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## Impact of selected yogic practices on cortisol level of persons with hypertension

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### Abstract

In humans, the hypertensive effects of adrenocorticotrophic hormone (ACTH) infusion are reproduced by intravenous or oral Cortisol. Oral Cortisol increases blood pressure in a dose-dependent fashion. At a dose of 80–200 mg/day, the peak increases in systolic pressure are of the order of 15mmHg. Direct and indirect measures of sympathetic activity are unchanged or suppressed during Cortisol administration, suggesting that cortisol-induced hypertension is not mediated by increased sympathetic tone. Cushing syndrome happens when the body has too much of the hormone cortisol for a long time. This can result from the body making too much cortisol, or from taking medicines called glucocorticoids, which affect the body the same way as cortisol. Hypertension, which is a significant risk factor for cardiovascular disease, is often assessed in clinical settings using reference ranges for various haematological and immunological parameters. Specific haematological parameters, such as red blood cells, red cell distribution width, mean cellular/corpuscular haemoglobin, mean cellular/corpuscular haemoglobin concentration, haemoglobin, haematocrit, mean cellular/corpuscular volume, platelet count, white blood cells, basophils, lymphocytes, neutrophils, monocytes, eosinophils, neutrophil-to-lymphocyte ratio, monocyte-to-lymphocyte ratio, platelet-to-lymphocyte ratio, have a role to play in the development of hypertension. Yoga Therapy is the professional application of the principles and practices of yoga to promote health and well-being within a therapeutic relationship that includes personalized assessment, goal setting, and lifestyle management.

Adapting the essential and important yogic management conveniently and comfortably, one can easily get into the flow chart. Various Sukshma Vyayams, Asanas with proper inhale/exhale sequences, Pranayam, antar kumbaka, bahir kumbaka, meditation, and Savasana are included in the training program for the Pre-hypertensive volunteers. The present study was done to assess the efficacy of selected yoga practices for reducing high blood pressure to a minimum among middle-aged men. The study was performed to study the influence of yogic management on patients with hypertension.

The potential mechanisms of Cortisol action may be relevant in a number of clinical contexts, including Cushing's syndrome, apparent mineralocorticoid excess, the hypertension of liquorice abuse and chronic renal failure. There is also preliminary evidence suggesting a role for Cortisol in essential hypertension. The associated symptoms like stress, depression, anxiety, etc. can also be treated along with hypertension.

**Aim & Objectives:** To observe the blood pressure variations among hypertensive middle-aged men in experimental and controlled groups, and to propose the yogic management for bringing down the hiked systolic and diastolic blood pressure to the required level. We aimed to find the role of yoga as an efficient tool for rejuvenating the functions of organs involved in the pre-hypertension stages, specially by balancing the serum cortisol levels.

**Materials and Methods:** 30 patients with pre- hypertension between the ages of 35-50 years were selected. After a rest of 15-20 minutes in a comfortable posture their baseline physiological parameters such as Heart rate(HR) and Respiratory rate(RR). Systolic blood pressure (SBP) and diastolic blood pressure (DBP) were recorded by an automated digital Sphygmomanometer. the cortisol level in the morning hours and the haemoglobin were also earmarked for the study. The controlled group and the experimental group were volunteer to participate and the experimental were given a proper training program.

**Results:** A significant result was achieved during the research. The cortisol level has come down to the requisite level.

**Conclusion:** It is evident from the results that yoga plays a vital role in the lifestyle diseases, especially for the Pre-hypertensive men so as to prevent the later stage of hypertension. Relative increase in Hb level, dropping of excess cortisol are evident from the following reports.

**Keywords:** Yoga, blood pressure, cortisol, hypertension

### Introduction

Blood pressure is a fundamental indicator of cardiovascular function that reflects the force of blood flow against the inner walls of blood vessels.

This force is determined by several factors, including vascular resistance and cardiac workload. Knowledge of blood pressure is crucial for maintaining optimal health and preventing a range of conditions, including but not limited to heart disease, stroke, and kidney failure. Blood pressure is a measure of two pressures, the systolic and the diastolic. The systolic pressure (the higher pressure and the first number recorded) is the force that blood exerts on the artery walls as the heart contracts to pump the blood to the peripheral organs and tissues. The diastolic pressure (the lower pressure and the second number recorded) is the residual pressure exerted on the arteries as the heart relaxes between beats.

