Original Article

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Physiology Section

Effect of Surya Namaskar on Autonomic Status and Serum Cortisol Levels in Male Medical Students: A Longitudinal Study

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ABSTRACT

Introduction: Stress is an unavoidable and ongoing phenomenon in human life that affects physiological processes in the body. Regular practice of Surya Namaskar, a yogic exercise, has been shown to improve autonomic functions by reducing sympathetic activity, thereby decreasing stress levels and improving cortisol levels.

Aim: To evaluate the effects of Surya Namaskar on autonomic status and serum cortisol levels among medical students.

Materials and Methods: A longitudinal study was conducted in the Department of Physiology at the Faculty of Medicine and Health Sciences, SGT University, Gurugram, Haryana, India. The study duration was three months, from November 2021 to January 2022. A total of 30 male medical students, aged between 18 and 21 years, were included in the study. Blood samples for cortisol estimation were collected before the start of the study and after six weeks of regular yogic practice. Parameters such as mean pulse rate, Blood Pressure (BP), and Low Frequency to High Frequency (LF/HF) ratio were also studied during these two time points. Statistical analysis of Heart Rate Variability (HRV) parameters, including Standard deviation of the N-N interval (SDNN), mean Heart Rate (HR), and pNN50, was performed using Analysis of Variance (ANOVA) at baseline and after six weeks. Comparison of serum cortisol levels within the groups was done using paired t-tests.

Results: The mean age of the study participants was 20.37 years. Comparison of HRV frequency domain parameters (LF, HF, and LF/HF ratio) at baseline, day one, and after six weeks of yogic practice showed statistically significant variations in LF/HF ratio after six weeks (p-value=0.001). Baseline serum cortisol levels compared to levels after six weeks of yogic practice were also found to be statistically significant (p<0.001).

Conclusion: There is a positive association between cortisol levels and autonomic parameters, as evidenced by the results of the autonomic battery of tests. Incorporating yogic interventions into one's lifestyle helps reduce sympathetic parameters and shift the balance towards parasympathetic dominance.

Keywords: Autonomic battery tests, Heart rate variability, Stress

INTRODUCTION

Stress can be defined as a condition or feeling experienced when a person perceives that the demands placed on them exceed the resources available to them [1]. It is a complex, multidimensional process in which certain stressors, such as environmental factors, trigger physical and psychological responses [2]. Stress is an integral and unavoidable part of modern life [3]. The compensatory responses to these stresses are known as the stress response [4]. Stress is a never-ending phenomenon that starts from childhood and continues into adult life, affecting various physiological processes in the human body. It results in an increase in cortisol levels and an increase in sympathetic activity, thereby affecting physiological processes [5,6].

The Hypothalamic-Pituitary-Adrenal (HPA) axis is the stress-response pathway. When exposed to various stressors, the synthesis of Corticotropin-releasing Hormone (CRH) and Vasopressin (AVP) increases. These neurons release peptides into the portal vascular system, where they bind to the CRHR1 receptor and stimulate the production of Pro-opiomelanocortin (POMC) in the anterior pituitary [7-9]. POMC gives rise to Adrenocorticotropic Hormone (ACTH), opioid peptides, and melanocortin peptides. ACTH, in turn, stimulates the adrenal cortex to synthesise and secrete the glucocorticoid cortisol, triggered by CRH-induced release of ACTH. Cortisol, in a negative feedback loop, reduces the secretion of ACTH and CRH, aiming to maintain homeostasis [7-9].

Cortisol is a stress hormone that mediates the stress response through immediate and delayed biphasic effects. The immediate effects, characterised by the release of catecholamines and neuropeptides, occur within milliseconds, while the delayed effects start within 1-2 hours after exposure to a stressor [10]. Yogic practices, such as Surya Namaskar, have been shown to be effective interventions for reducing stress through regular yoga and meditation practice [11]. Yoga plays a role in balancing the autonomic status by increasing the parasympathetic tone of the body. It is an exercise that directly affects the autonomic system [12]. In today's life, the most common aspects of yoga practice aim to focus the mind, achieve relaxation, and enhance overall wellness [13]. Regular practice of yogic breathing improves autonomic functions by decreasing sympathetic activity or increasing vagal tone [14]. Furthermore, yoga has been found to lower serum cortisol levels.

Surya Namaskar, consisting of 12 counts, is a form of worship and exercise [15,16]. The present study aimed to investigate the acute and long-term effects of yogic practice on various parameters such as HRV and serum cortisol levels. HRV, which represents the beat-to-beat variation in HR under resting conditions, is influenced by circadian rhythm, environmental factors, and exercise. It is considered a sensitive indicator of the autonomic system. During stress, there is an increase in LF HRV power, reflecting an increase in sympathetic stimulation [17]. Stress affects the hypothalamus through the limbic system and leads to changes in HRV through the autonomic nervous system. HRV, which represents the heart's ability to respond to a various physiological and environmental stimuli, serves as a sensitive tool for evaluating the autonomic nervous system's influence on the myocardium [18]. The purpose of the present study was to directly examine the effects of regular

yogic practice on stress by assessing autonomic status and cortisol levels.

