

Role of Exercise in Modulating Neuroendocrine Response to Psychological Stress

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ABSTRACT

Background: Psychological stress activate two axes: ‘Hypothalamic- Pituitary-Adrenal axis’ and ‘Sympathoadrenal axis’ leading to production of cortisol and catecholamines. Raised level of morning cortisol is a measure of biochemical. disturbance induced in the body as a result of stress. Exercise normalizes cortisol response to stress.

Study design: Experimental study.

Setting: Islamic International Medical College from July 2014 to January 2015.

Methods: Subjects were labeled as stressed and control on basis of DASS questionnaire proforma. Only stressed subjects were taken and Morning Cortisol level of all the subjects was measured by quantitative ELISA method. Subjects were then subjected to moderate exercise five days a week for a period of six weeks. After the completion of six weeks morning cortisol level were measured again.

Results: Cortisol level was higher in the stressed subjects before exercise and there was significant reduction in morning cortisol level after exercise ($p \leq .000$).

Conclusion: Stress can lead to increase morning cortisol level. Exercise has a stress buffering effect and it lowers cortisol level in body in response to stress.

Keywords: Stress, Hypothalamic- Pituitary- Adrenal Axis, Morning cortisol and moderate Exercise

INTRODUCTION

“Stress is defined as a state of physiological and/or psychological imbalance resulting from disparity between situational demand and individual’s ability and/or motivation to meet these demands¹”. Psychological stress is one of the main health burden on the society and it reduces person’s ability to cope with normal daily life activities². Hall mark feature of stress is the activation of “hypothalamic pituitary adrenal axis”. This neuroendocrine cascade is initiated when “paraventricular nucleus (PVN)” of the “hypothalamus” stimulates release of “pituitary adrenocorticotrophic hormone (ACTH)” this then stimulates the release of “cortisol” from the “adrenal gland”³. “Cortisol” regulates “HPA axis” activation by exerting an inhibitory effect on “hypothalamus and pituitary”⁴, through “medial prefrontal cortex receptors.”⁵

“Exercise” adjusts the “HPA axis response” to psychological stress. Physically active individuals have lower “cortisol” response to stress in comparison to sedentary. The mechanism by which exercise lowers “hypothalamic pituitary axis” reaction to stress are still unknown⁶. Many researches are trying to investigate the role of exercise in relieving anxiety and depression⁷. “Exercise” is a physical stress. This good stress cause increase in cortisol level in blood by the same pathway as Psychological (bad) stress but physical stress in contrary to psychological stress is accompanied by increase in growth hormone³.

“Exercise” causes elevated “cortisol” largely for two hours. After a rest day cortisol level upon awakening cortisol level in physically active person are the same as

non active but higher in stressed patients⁸. Exercise promotes the conversion of active cortisol to inert “cortisone”⁹ but with chronic psychological stress cortisol conversion to cortisone is abolished and cortisol remains elevated causing deleterious effect in the body¹⁰.

“Exercise” lowers cortisol response in healthy and unfit subjects¹¹. Regular moderate exercise has been shown to illicit changes in brain structure which lead to improved cognitive performance¹². Moderate physical “exercise” is an “exercise” during which heart rate increases, person sweats, he can talk but can’t sing a song, like bicycling, fifteen to twenty miles per hour walk for thirty minutes or doing “exercise” on a stationary bicycle at the rate of thirty miles per hour for thirty minutes, four days in a week¹³.

Regular “exercise” is recommended as a therapeutic modality in treatment of many metabolic illnesses as it attenuates the progression of atherosclerosis, “cardiovascular” and inflammatory changes in the body and enhances the cognitive ability, thus improving quality of an one’s work. In Pakistan there is no such study which has demonstrated the effect of moderate exercise in lowering cortisol response in psychologically stressed subjects. Aim of current study is to unleash the stress buffering effect of exercise.

