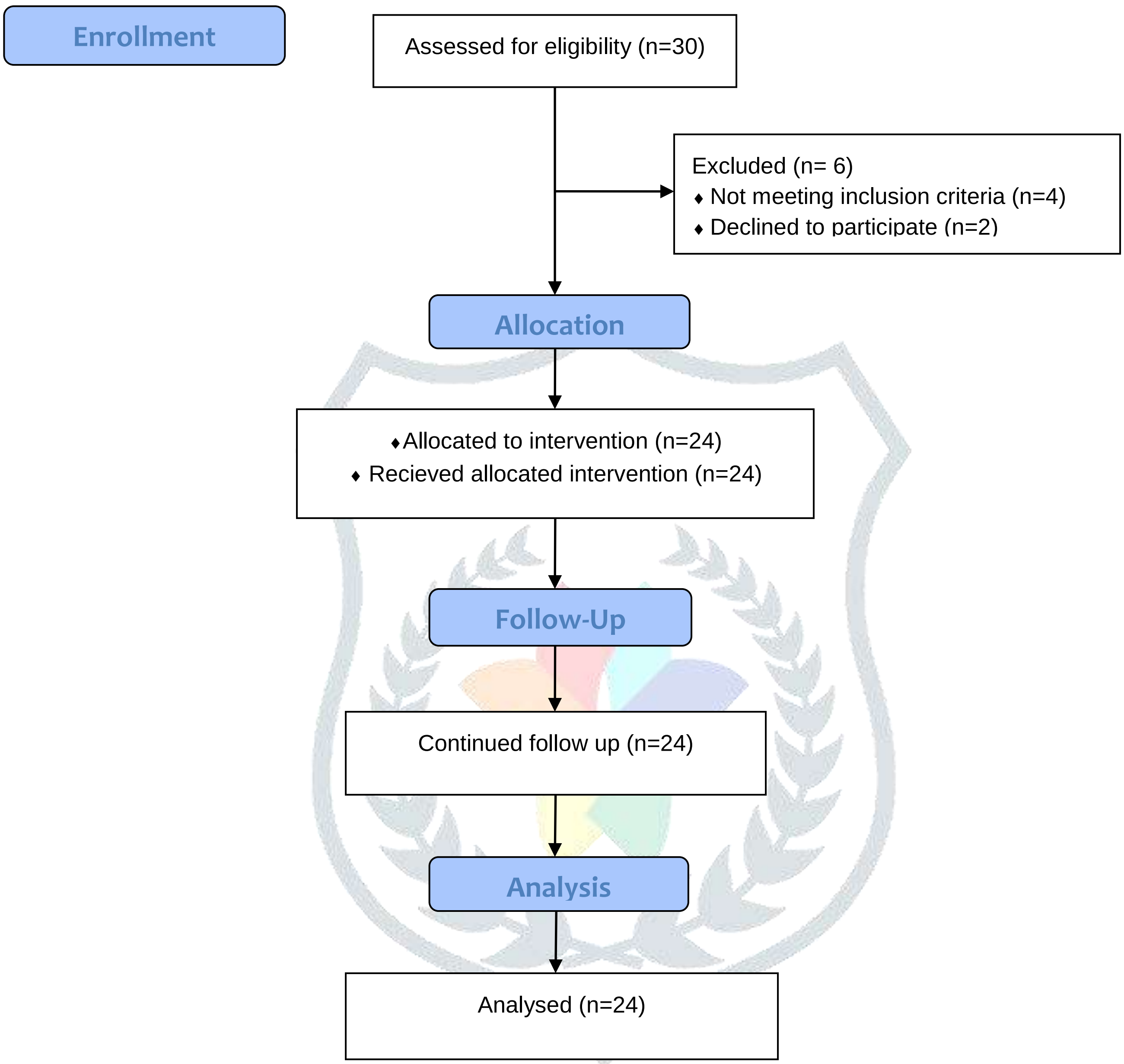


Figure 4: CONSORT flow chart describing participant flow during the study.

