



Effect of Treadmill Exercises on Stress, Cognition and Quality of Life in Stage-1 Hypertensive Patient-An Experimental Study

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ABSTRACT

Background: Stress is one of the direct or indirect causes of hypertension. Chronic stress and particularly the non-adaptive response to stress are more likely causes of sustained elevation of blood pressure. Hypertension accelerates arteriosclerotic changes in the brain predisposing to atheroma formation in large diameter blood vessels and arteriosclerosis and arteriolar tortuosity of small vessels of the cerebral vasculature. These vascular changes result in a reduction of luminal diameter, increased resistance to flow, and a decline in perfusion. **Aim:** The current study aimed to evaluate the effect of the treadmill exercises on stress, cognition, and quality of life in stage -1 hypertensive patients. **Methods:** The study included 32 subjects. Samples are being recruited from a tertiary care hospital, Belagavi, aged between 20 to 45 years, scoring ranging from 13 and above on Perceived Stress Scale for 12 months as per convenience. They are being evaluated for their Cognition using ACE-R and Quality of Life using the SF-36 QOL Questionnaire. **Results:** The results state that there was a statistically noteworthy change in the Serum Cortisol. Improvements were also seen in the parameters of ACE-R, PSS, and quality of life. **Conclusion:** This study concluded that a 3 week for consecutive 5 days treadmill exercise protocol showed improvement in stage-1 hypertension patients and terms of their serum cortisol, stress, and cognition and SF- 36 quality of life.

Keywords: Stage-1 hypertension, Treadmill exercises, Serum cortisol, Cognition, Stress, Quality of life

Abbreviation: JNC: Joint National Committee, ACE-R: Addenbooke's Cognitive Examination, ACTH: Adrenocorticotropic Hormone, HPA: Hypothalamic Pituitary Adrenal Axis

INTRODUCTION

Hypertension is a serious medical condition that can increase the risk of heart, brain, kidney and can cause other diseases [1]. Worldwide, 7.6 million premature deaths are due to high blood pressure. The overall prevalence of hypertension in India was 29%. Prehypertension is reclassified as stage 1 hypertension because of adults with BP on average SBP of 130 mm Hg to 139 mm Hg and average DBP of 80 mm Hg to 89 mm Hg [2].

Stress is one of the direct or indirect causes of hypertension. When the environmental demands increase the capacity of a human which results in psychological and biological changes and these changes cause repeated blood pressure elevations as well as by stimulation of the nervous system to produce large amounts of vasoconstricting hormones that increase blood pressure. Although stress may not directly cause hypertension, it can lead to repeated blood pressure elevations, which may lead to hypertension [3].

Hypertension increases arteriosclerotic changes in the brain leads to atheroma formation in blood vessels and arteriolar tortuosity of small vessels of the cerebral vasculature. These vascular changes lead to medial thickening and proliferation, resulting in a reduction of luminal diameter, increased resistance to flow, and slowing down perfusion. This hypo-perfusion can produce discrete regions of cerebral infarction causing cognitive problems [4].

Exercise is one of the major factors in combating all the problems. In response to exercise, the hypothalamus secretes CRH. CRH activates the anterior pituitary, stimulating the release of ACTH, and this stimulates the

adrenal cortex to release cortisol. Thus decreasing the stress and directly or indirectly decreasing the rate of hypertension in individuals [5].

MATERIALS AND METHODOLOGY

The study was conducted on Neurology Department of Physiotherapy, KIPT, Belagavi, Karnataka, enrolled between 1st April 2019 to 31st March 2020. The ethical clearance was obtained from the Institutional Ethical Committee. Signed informed consent was obtained from all the participants before any study procedures. Men and women were eligible if they were above 20 to 45 years, diagnosed with hypertension (stage-1), not participated in regular physical activity for the previous 3 months, had PSS score ranging from 13 and above, able to follow commands, and subjects currently participating regular physical activity outside of the study, any congenital, malignant, autoimmune, and neurological conditions, severe psychiatric disorders, ischemic heart disease, diagnosed with Hepatic, Renal, mitochondrial dysfunction, any physical limitation that prevented subjects from performing the exercise, pregnancy were excluded from the study. A total of 32 participants were recruited according to convenience sampling. All the outcomes measures were recorded by the therapist before the intervention (Baseline measures) and post-intervention (i.e. after 3 weeks).