MATERIALS AND METHODS

A longitudinal study was conducted in the Department of Physiology at the Faculty of Medicine and Health Sciences, SGT University, Gurugram, Haryana, India, from November 2021 to January 2022. The study was conducted after obtaining approval from the Institutional Ethics Committee (IEC). Medical students were selected based on specific inclusion and exclusion criteria. Detailed information was collected through careful history-taking and physical examination, and baseline samples were collected.

Inclusion criteria: All healthy male students were required to report to the laboratory in the morning on an empty stomach were included in the study.

Exclusion criteria: Students with a history of neurological disorders, those taking medications affecting emotional status, and those with cardiovascular abnormalities. Individuals with tobacco addiction, a history of diabetes mellitus, chronic illnesses, and athletes were excluded from the study.

Study Procedure

A total of 30 healthy male medical students, aged 18-21 years, were included in the study using convenient sampling. Out of 150 medical students, only 80 were male students. Among the 50 students who expressed consent to participate, 20 did not meet the inclusion criteria and were therefore excluded, leaving 30 participants for the study. Serum cortisol levels, pulse rate, blood pressure, and HRV recordings were assessed before and after six weeks of yogic practice during the study.

- **Surya Namaskar:** Subjects were instructed to perform Surya Namaskar for 30 minutes a day for six weeks, consisting of three rounds of Surya Namaskar's 12 poses.
- **Heart rate variability:** The HRV was assessed using the Physio-Pac HRV analytic equipment. Continuous HRV data were recorded for 10 minutes via Electrocardiogram (ECG) to quantify sympathetic and parasympathetic tone. The HRV variables were then analysed.
- **Serum cortisol:** Cortisol levels were measured in plasma using the access cortisol kit on an automated chemiluminescence immunoassay analyser.

STATISTICAL ANALYSIS

Continuous data were summarised as mean±SD, while discrete data were presented as frequency (n) and percentage (%). Statistical analysis was performed using Statistical Package for Social Sciences (SPSS) software version 23.0. A p-value <0.001 was considered statistically highly significant, while a p-value >0.05 was considered non significant at a 95% confidence interval.

RESULTS

A total of 30 healthy male first year medical students were recruited for the study with the aim of evaluating the effect of Surya Namaskar on autonomic status and serum cortisol levels. [Table/Fig-1] presents the comparison of (Mean±SD) pulse rate, Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP), and Mean Arterial Pressure (MAP) at different time intervals: baseline, day 1, and the end of six weeks. [Table/Fig-2] displays the comparison of HRV time domain parameters at different time intervals, and the statistical analysis of HRV (T) SDNN, mean HR, and pNN50 using ANOVA showed a statistically highly significant result with p<0.001.

[Table/Fig-3] illustrates the comparison of HRV frequency domain parameters - LF, HF, and LF/HF ratio at different time intervals. The application of ANOVA test revealed that the variation in LF/HF after six weeks was statistically highly significant with a p-value=0.001. [Table/Fig-4] compares the baseline serum cortisol levels with the cortisol levels after six weeks of yogic practice. The analysis demonstrated a statistically significant difference with p<0.001.

Parameters	Baseline Mean±SD	At day 1 Mean±SD	At six weeks Mean±SD	F-value	p-value
Pulse rate (beats/min)	89.2±6.50	85.7±7.04	86.23±5.83	2.80	0.069
SBP (mmHg)	135.30±10.12	131.93±7.11	135.50±6.67	2.35	0.104
DBP (mmHg)	82.70±8.84	83.30±7.40	82.63±7.79	0.06	0.930
MAP (mmHg)	99.40±6.52	99.73±6.19	101.23±5.88	0.91	0.408

[Table/Fig-1]: Comparison of pulse rate, Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP) and Mean Arterial Pressure (MAP) at different time intervals.

Parameters	Baseline Mean±SD	Day 1 Mean±SD	Six weeks Mean±SD	F-value	p-value
HRV (T) SDNN	26.37±11.07	32.17±12.46	48.7± 17.67	25.42	0.001**
HRV (T) Mean HR	46.04±6.12	44.50±6.29	40.64±3.84	8.43	0.001**
HRV (T) pNN50	9±3.34	11.16±3.54	15±5.22	24.96	<0.001

[Table/Fig-2]: Comparison of HRV time domain-SDNN, Mean HR, pNN50 at baseline, day 1 and after six weeks time of performing yogic practice.
HRV: Heart rate variability; HR: Heart rate; pNN50: Proportion of NN50

Parameters	Baseline Mean±SD	Day 1 Mean±SD	Six weeks Mean±SD	F-value	p-value
LF	71.47±33.84	48.53±29.80	25.83±25.42	22.38	0.001*
HF	4.59±1.99	6.26± 2.33	9.50± 5.58	3.4	0.001*
LF/HF	19.49±14.83	8.12±4.97	2.39±1.83	36.35	0.001*

