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**ORIGINAL RESEARCH ARTICLE**

# Physiological Effects of *Yoga* and *Pranayama* on Serum Adipokines, Lipoprotein (a), Thyrotropin Levels, and Blood Pressure among Obese Hypothyroid Patients with Hypertension

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**ABSTRACT**

**Background:** The trio of obesity, hypothyroidism, and hypertension can act as a strong synergistic risk factor through parameters, like elevated serum leptin and lipoprotein (a) and decreased adiponectin levels, for the development of atherosclerotic diseases. Very few studies have focused on the effects of yoga/pranayama on these parameters among obese hypothyroid patients with hypertension. Hence, the present research work was carried out to evaluate the effects of 6 months of yoga and pranayama practices on these parameters.

**Materials and Methods:** The present interventional study was conducted involving 20 obese hypothyroid patients with hypertension, their baseline values of serum adipokines, lipoprotein (a), thyrotropin-releasing hormone (TRH) levels, blood pressure (BP), and body mass index (BMI) were recorded and they were subjected to 6 months of yoga/pranayama and the same were recorded at the end of 6 months, and data were statistically analyzed.

**Results:** There was a statistically significant reduction ($P < 0.01$) between baseline versus after 6 months in parameters such as serum leptin (23.94 ± 12.96 vs. 11.88 ± 10.32 ng/mL); serum lipoprotein (a) (28.45 ± 3.12 vs. 12.98 ± 3.56 mg/dL); BMI (29.42 ± 3.01vs. 25.36 ± 2.41 kg/m$^2$); and significant improvement ($P < 0.01$) in serum adiponectin (3.44 ± 2.32 vs. 8.86 ± 4.88 ug/mL); systolic BP (147.24 ± 7.39 vs. 126.88 ± 6.34 mmHg); diastolic BP (95.76 ± 6.32 vs. 82.04 ± 4.56 mmHg); and TSH (13.41 ± 3.34 vs. 2.83± 2.62 mIU/L).

**Conclusion:** Yoga and pranayama practice for 6 months resulted in beneficial effects such as reduction of serum leptin, lipoprotein (a) levels, BMI, BP, and improved adiponectin levels and thyroid functions among obese hypothyroid patients with hypertension.

## 1. INTRODUCTION

Obesity is a growing global epidemic and it is associated with chronic inflammation, orchestrated by metabolic cells in response to excess nutrients. This inflammatory state is present in structures such as the blood vessel wall, liver, brain, pancreas, and adipose tissue and has been implicated in immunometabolic disease. Among the adipokines secreted by adipocytes, leptin and adiponectin are the two most common hormones associated with obesity. Leptin exerts pro-inflammatory effect and is considered as a potential marker of obesity and its comorbidities such as Type 2 diabetes and cardiovascular disease, due to its angiogenic, atherogenic effects through a novel leptin receptor mechanism.[1-4] Whereas, adiponectin is an anti-inflammatory, anti-diabetic, and anti-atherosclerotic adipokine, acting through the AdipoR1 and AdipoR2 receptors. Low levels of adiponectin are associated with an increased risk of developing atherosclerotic diseases and inversely related to BMI. Obesity is also associated with high levels of low-density lipoprotein-cholesterol-lipoprotein(a), which are independent and causal risk factor for atherosclerotic diseases through mechanisms such as increased atherogenesis, inflammation, and thrombosis.[3,5-8]

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### 1.1. Obesity-hypothyroidism-hypertension Interlink

The relationship between obesity, hypothyroidism, and hypertension is very complex and pivotal. Both hypothyroidism and subclinical hypothyroidism are associated with a higher prevalence of obesity. Hypothyroidism causes decreased thermogenesis, decreased metabolic rate, and slow peristalsis causing chronic constipation, resulting in weight gain. Conversely, increased leptin levels in obese patients enhance activity of deiodinases and stimulate centrally the transcription of pro-thyrotropin-releasing hormone and consequently formation of thyrotropin-releasing hormone (TRH) and thyroid-stimulating hormone (TSH).[9-12]

The relationship between obesity and hypertension has been found among all age groups and across both sexes. As per Framingham offspring study, an increase in weight by 5% was associated with a 20–30% of increase in the incidence of hypertension.[13,14] The mechanisms through which obesity can cause hypertension include sympathetic overactivation, stimulation of the renin-angiotensin-aldosterone system, excessive cortisol secretion, alterations in adipose-derived adipokines, and insulin resistance.[15,16] Similarly, hypothyroidism has also been recognized as a cause of secondary hypertension due to significant volume changes, low plasma renin activity, increased peripheral vascular resistance, and low cardiac output.[17-19]

Thus, the combination of obesity, hypothyroidism, and hypertension can act as a strong synergistic risk factor, for the development of atherosclerotic diseases, through altered levels of serum adipokines and lipoprotein (a). Even though medications are used in the management of these patients, the overall effectiveness in ameliorating symptoms and prevention of complications is insufficient.