Outcome Measures

Serum cortisol: The test is used in the diagnosis of these diseases and as a way to assess the functioning of the adrenal and pituitary glands. Normal serum cortisol ranges from 6 and 23 micrograms per deciliter (mcg/dL) [5].

Rate of perceived exertion: The subjects were instructed to use any number on the scale to rate their overall effort during resistance exercise. A rating of 6 was to be associated with no exertion and a rating of 20 maximal exertions. The reliability and validity of the scale are 0.86 and 0.89 [6].

The perceived stress scale: It is a psychological instrument and it is a self-reported measure that assesses the degree to which the respondent has perceived the situation within the past month as stressful. The test/retest reliability of the scale is 0.85 [7].

Quality of life questionnaire: The SF-36 questionnaire is a self-administered questionnaire containing 36 items that take about five minutes to complete. The reliability of the SF-36 (Cronbach's $\alpha > 0.85$, reliability coefficient > 0.75) for all dimensions [8].

Addenbrooke's cognitive examination-R: Addenbrooke's Cognitive Examination (ACE-R) ACE-R is a brief cognitive test with a maximum score of 100 points. The domain includes orientation registration, attention, recall, verbal fluency language, visuospatial abilities, perceptual abilities [9].

Intervention

All participants were given a good orientation before starting the procedures. THR was calculated and 3 sets of 30 seconds warm-up exercises were performed which include hamstring stretch in the supine position, quadriceps stretch in the prone position, lumbar stretch in the supine position (knee to chest position), and standing wall supported calf stretch with the leg in dorsiflexion, walking and spot jogging at patient's comfort level [3].

The participants were asked to walk on the treadmill at an average of 50% to 60% of the THR. Once the THR is achieved, a rest period of 2 minutes was given and start again. This will continue for 40 minutes with a rest period intermittently. Participants were monitored throughout the program. RPE should be in between 3 to 5. The THR can be increased up to 80% over 3 weeks of treadmill exercise. Exercise will be discontinued who suffer any adverse events including syncope, dizziness during exercise. The same routine will be carried out for consecutive 5 days for 3 weeks. The treatment will last for 40 minutes each day. At the end of the 3rd week, the subject's Serum Cortisol, PSS, quality of life, The ACE-R will again be assessed [10-12].

Statistical Analysis

SPSS version 23 was used for the statistical analysis. The test for normality for the data set was done using the Kolmogorov-Smirnov test. The homogeneity of the data was checked using the Chi-Square Test for gender distribution age, weight, height, and BMI. Dependent t-test was administered for all the before and after outcome measures in terms of Serum Cortisol, ACE-R, PSS, RPE, and SF-36 QOL Questionnaire were measured.

RESULTS

The total number of males in the current study were 16 that is 50% and the total number of females in the current study was 16 that is 50%. The participants included in the study were between 20 to 45 years of age and the mean age was 29.28 ± 5.66 years (Table 1). The mean BMI of the participants was 25.80 ± 3.60 . In the category of normal BMI, there are 12 participants. In the category overweight, there are 20 participants.

Table 1 Demographic profile of patients in the study

| Demographic profile | No. of patients | % of patients |
|---------------------|-----------------|---------------|
| Gender | | |
| Male | 16 | 50 |
| Female | 16 | 50 |
| Age groups | | |
| 20-24yrs | 7 | 21.88 |
| 25-29yrs | 9 | 28.13 |
| 30-39yrs | 10 | 31.25 |
| 40+yrs | 6 | 18.75 |
| Mean age | 29.28 | |
| SD age | 5.66 | |
| BMI | | |
| Normal | 12 | 37.5 |
| Over weight | 20 | 62.5 |
| Mean BMI | 25.8 | |
| SD BMI | 3.60 | |
| Total | 32 | 100 |