Statistical analysis

Data analysis was done using SPSS version 21.0.The demographic characteristics and the baseline criterion measures were compared between the two groups by an independent *t*-test. Baseline characteristics are reported as Mean ± SD with changes from baseline given as mean and the 95% confidence interval (CI). For testing the differences between groups, comparisons of the changes between groups, independent *t*-test was used. Statistical significance was set as $p<0.05$.

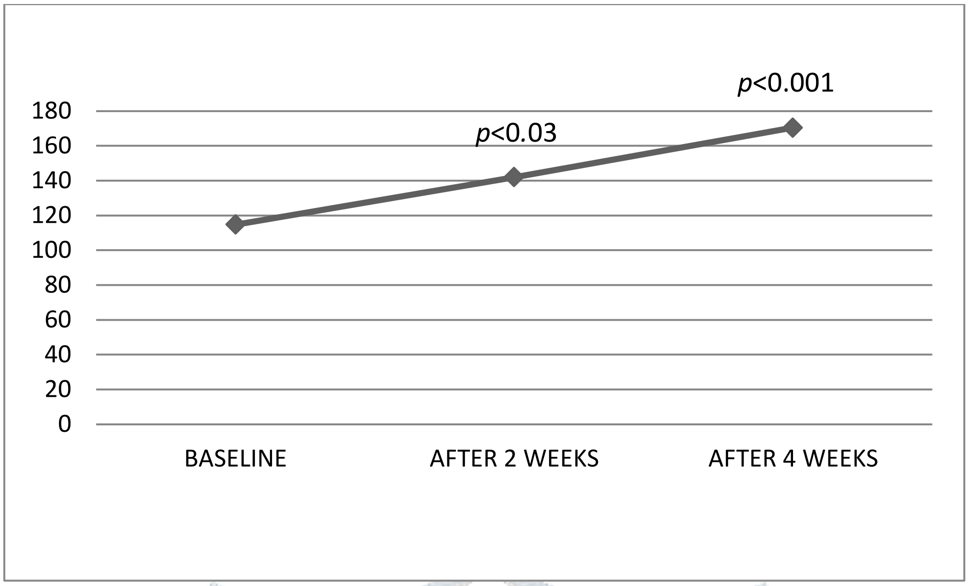
Results

The pre intervention measurements of the core endurance of trunk flexion, trunk extension, right side bridge, left side bridge were documented initially. After 2 weeks of intervention and then after 4 weeks consequently, the core endurance measurements were again documented. The resting heart rate was also measured pre intervention and after 4 weeks of intervention. Significance level with $p<0.01$ in the core endurance(trunk flexion, trunk extension, right side bridge, left side bridge) and also in the resting heart rate after 4 weeks of treadmill jogging. However, an improvement in the core endurance levels was also noted after 2 weeks of treadmill jogging with the value of $p<0.01$ except trunk flexion which showed an improvement after 2 weeks with $p<0.05$.

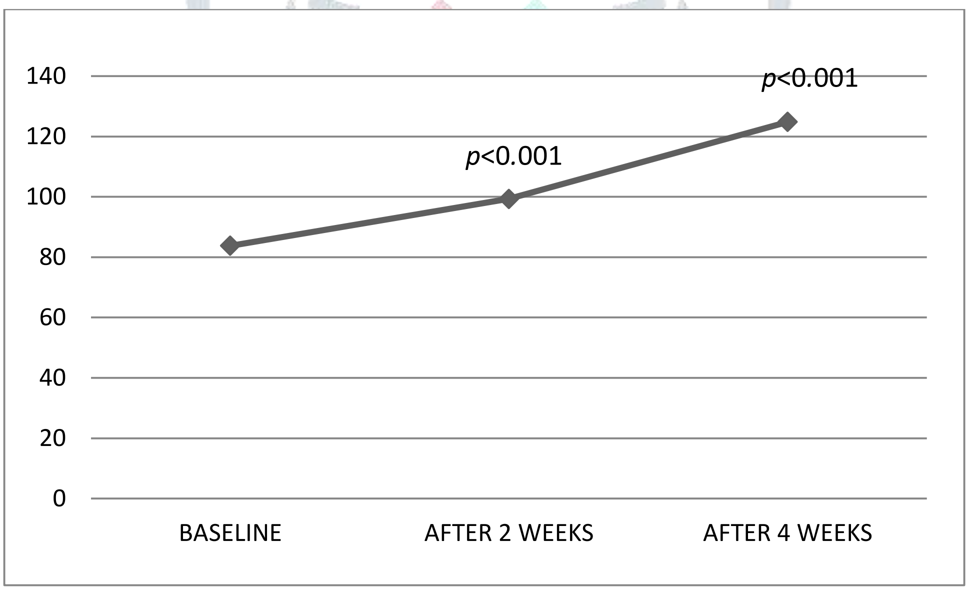
Table 1: Descriptive features of core endurance and resting heart rate