There can be several causes of prehypertension, including genetics, age, lack of physical activity, unhealthy diet, stress, smoking, alcohol consumption, and certain underlying medical conditions such as kidney disease, diabetes, and sleep apnea. It is important to identify the underlying cause of prehypertension and take appropriate measures to manage it in order to prevent it from progressing to hypertension.

Prehypertension is the range between normal and high blood pressure. If it surpasses this range, it becomes hypertension, or high blood pressure. Prehypertension should be taken seriously. It indicates you're on the path to developing high blood pressure, which can lead to a wide range of health problems. But that doesn't mean it can't be reversed. By making key lifestyle changes, it's possible to lower your blood pressure to healthy levels and protect your arteries from damage. Prehypertension can develop for many reasons. This includes:

- **Lack of physical activity.** A sedentary lifestyle can increase the force of blood in your arteries. That's because exercise strengthens your heart, helping it pump blood more efficiently. – Selective Asanas.
- **Higher sodium intake.** Sodium increases the pressure of blood in your arteries. Examples of high sodium foods include processed meats, store-bought soups and sauces, and packaged meals. – Satvik diet
- **Smoking and vaping.** The chemicals in nicotine can constrict blood vessels, which increases blood pressure. – Paranayama
- **Alcohol intake.** A high intake of alcohol can also raise blood pressure by constricting (narrowing) your blood vessels. – Pranayama & meditation.
- **Lack of sleep.** Your blood pressure naturally decreases during sleep. But if you don't get enough sleep, your blood pressure may stay high for a longer time. – Savasana.

Hypertension, or high blood pressure, is when your blood travels through blood vessels with more force than is considered healthy. When blood pressure is high, it can damage artery and blood vessel walls over time. This leads to dangerous complications and even death if left untreated. Blood pressure is measured by systolic over diastolic pressure.

Systolic refers to the pressure when the heart is beating, and diastolic refers to the pressure when the heart rests between beats. For an average adult, a blood pressure reading is considered normal if it's below 120/80 mmHg. The following are various systems, which will be effected badly with hypertension.

### Hormones

Hormones are chemicals that coordinate different functions in your body by carrying messages through your blood to your

organs, skin, muscles and other tissues. These signals tell your body what to do and when to do it. Glucocorticoids are a type of steroid hormone. They suppress inflammation in all of your bodily tissues and control metabolism in your muscles, fat, liver and bones. Glucocorticoids also affect sleep-wake cycles hypothalamus, a small area of the brain involved in hormonal regulation, and the Pituitary gland, a tiny gland located below the brain, regulate the production of cortisol in the adrenal glands. When the levels of cortisol in the blood fall, hypothalamus releases corticotrophin-releasing hormone (CRH), which directs pituitary gland to produce adrenocorticotrophic hormone (ACTH). ACTH then stimulates the adrenal glands to produce and release cortisol.

Cortisol is a steroid hormone, glucocorticoid produced by the adrenal gland. It regulates the body's response to stress. Cortisol is an essential hormone that affects almost every organ and tissue in your body. It plays many important roles, including regulation of body's stress response, metabolism, suppression of inflammation, regulation of blood pressure, blood sugar, sleep-wake up cycle. It is to be noted that higher than normal or lower than normal cortisol levels can be harmful. Almost all tissues in your body have glucocorticoid receptors. Because of this, cortisol can affect nearly every organ system such as Nervous system, immune system, cardiovascular system, Respiratory system, Reproductive system, Integumentary system, and Musculoskeletal system in our body. More specifically cortisol affects our body in the following ways:-

**Response to stress:** During times of stress, your body can release cortisol after releasing its "fight or flight" hormones, such as adrenaline, so you continue to stay on high alert. In addition, cortisol triggers the release of glucose (sugar) from the Liver for fast energy during times of stress.

**Metabolism:** Cortisol helps control how your body uses fats, proteins and carbohydrates for energy.

**Inflammation:** In short spurts, cortisol can boost your immunity by limiting inflammation. However, if you have consistently high levels of cortisol, your body can get used to having too much cortisol in your blood, which can lead to inflammation and a weakened immune system.