The mean serum cortisol levels pre-intervention was 93.48 ± 18.19 and post-intervention after 3 weeks was 85.90 ± 15.78 (Table 2). The mean difference in the pre and post-intervention scores was 7.58 ± 4.70 . The p-value was 0.0001 which was highly statistically significant. The mean score of ACE-R pre-intervention was 77.78 ± 11.34 and the mean score post-intervention was 85.34 ± 8.47 . The mean difference in the pre and post-intervention scores was -7.56 ± 9.33 . The p-value was 0.0001 which was statistically significant. The mean score of PSS pre-intervention was 25.03 ± 18.22 and the mean score post-intervention of 3 weeks was 18.22 ± 5.19 . The mean difference in the pre and post-intervention scores was 24.56 ± 94.32 . The p-value was 0.023 which was statistically significant. The mean score of SF-36 Questionnaire pre-intervention was 91.94 ± 11.99 and the mean scores post-intervention of 3 weeks was 87.00 ± 11.40 . The mean difference in the pre and post-intervention scores was 4.94 ± 11.00 . The p-value was 0.0164 which was statistically significant. The mean score of the Rate of Perceived Exertion Scale pre-intervention was 14.88 ± 2.11 and the post-intervention of 3 weeks was 11.22 ± 1.81 . The mean difference in the pre and post-intervention scores was 4.94 ± 11.00 . The p-value was 0.0001 which was statistically significant.

Table 2 Comparison of pre-test and post-test of serum cortisol levels, ACE-R, Perceived Stress Scale, SF-36, RPE

| Time points | Mean | Std.Dv. | Mean Diff. | SD Diff. | % of effect | t-value | p-value |
|--|-------|---------|------------|----------|-------------|---------|---------|
| Serum Cortisol Levels | | | | | | | |
| Pre-test | 93.48 | 18.19 | 7.58 | 4.7 | 8.11 | 9.1172 | 0.0001* |
| Post-test | 85.9 | 15.78 | | | | | |
| Addenbrooke's Cognitive Examination-R | | | | | | | |

| | | | | | | | |
|---|-------|-------|-------|------|-------|---------|---------|
| Pre-test | 77.78 | 11.34 | -7.56 | 9.33 | -9.72 | -4.5875 | 0.0001* |
| Post-test | 85.34 | 8.47 | | | | | |
| Perceived Stress Scale | | | | | | | |
| Pre-test | 77.78 | 11.34 | -7.56 | 9.33 | -9.72 | -4.5875 | 0.0001* |
| Post-test | 85.34 | 8.47 | | | | | |
| SF-36 Quality of Life Questionnaire | | | | | | | |
| Pre-test | 91.94 | 11.99 | 4.94 | 11 | 5.37 | 2.5389 | 0.0164* |
| Post-test | 87 | 11.4 | | | | | |
| Rate of Perceived Exertion | | | | | | | |
| Pre-test | 14.88 | 2.11 | 3.66 | 1.73 | 24.58 | 11.9272 | 0.0001* |
| Post-test | 11.22 | 1.81 | | | | | |
| Difference=Post-Pre; *: indicate significance | | | | | | | |

DISCUSSION

The effect of treadmill exercises in stage-1 hypertension patients was investigated in the current study. The participants were given treadmill exercises for consecutive 5 days over 3 weeks for 40 minutes.

Patients suffering from stress always sense there is some danger either it is real or imagined which eventually leads them to the stress response which is flight or fight. Stress can act in a patient's mind either in a good or a bad way. Stress can cause many major damages like mood swings, productivity, relationships, and the quality of life. Many studies show that daily routine exercises like jogging, yoga, or group therapy help in coping with stress. Psychosocial stress is also an independent factor in predicting hypertension. Exercise and dietary modification play an important role in patients with stress [13,14].

The outcomes of the present research state that there were affirmative effects of treadmill exercises on the levels of serum cortisol. There were also significant improvements in the cognition which was analyzed using ACE-R. The intervention also showed improvements in the overall health of the participants which was assessed using the SF-36 QOL questionnaire.