MATERIALS AND METHODS

It was an experimental study carried out in “Physiology lab/ multidisciplinary research lab at Islamic International Medical college, Riphah University” from “July” 2014 to January 2015 after acceptance from “research ethical

committee IIMC". Study inducted healthy subjects, both male and female in the age between 24 to 38 years. They were grouped as stressed and control after filling "DASS (Depression anxiety stress scale) questionnaire profoma"¹⁴. Only eighty stressed subjects were included in the study. Written informed consent was taken from the subjects and they were requested to come to research lab in the morning between 7.30am to 8.30am. Blood sample was taken for measuring "morning cortisol level". "Cortisol level" was estimated using "quantitative ELISA kit, DRG Cortisol ELISA, lot no; 43Ko84, GmbH, Germany". Subjects' weight and height was recorded, BMI calculated, subjects were made to relax for five minutes and their blood pressure was measured using sphygmomanometer. Subjects were then requested to do "exercise" five days a week for consecutive 6 weeks using exercise cycle model "HF-700". "Exercise" was carried out at thirteen miles per hour for thirty minutes duration keeping the resistance at moderate level. At the end of six weeks training, subjects were asked to report to the lab again in morning and the blood samples for "morning cortisol" were drawn.

Statistical analysis: Subjects' weight was recorded and body mass index was calculated. Data analysis was done using SPSS 21. "Mean±SD" of the variables was calculated. The normality of each quantitative variable was checked through "Shapiro Wilk's test". Paired t test was performed to see the difference in cortisol level in stressed subjects after exercise.

RESULTS

The study included 80 subjects labelled as stressed on the basis of DASS questionnaire profoma. Morning cortisol level before and after exercise intervention was compared. Descriptive statistics of the subjects are given in the Table I. Table II shows level of cortisol in the subjects before and after exercise. There was significant reduction in cortisol level in stressed subjects after exercise ($p < 0.000$).

Table: Descriptive characteristics of stressed subjects

Characteristics	Stressed subjects (n=80) $\bar{x} \pm SD$
Age (years)	30 \pm 6
BMI (kg/m ²)	24.00 \pm 2.3
Weight (kg)	60.70 \pm 13.72
Heart rate /min	79.31 \pm 8.93
Systolic BP(mmHg)	117 \pm 7
Diastolic BPmmHg)	77 \pm 8

Table II: Cortisol level in stressed subjects before and after exercise

Parameters	Before exercise(n=80) $\bar{x} \pm SD$	After exercise(n=80) $\bar{x} \pm SD$	p value
Cortisol (50-230ng/dl)	122.97 \pm 68.74	95.08 \pm 62.82	<0.000**

*p value ≤ 0.05 is significant and **p value ≤ 0.000 is highly significant

DISCUSSION

Psychological stress is one of the main risk factors for the development of metabolic syndrome and different researches have proved how it affects cardiovascular and different biochemical parameters. Evidence based reviews have described the effect of exercise in relieving the

disorders in human body. The current study examined the effects of psychological stress on biochemical parameter which is cortisol and also role of exercise in relieving stress.

A study conducted by "Maina et al., (2009)" reported significantly increased morning cortisol level in psychologically stressed subjects because of excess "HPA axis" reactivity¹⁵. "Vreeburg et al., (2012)" depicted raised "salivary cortisol" in subjects suffering from anxiety disorder¹⁶. Findings of current study were consistent with the results of above mentioned study.

Clinical trials are trying to unleash the ability of exercise to cure symptoms of psychological stress. "Exercise" reduces cortisol response to stress and enhances stress coping ability. The present study also reported decrease post exercise "cortisol" level in stressed subjects which proves that "exercise" improves "HPA axis" feedback mechanism. Findings of current study were in line with the results of "Baker et al., (2010)" who documented reduction in "cortisol" level after six months exercise training in subjects with cognitive impairment by decreasing "HPA axis" reactivity to stress¹⁷. "Navarro et al (2011)" reported decrease salivary cortisol following six weeks of exercise training¹⁸ which proves that exercise can lower stress level and improve the stress coping ability in a person. In a review article by Saskia Heijnen (2016), it is also shown that exercise decreases cortisol level by converting cortisol into corticosterone thus normalizing the level of stress hormone in the body.¹⁹ An article by Christian Knöchel (2011), also showed that exercise has positive impact in the outcome of psychiatric patients.²⁰

CONCLUSION

Regular moderate physical exercise is a valuable intervention that can assist in normalizing the biochemical disturbances produced in body because of psychological stress.

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Limitations: Our study had several limitations like financial constraints and fewer resources. We did not perform genetic study to see genetic variability among enrolled subjects. Sample size was small due to limited resources.

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