**Blood Sugar:** Under normal circumstances, cortisol counterbalances the effect of insulin to regulate the blood sugar. Cortisol raises blood sugar by releasing stored glucose, while insulin lowers blood sugar. Having chronically high cortisol levels can lead to persistent high blood sugar (hyperglycaemia), and can cause Type 2 Diabetes.

**Sleep Wake up cycle:** Under regular circumstances, you have lower cortisol levels in the evening when you go to sleep and peak levels in the morning right before you wake up. This suggests that cortisol plays a significant role in the initiation of wakefulness and plays a part in your body's circadian rhythm.

**Blood Pressure:** The exact way in which cortisol regulates blood pressure in humans is unclear. However, elevated levels of cortisol can cause high blood pressure, and lower-than-normal levels of cortisol can cause low blood pressure.

### Cortisol can affect blood pressure in humans in several ways

- a) Elevated levels of cortisol can cause high blood pressure.
- b) Lower-than-normal levels of cortisol can cause low blood pressure.
- c) If the adrenal glands make too much aldosterone, cortisol, or hormones similar to adrenaline, it can cause

high blood pressure.

- d) Acute stress can have a dramatic effect on raising blood pressure through the body's stress response, which includes hormones like adrenaline and cortisol.
- e) If a person's adrenal glands produce too much cortisol, they may develop Cushing's syndrome, or hypercortisolism. This can cause a person to have hypertension and other symptoms.

**Measurement of Cortisol:** The level of cortisol in your blood, urine and saliva normally peaks in the early morning and declines throughout the day, reaching its lowest level around midnight. This pattern can change if you work a night shift and sleep at different times of the day. The level of cortisol in the blood, urine, and saliva normally peaks in the morning and declines throughout the day. Reaching its lowest level around midnight. This pattern can change according to the night shift and sleeping patterns. Normal ranges are 0600hrs to 0800hrs – 10 to 20 micrograms per decilitres, and around 1600 hrs it will be 03 to 10mcg/dL.

Please be noted that experiencing abnormally high levels of cortisol (hypercortisolism) for an extended period of time is usually considered Cushing's syndrome. Based on many reviews the following are the counter measures for balancing the cortisol level and how it can be most appropriate or associated with Yoga therapy.

Sleep apnea – Ujjayi pranayama / Savasana, learn to limit stress – sasankasana, padahastasana etc. followed by meditation. Breathing exercises - Pranayama, positive assumptions – mind or thought reformations, enjoy & laugh, and maintain good relationships – Sangachatvam.

### Yoga at its application mode

The ancient medical treatment method, YOGA proved its efficacy to prevent and cure many lifestyle diseases. Hypertension is one of the main causes of cardiovascular disorders at the beginning and ends up in disaster after becoming a serious victim of high blood pressure. Yoga is a means of balancing and harmonizing the body, mind, and emotions through the practices of asana, pranayama, mudra, bandha, shatkarma, and meditation and must be achieved before union can take place with the higher reality. When we look around, it is evident from the recent cardiac arrests, and heart attacks leading to a great loss of dependents even after medication. Yoga can do much more than medicine can reach. The union of mind and the body is the aspect that plays a vital role in curing any disease.

While doing the sukshma vyayams with synchronized breathing itself starts massaging the internal organs, and muscles, allowing more concentration of blood cells. Asana are one of the important parts of stretching and relaxing internal and external core muscles engaged in particular postures. The expansion and relaxation of cardiovascular muscles with breathing techniques definitely strengthen the system. Antar kumbaka and bahir kumbaka focuses on the vital capacity. Anterior neck muscles, the apex of lungs, pectoralis major, and pectoral minor/major are directly involved in certain asanas. Backward bending asanas improves the strengthening of cardiac muscles. With the help of kapalbhati we can exhale toxins. In the pranayama process, as the ratio and duration increases the breadth becomes very light and subtle. Nadi shodhana pranayama is the practice to purify the nadis.

The yogic breathing, and the engagement of chest and the diaphragm muscles will enhance the rhythmic breathing. The

physical movement or the postures will be tuning the external and internal muscles and the pranayama techniques, or wherein the breath is involved, the cardiac muscles will become stronger and will allow smooth functioning of the system. Once the breathing becomes natural, our body gets relaxed, the entire system gets enough supply of energy, and heartbeats become smooth and steady, thereby the blood pressure is maintained. Adoption of chin mudra pranayama and followed by the Savasana, makes the body feel the sympathized relaxation of entire limbs and organs. The conscious, subconscious state of mind becomes one, the pulse rate becomes, normal without any misleading.