Variable	Mean ± SD	*p* value
TF After 2 weeks (seconds)	141.92±105.262	0.039
TF After 4 Weeks (seconds)	170.42±113.089	0.001
TE After 2 weeks (seconds)	99.29±36.271	0.000
TE After 4 weeks (seconds)	124.79±48.043	0.000
RSB After 2 weeks (seconds)	49.25±20.741	0.000
RSB After 4 weeks (seconds)	64.71±33.087	0.000
LSB After 2 weeks (seconds)	45.00±15.910	0.000
LSB After 4 weeks (seconds)	58.58±17.837	0.000
RHR After 4 weeks (beats/min)	87.00±8.837	0.000

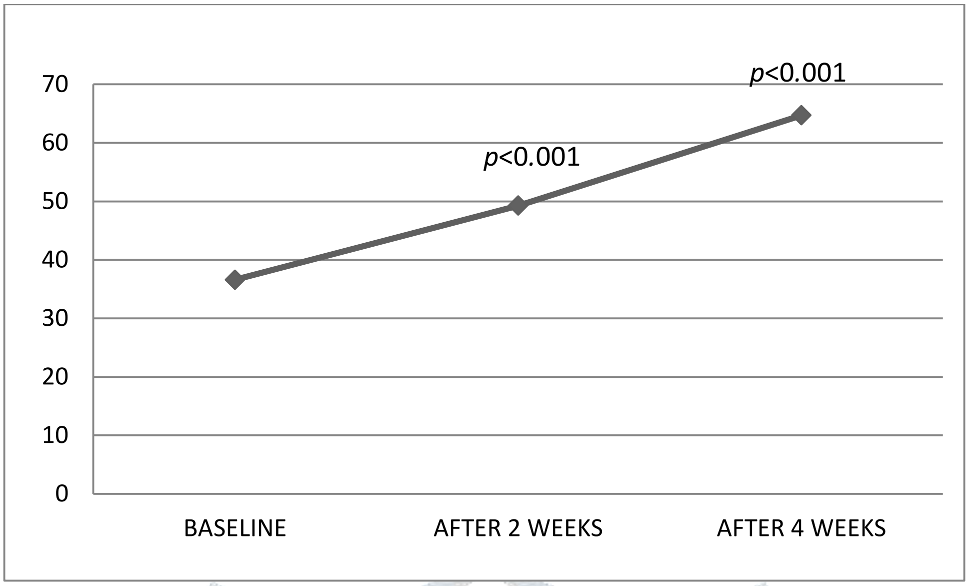
Abbreviations: RHR-Resting Heart Rate, TF-Trunk Flexion, TE-Trunk Extension,RSB-Right Side Bridge, LSB-Left Side Bridge