[Table/Fig-3]: Comparison of HRV frequency domain- LF, HF and LF/HF ratio at baseline, day 1 and at 6th week time of performing yogic practice.
LF: Low frequency; HF: High frequency

Variables	Mean	Std. Deviation	p-value
Serum cortisol (BL)	15.77	2.48	0.001**
Serum cortisol (six week)	8.25	1.46	

[Table/Fig-4]: Comparison of baseline serum cortisol levels with levels of serum cortisol after six weeks of yogic practice.
**=significant at 0.01 level of significance

DISCUSSION

In stress, expectations are genetically programmed and established through prior learning from circumstances, often not aligning with the perceived perceptions of the internal or external environment [19]. Stress and anxiety are major contributors to morbidity, significantly reducing the quality of life and even lifespan [20]. Prolonged stress results in altered physiological activity, which correlates with daily somatic complaints [21]. The Autonomic Nervous System (ANS) aids in maintaining homeostasis by regulating blood pressure, gastrointestinal responses to food, physical activity responses, and thermoregulation [22]. Therefore, autonomic function tests serve as reliable indicators for understanding homeostasis. Quantitative analysis of stress involves measuring HRV, which is a reliable, non invasive, and reproducible method for assessing sympathetic and parasympathetic activity, in addition to stress markers.

Regular practice of yoga over a six-week period induces a physiological state that counters the flight-or-fight stress response. This disruption in the stress response fosters a sense of balance and harmony between the mind and body [23]. Yoga, as a form of Complementary Alternative Medicine (CAM), triggers physiological changes in the body that help reduce the stress response. In the

present study, cardiovascular parameters were examined, and the findings align with increased sympathetic activity during stress. This, in turn, leads to higher release of stress hormones, resulting in elevated heart rate and force of contraction, leading to increased systolic blood pressure. Additionally, vasoconstriction elevates total peripheral resistance, causing high diastolic blood pressure. These findings from the present study are consistent with the research conducted by Lewis MJ [24].

Continuous practice of Surya Namaskar for six weeks resulted in a decrease in mean pulse rate and mean heart rate, as reflected by SDNN and pNN50. These changes indicate that yoga enhances vagal tone and reduces cardiac sympathetic activity, leading to a decrease in HR and a shift in autonomic balance from sympathetic to parasympathetic tone. The results of the present study were in agreement with the studies conducted by Wallace RK, Billman GE, and Kukielka M [25,26]. In summary, it can be concluded that yoga enhances the plasticity of the autonomic nervous system and improves the ability to recover from stress [27,28].

The LF/HF ratio is a measure of sympathovagal balance, indicating the shift in autonomic balance towards parasympathetic dominance. In the present study, the LF/HF ratio demonstrated a decreasing trend after the implementation of a yogic lifestyle intervention. This suggests that the autonomic balance shifted towards parasympathetic dominance. It is important to note that physiological therapies such as yoga, exercise, and meditation typically elicit reciprocal changes in sympathetic and parasympathetic nerve activity, enabling proper interpretation of the LF/HF ratio [26,29]. When sympathetic nerve activation occurs, parasympathetic nerve activation completely overrides sympathetic nerve stimulation, leading to a decrease in HR. These interactions influence the autonomic system and consequently impact the interpretation of the LF/HF ratio [30].

Stress has been shown to decrease HRV and increase serum cortisol levels, which is consistent with the findings of the present study. Cortisol, as a stress hormone released from the adrenal cortex, is known to increase in the blood during various physical and psychological disorders. Results of the present study were in line with the research conducted by Thrithali J et al., who divided 54 patients into three groups: yoga alone, yoga along with antidepressants, and antidepressants only [11]. The study found that individuals practicing yoga had lower levels of cortisol, indicating a reduction in stress.

The present study highlights the autonomic basis of the effectiveness of yoga practices on HRV and cortisol levels. Yoga leads to a decrease in LF, an increase in HF, and a decrease in the LF/HF ratio. These changes indicate that the mean heart rate interval increases due to vagal modulation, resulting in an increase in HRV. The present study shows a positive association between HRV and cortisol levels, suggesting the role of yoga in reducing stress levels.

Limitation(s)

The authors were able to include only 30 students in the study due to the active involvement of this age group in physical activity, gym, and exercise. Additionally, the follow-up of the students was challenging as many of them did not attend for the entire duration of six weeks.

CONCLUSION(S)

The autonomic nervous system's response to yogic practices is a conditioning phenomenon, and HRV serves as a neurocardiac function that reflects heart-brain interactions and dynamics of the autonomic nervous system. The inclusion of the yoga model in the study provided the authors with insights into incorporating yogic exercises into the medical curriculum, as it helps reduce academic-related stress among medical professionals. Therefore, the inclusion of yoga as a lifestyle modification can be considered an essential stress reliever, as it not only benefits the body but also influences the mind, behaviour, attitude, perception, learning, and memory. Regular practice of Surya Namaskar has been shown to reduce mental stress and optimise autonomic regulation in young adults.

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