When we're stressed out, our sympathetic nervous system responds as if we're in danger, the fight-or-flight response. And while not all stress is bad, chronic stress can lead to a myriad of health issues such as reduced immunity, heart disease, anxiety, and depression. To help combat stress, yoga can be a particularly effective tool. Thanks to its physical benefits like toned muscles and increased flexibility, it's become incredibly popular. But it's actually the internal effects that make it so powerful. Studies trusted Source have shown yoga to be linked to lowered cortisol levels (the stress hormone), increased resilience and pain tolerance, improved mood, and reduced anxiety. Certain yoga poses and longer hold times are even believed to activate the parasympathetic nervous system — our rest-and-digest response, which is the body's antidote to fight-or-flight.

### Therapy, and the Methods

The principles of scheduling of sukshma vyayams, physical practicing of the body, Skelton relaxation, timing & duration, and influence of poses provide a framework to structure the progression and content of therapy. Sequencing refers to the deliberate progression of sukshma vyayams, postures selected to specifically target a group of muscles, with variations of postures that gradually release muscle tension, open up joint spaces, increase circulation, decrease inflammation, smooth function of our respiratory systems, by ensuring correct alignment and movement in the postures. The pranayama is to be commenced once they get mastery over the selective asanas. The rounds on each nostril, by focussing on the left/right hemisphere; in between proper kumbaka can also be carried out under correct supervision. Surya bedha and Chandra beda, the mudra pranayams.

Timing refers to the length of time each pose or âsana is held, depending on the capacity of the participant, to optimize the release of tension and "opening" of joints while minimizing pain. The synchronization of breath with the movement will definitely affect the target muscles and the respiratory system as well. When mobility is the goal, more active stretching is involved and poses are held for short time periods (15–20 seconds) and repeated up to 3 times. Once mobility is achieved, the participants are advised to stay longer in the pose (1–2 minutes) with less repetition according to their capacity to regain proper anatomical alignment, flexibility, and strength.

These movements are "intricate" and highlight the mind-body nature of Yoga that emphasizes awareness, concentration, and bidirectional communication between the mental, nervous, skeletal, and muscular systems. Yoga is not a passive activity that simply occurs by itself; it instead requires an active mind and body integration to assure the anatomically correct pose occurs that stimulates all muscles and tissues to achieve proper alignment, strengthening, flexibility, stability, and physiological function of the surrounding tissues and organs.

The intricacy that occurs allows practitioners to stay in the pose for longer periods of time, at first with effort. As they practice and progress they can remain in the pose with lightness and ease. Sustaining the posture in a dynamic state permits positive physical and psychological changes to occur, and intricacy is thus central to the healing of musculoskeletal imbalances.

Once they gain mastery over the asanas, the pranayam will be taught in order to expand the lungs, and the exhalation procedures emitting maximum carbons, and toxins help them to breathe easily before the bhastrika. The Kapal Bhati and bhastrika pranayam will be given to them alternatively in order to enhance lung capacity. Continuing the calm and rhythmic breath through the nostrils, observe the throat, and feel the breath passing through the throat. With the beginning of this UJJAYI breath, the entire nervous system will be smoothened. It has a profoundly relaxing effect on the psychic level. It can slow down the beneficial for the heart rate, high blood pressure patients. If experienced, they can adopt jalandhara badha, moola badha. Further, the pranayam chin mudra and hridaya mudra are being practiced for the health and strength of our HEART. Meditation also can be done in continuation to the pranayam and then savasana.

The method of Yoga therapy for hypertension includes a scheduled training program. Sukshma vyayams, each asana individually of suryanamaskar, recommended asanas like Pada hasthasan, ardha kati chakra asana, Marjara asana, shasankasan, bhujangasana, dhanurasan, gomukhasan. The kapalbhati, bhastrika, ujjayi breath, mudra pranayam followed by meditation and savasana.