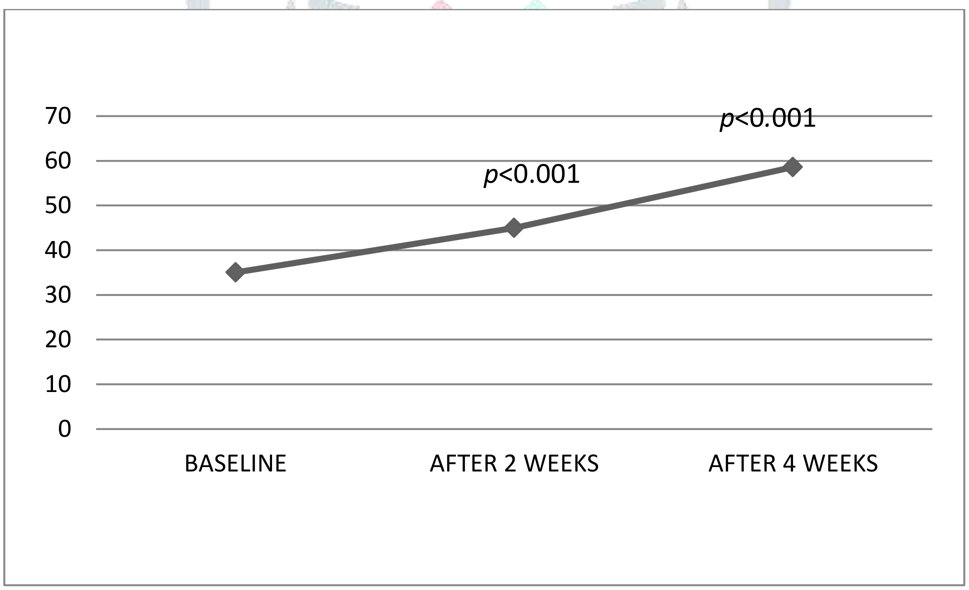
Graph 1: The present picture demonstrates changes in the duration of trunk flexion



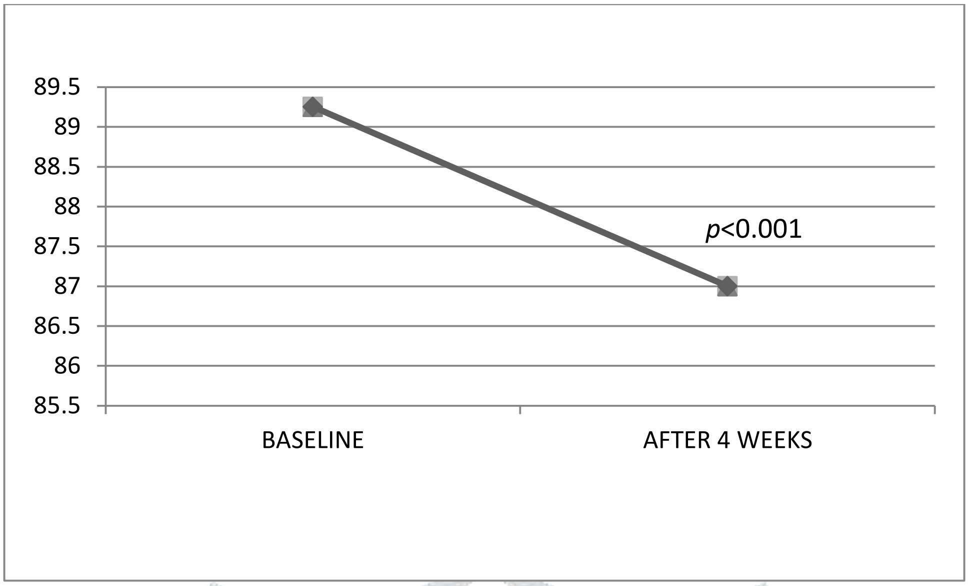
Graph 2: The present picture demonstrates changes in duration of trunk extension



Graph 3: The present picture demonstrates changes in the duration of right side bridge.



Graph 4: The present picture demonstrates changes in the duration of left side bridge.



Graph 5:The present picture demonstrates changes in the Resting Heart Rate

Discussion

The objective of the study was to determine the effectiveness of treadmill jogging on core endurance among sedentary individuals. The present study included 24 subjects (15 Females and 9 males) in the experimental group design study. The core endurance (trunk flexion, trunk extension, right side bridge, left side bridge) and resting heart rate was measured. Differences of values in each variable were calculated. The result of the study showed that there was significant improvement found with the *p*-value ($p<0.01$) in the core endurance (trunk flexion, trunk extension, right side bridge, left side bridge) and also in the resting heart rate after 4 weeks of treadmill jogging. However, an improvement in the core endurance levels was also noted after 2 weeks of treadmill jogging with the p-value ($p<0.01$) except trunk flexion which showed an improvement after 2 weeks with *p* value ($p<0.05$).