The present dataset included subjects between 20 to 45 years of age i.e. average age of the participants was 29.28 ± 5.66 years. All the subjects recruited in the study were having stage-1 hypertension which was newly diagnosed with prehypertension and was not on any medications. As per the JNC 7 classification of Blood Pressure, the prevalence of adult hypertension is 29% of the total population of India. Hypertension is also responsible for 57% of all strokes and 24% of coronary heart disease-related deaths in deaths in India [15].

These studies were having similar age groups as per the present study and show that prehypertension is prevalent in adults of 20-45 years. The probable cause for prehypertension in this populace could be sedentary lifestyles and coping with stress [16-18].

BMI is one major factor in hypertension, the mean BMI of the participants is 25.80 ± 3.60 where 20 participants fall under the category of overweight according to WHO criteria. A. Colin Bell, et al. done a study on ethnic differences in the association between body mass index and hypertension, and he concluded that there is a strong association between BMI and hypertension and in underlying prevalence and he also said that there is genetically determined differences in body composition and metabolic response, as well as risk factors due to differences in social and environmental factor [19].

There was an increase in the levels of serum cortisol was observed in our study and these levels decreased significantly after treadmill exercises. The likely mechanism for increased levels of serum cortisol in the blood levels is due to stress. The possible mechanism might be HPA which functions by releasing CRH from the hypothalamus to stimulate the pituitary gland to release ACTH. ACTH stimulates the adrenal cortex to release cortisol. The activation of this stress pathway from psychological stressors as well as physical stressors stimulates noradrenaline secretion. Both

pathways cause several physiological changes that activate the sympathetic system increasing pulse rate and blood pressure which can cause hypertension. Cortisol levels are increased by stress from infection, fever, prolonged strenuous exercise, and acute anxiety [5,20].

The statistical analysis suggested, there is a decrease in the level of serum cortisol after the 3 weeks of intervention which suggested that treadmill exercise helps the participants to reduce the stress by suppressing the pituitary-gonadal activity.

Studies have proven that mindfulness exercise, aerobic exercises, and yoga show better results in combating stress. Only 30 minutes of daily routine exercise will help participants show better results than pharmacological intervention [21].

A similar protocol of a total of 35 minutes to 40 minutes within between rest (total of 25-30 sessions for 10 weeks) was given to patients with hypertension results concluded by this study are in harmony with the results of the current day study which shows significant enhancements which shows ten weeks of brisk treadmill walking improved 6MWT distance, cardiorespiratory function, and patient-reported quality of life in female patients with group 1 Hypertension. Thus the current study suggests that high-intensity exercise is safe and effective as a therapeutic adjunct for improving functional capacity, cardiorespiratory function, HRQoL, and possibly survival in patients with hypertension [22].

Improvements in the perceived stress scale were also been seen in the prevailing study. Many studies suggested that patients suffering from any psychological disorder can be treated better with non-pharmacological management [23,24].

The improvement in the overall health and HRQoL of the hypertensive individuals after a bout of exercises was concluded by the results of the prevailing study which was measured using the SF-36 quality of life questionnaire. These individuals usually have a sedentary lifestyle and introducing some form of exercise may give a recreational effect and a positive image of oneself.

The limitation of the study is there was difficulty in convincing the patients for the treadmill exercise and difficulty in having their co-operation and compliance for the whole intervention because of the duration of the study.

Future Scope

To assess the long-term effect of treadmill exercises in different stages of hypertension. Land v/s aquatic treadmill exercises in the same population with different biomarkers can be performed.

CONCLUSION

The present study concludes that 3 weeks of treadmill exercises prove to be effective in improving the levels of serum cortisol, cognition, stress, quality of life, and exertion in patients with stage-1 hypertension. The improvements can be safely attained at different training intensities, durations, and weekly frequencies that are standard in most pulmonary or cardiac rehabilitation programs.

DECLARATIONS

Conflicts of Interest

The authors declared no potential conflicts of interest concerning the research, authorship, and/or publication of this article.

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