Mudras are hand gestures used in yoga and meditation practices to channel energy flow within the body and promote healing. Each mudra has a specific meaning and purpose, and they are believed to help balance the chakras and enhance mental and physical health. Effective mudra practice for prehypertensive male adults is Hridaya mudra and prana mudra.

Affirmations are positive statements that aim to reprogram the subconscious mind, replacing negative and limiting beliefs with empowering and uplifting ones.

- My heart is strong and healthy
- All the circulations in my body are regular and normal throughout
- I thank my body with gratitude for functioning in a regular and normal manner.

Meditation is a practice that involves training the mind to induce a state of relaxation, calmness, and inner peace. Through regular meditation, one can reduce stress, improve concentration, boost emotional well-being, and gain a deeper understanding of oneself. Practice of breath awareness meditation, nadaanusandhana.

Relaxation techniques are methods used to achieve a state of calmness and tranquillity by reducing physical and mental tension. This technique can involve various methods such as deep breathing exercises, part-by-part body relaxation, visualization, and meditation. The aim of deep relaxation is to reduce stress, promote better sleep, and improve overall well-being. Practices of deep relaxation technique, yoga nidra.

**Sample Size:** 30 Pre-hypertensive middle-aged Men volunteers aged between 35-50 yrs. They are divided into two groups Experimental groups (15) and Controlled group (15). Experimental group practises Yoga while the Controlled group did not do any yoga practice, and the study structures

are as follows: -.

- a) Study Design: Simple Random Group Design
- b) Study Duration: 5 days in a week for 8 weeks.
- c) Study Instrument: Systolic, diastolic blood pressure and Resting Pulse Rate

**Interventional Modules:** Sukshma vyayams. Tadasana, Utkatasana, Marjari asana, Vakrasana, Shasankasana, bhujangasana, Ardha Halasana, Dhanurasana, Gomukhasana, Brahmari Pranayama, chandravedha, and Nadi sudhi pranayama, Ujjayi breathing, Meditation. Application of Apana vayu mudra, focusing on the breath and inner silence. Savasana regularizes the resting pulse rate and improves abdominal and crevicular, adham pranayama breathing patterns in addition to complete relaxation at a very conscious state. (References are Asana-Pranayama-Mudra-and-Bandhas-Bihar-School, Gheraṇḍa saṃhita)

#### Inclusion Criteria

- a) Male Volunteers with Hypertension
- b) Subject aged between 35 to 50 years
- c) Subjects willing to participate in the study regularly.

#### Exclusion criteria

- a) Subjects already practice yoga
- b) Subjects who has undergone surgery
- c) Pacemaker and high-risk personnel

**Study Instruments:** blood samples

**Statistical Technique:** Analysis of Variance

**Measures:** Psychological, Bio chemical, Physiological variables

Lack of a significant decrease in cortisol levels in antidepressant-treated patients may have been confounded by this effect. Yoga-only group was devoid of this biological confound. Therefore, the effects of yoga in reducing the cortisol level could be detected robustly. Even better, the relationship between the cortisol-lowering effect and the antidepressant effect was best demonstrated in this (yoga-only) group. Consistent with our findings, it has been observed that greater reduction of cortisol occurs in depressed patients who receive psychological treatment along with antidepressant medication than those who receive antidepressant medication alone.

Reduction in stress may be expected to lower the cortisol levels. The effect of yoga on reduction of cortisol may be attributable to the reduction of stress-related consequences. However, how does cortisol reduction produce antidepressant effects? Does cortisol reduction trigger yet another mechanism? There is evidence to suggest a reciprocal role for stress and cortisol on brain-derived neurotrophic factor (BDNF). Further, impaired hypothalamo-pituitary-adrenal axis has been associated with reduced hippocampal volumes, suggesting its interference with neuroplasticity. It is hence likely that lowered cortisol levels facilitate neurotropism. Increase in levels of BDNF could be one such evidence, which, if demonstrated to associate with cortisol reduction, have the potential to explain these observations. Increased BDNF levels related to antidepressant drugs have been interpreted as neuroplastic mechanisms in the relief of depressive symptoms. Alternatively, it is known that “de-stressing” effects of some treatments, including yoga, reduce cortisol. The direct effect of cortisol on certain steroid receptors in selected brain areas (hippocampus being one),

causing depression, could hence be thwarted by antidepressant treatments, including yoga. This finding could be a link to newer molecules for antidepressant action, based on cortisol/steroid receptor blockade.