The hip extensors (gluteus maximus and hamstrings), the hip flexors (the iliacus and the psoas) and the hip abductors (the gluteus medius and minimus) are the three muscle groups at the hip play a important role during normal ambulation.[11] The activation of core muscles during slow running has been studied to some extent in the past. It has been shown that in walking and running upto the speed of 3 $m.s^{-1}$, the deep abdominal muscle, the transversus abdominis is tonically active. During slow running, lumbo-pelvic motion in each plane is associated with low level of trunk muscle activity. With increase running the lumbopelvic motion increases and there is increase in abdominal muscles and superficial muscles activity. Eccentric phases of trunk muscle activity are associated with running with increase of running internal oblique and speed increases multifidus.[12] The pelvic floor and hip musculature forms as the base of support for the core. Synergistic activation patterns exist in pelvic and trunk controlling musculature. The gluteal muscles stabilize the trunk in movements as in running.[13]

Running in place can reduce muscle fatigue and puts loads on various muscles, thereby improving aerobic exercise ability and muscle strength at the same time, as well as strengthening the trunk and abdominal muscles that contribute to lumbar stabilization. Further, the study highlighted that core stabilization exercises can maintain spinal balance based on contraction of the transverse abdominis, thereby increasing lumbar muscle strength and stability.[14] Several reports have suggested that the torque promoting the pelvic rotation is extended at the lumbar-pelvic region during running. The lumbar spine rotates towards the free leg side prior to pelvic rotation during slow running. The obliquus externus and internus abdominis muscles get activated to reduce the difference between pelvic and lumbar rotation during rotation. Electromyography recordings of abdominal and paraspinal muscles were also conducted in a study emphasizing the increase in the activity of the abdominal muscles and the superficial fibres of multifidus with locomotor speed. A strong association between lumbo-pelvic motion and trunk muscle activity during locomotion at different speeds and modes was emphasized signifying that core activation occurs during running activities. With increased running, the lumbo-pelvic motion increases and there is increase in abdominal muscles and superficial muscles activity.[15]

The activation of trunk muscle activity during locomotion of different speeds has also been highlighted in the past. The current study also emphasizes the significant improvement in core muscle activity during jogging. An improvement in all the core endurance tests including flexor, extensor as well as right & left side bridge has been achieved. The various studies in the past have also highlighted the role of the different core muscles in running & walking activities as well as correlated the lumbo-pelvic motion to locomotion speed. An early improvement in trunk endurance within 2 weeks has also been reported in the current study signifying the importance of jogging in early improvement of core endurance which can have a significant impact on faster outcome measures.

There are several limitations in the present study. Firstly, a very small number of subjects were available to us for the study; this study could be done in a larger sample of population to gain more generalized results. Secondly, the activity level in the sample population being "sedentary" can be determined with the help of MET levels calculation using questionnaires like International Physical Activity Questionnaire (IPAQ) which wasn't done in the current study. Thirdly, advanced methods for determination of core endurance levels using equipment like isokinetic dynamometer wasn't used in the current study. Additionally, adequate literature regarding studies on treadmill jogging and its effects on core endurance wasn't available in published literature. Future studies are still required to clarify whether treadmill jogging may benefit the core endurance among athletes population.

Conclusion

This study shows a significant improvement in core endurance levels of trunk flexion, extension, right side & left side bridge post 2 weeks and 4 weeks with a significant drop in resting heart rate after 4 weeks of treadmill jogging. Hence, this study signifies the importance of treadmill jogging in improvement of core endurance among sedentary individuals which can be incorporated into their lifestyle & prevent the development of various WRMSD (work-related musculoskeletal disorders). Improvement in the heart rate levels can lead to better aerobic capacity in the sedentary population.

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