A few additional possible mechanisms of reduction of cortisol with yoga are worth discussing: Yoga is known to result in enhancement of parasympathetic (vagal) tone. Increased parasympathetic activity may cause reduced firing of paraventricular nucleus of medulla to locus ceruleus. Decreased stimulation of locus ceruleus could decrease norepinephrine output, resulting in relaxation, quiescence and reduced respiratory and heart rates. Reduced input of norepinephrine to paraventricular nucleus of hypothalamus may explain the decreased corticotropin-releasing hormone and cortisol. Enhanced parasympathetic tone and the resultant drop in blood pressure could relax arterial baroreceptors, leading to decreased  $\gamma$ -aminobutyric acid-ergic inhibition of supraoptic nucleus of hypothalamus, which in turn could cause the release of arginine vasopressin (AVP). AVP is known to cause positive affect. Finally, yoga may cause activation of prefrontal cortex and enhanced glutamate

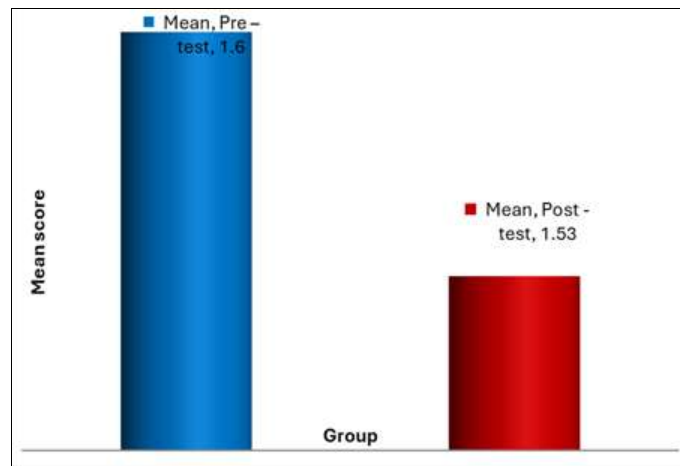
transmission in the arcuate nucleus of the medial hypothalamus resulting in the release of beta-endorphin – the latter cause’s anxiolytics which, in turn, may cause a reduction of cortisol.

**Table 1:** Showing the mean, standard deviation and t - value of the Systolic

Group	N	Mean	Std. Deviation	t-value	p-value
Pre - test	16	1.60	11.86	1.66	0.10 NS
Post - test	16	1.53	12.50		

**NS-Not Significant**

From the above table it is seen that in the pre-test, respondents scored of means value (1.60) than the post-test respondents are means value (1.53). This mean difference is statistically proved by the obtained t-value (1.66), the p-value is not significant. Therefore the framed research hypothesis that there is no significant difference in systolic level among the respondents between pre and post test is rejected.



**Fig 1:** Mean score

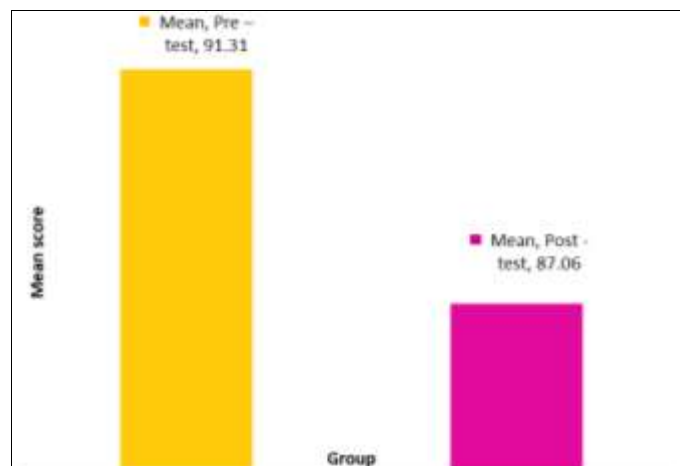
**Table 2:** Showing the mean, standard deviation and t - value of the Diastolic

Group	N	Mean	Std. Deviation	t-value	p-value
Pre - test	16	91.31	5.46	2.04	0.05 S
Post - test	16	87.06	6.26		

**S-Significant**

It is inferred from the above table result reveals that in the

pre-test, respondents are higher mean value (91.31) than the post-test respondents scored of means value (87.06). This mean difference is statistically proved by the obtained t-value (2.04), which is significant at 0.05 level. Therefore the framed research hypothesis that there is a significant difference in Diastolic level among the respondents between pre and post test is accepted.



**Fig 2:** Mean group pre-test and post-test

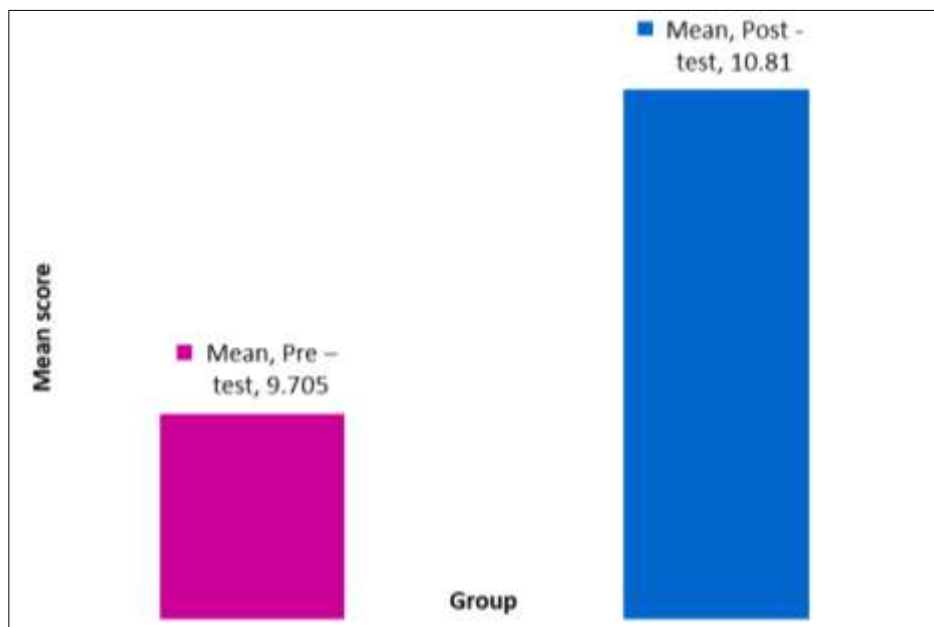
**Table 8:** Showing the mean, standard deviation and t - value of the Cortisol

Group	N	Mean	Std. Deviation	t-value	p-value
Pre - test	16	9.705	2.62	1.293	0.20 NS
Post - test	16	10.81	2.19		

NS-Not Significant

It is inferred from the above table result shows that in the pre-

test, respondents scored of means value (9.705) than the post-test respondents scored of means value (10.81). This mean difference is statistically proved by the obtained t-value (1.293), the p-value is not significant. Therefore the framed research hypothesis that there is no significant difference in Cortisole level among the respondents between pre and post-test is rejected.

**Fig 3:** Mean group

In summary, out-patients with depression have increased levels of cortisol. The latter is associated with severity of depression only poorly. However, treatments that lower the cortisol levels, e.g., yoga produced antidepressant effects. Yoga had a significant and direct influence on cortisol response that correlated with yoga's antidepressant effects.

### Conclusion

The present study has shown an efficacy of selective yogic practices on resting pulse rate and blood pressure among hypertensive middle aged men. Yoga, being a lifestyle incorporating Ashtanga yoga, managing stress and thereby creating positive attitude towards life. Hypertension is a common cause for cardiac disorders and by adapting yogic measures, we can easily control our heart rate and can increase our life span.

**Strength of study:** The yoga package was designed after extensive literature review by yoga experts and guides, and was a perfect combination of asana and pranayama targeted at the disease under study. Excellent compliance of study sample and there were no drop outs. Experimental group patients voluntarily reported to Holistic medicine department and were self-motivated for the practice of yoga. The control group was also under constant surveillance.

**Limitations of the study:** Direct supervision of the patients was not possible for the entire period of the study. Dietary data were not recorded. Long-term study was not possible due to threat of noncompliance of the patients.

### Conflicts of interest

All authors have none to declare.

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