Practice of yoga and pranayama has numerous beneficial physiological effects in human body. Yoga is derived from Sanskrit word "yuj" is a psycho-somatic-spiritual discipline for achieving union and harmony between our mind, body, and soul and the ultimate union with the universal consciousness. Pranayama means regulation of breath and is derived from Sanskrit words, namely, "prana," which means life energy or vital force, "ayama" means to prolong. Hence, the present research work aims to evaluate the effect of 6 months of yoga and pranayama practices on these parameters.

## 2. MATERIALS AND METHODS

The present interventional study was conducted from November 2022 to June 2023 at Preksha wellness and Yoga Centre, and Sakaria Hospital, Bangalore, India. Ethical clearance number: EC/PR/2022-156, was received from institutional ethics committee, Dr. B R Ambedkar Medical College and hospital, Bangalore. India. Informed written consent was obtained from the all patients and was also informed of their right to withdraw anytime during the study.

### 2.1. Inclusion Criteria

Age between 18 and 45 years and pre and newly diagnosed obese (BMI above 25 kg/m$^2$) hypothyroid patients with hypertension blood pressure (BP >140/90mmHg) were included in the study.

### 2.2. Exclusion Criteria

Type 2 DM, nervous system or respiratory ailments, cardiovascular disease including malignant hypertension, renal complications, liver disorders, glaucoma, hernia, or ulcers of the stomach or intestine, recent abdominal or spinal surgery, pregnancy or lactation and children, any type of addictions such as smoking, alcoholism, and tobacco chewing were excluded from the study.

Sample size was determined by considering a mean difference in SBP of 5 mmHg between the pre- and post-yoga practice, a standard deviation of 5.5 mm Hg and a drop-out rate of 10 %, and standard normal variate of 0.84 for power of 80%, and standard normal variate of 1.96 at 5% Type I error. *P* value below 0.01 was considered significant.

### 2.3. Study Protocol

Twenty patients (male – two and female – 18) were selected based on inclusion and exclusion criteria as mentioned above in the outpatient departments of Preksha Wellness and Yoga Center, and Sakaria Hospital, Bangalore, India. Baseline parameters were recorded and the patients were instructed to continue thyroid and BP medications. All patients were taught yoga and pranayama by single/same expert yoga instructor and the parameters were again recorded after 6 months of yoga and pranayama practice.

### 2.4. Protocol of Yoga/Pranayama in the Present Study

Total execution time for yoga and pranayama practices was 60 min per session per day, 6 days in a week, in the morning between 6.30 am and 7.30 am and 7.30 am to 8.30 am in two batches (online/offline) as per the time/batch chosen by the patients for 6 months. The specific protocol of yoga and pranayama was finalized by yoga expert based on the review of literature and consultation with many other yoga experts. Printed handouts with instructions, pictures of yoga, and recorded YouTube videos of yoga practices were also handed over to all patients, for better understanding and compliance. All patients were monitored telephonically during the study period to ensure there were no serious adverse effects, reported by any of the patients.[20]

- Execution time – 10 min – Warmup exercises – neck movements, shoulder rotation, wrist movements, twisting back, leg movements, and ankle joint movements.
- Execution time – 10 min – Suryanamaskara – 6–10 rounds/repetitions.
- Execution time – 20 min – Asanas.
    a. Standing – Trikonasana, Padahastasana, and Virabhadrasana 1 and 2.
    b. Sitting – Paschimottanasana, Ustrasana, and Marjariasana.
    c. Lying supine – Viparitakarni, Sarvangasana, Setubandhasana, and Matsyasana.
    d. Lying prone – Bhujangasana, Shalabhasana, and Dhanurasana.
- Execution time – 5–7 min Relaxation – Shavasana.
- Execution time – 15 min – Pranayama – Nadishuddhi Pranayama (1:4:2), Ujjayi Pranayama (1:4:2), and Bhramari pranayama.

### 2.5. Protocol of Measurement of Basic Components Like BP, BMI, and Serum TSH in the Present Study

BP was measured using Omron automatic BP monitor, model HEM 7124, Vietnam, with prior clinical validation. Patients were asked to avoid from strenuous physical activity for 24 h and avoid smoking, consumption of alcohol and caffeinated beverages for 12 h before the laboratory tests. The patients were asked to void urine before testing and made to sit in the laboratory comfortably to get accustomed to the new place. Measurements were obtained after the patient had been sitting quietly for 15 min. The mean of three consecutive measurements with a maximum variation of 4 mmHg of both systolic and diastolic BPs was recorded.

Body mass index (BMI) was calculated using Quetelet's index (BMI = weight (kg)/[height (m)]$^2$). Height was measured to the nearest 0.5 cm without shoes/footwear, using a stadiometer (V.M. Electronics

Hardware Ltd., India) which was mounted on a wall and body weight was measured using a body analysis scale (model EEF2001A, E.G Kantawalla Pvt. Ltd., Pune, India) to the nearest kilogram without shoes/footwear. Asian Pacific task force criteria for BMI and Indian society of hypertension IV (2019) guidelines were followed for BP measurements. Serum TSH was measured by TSH Rapid Quantitative Test kit (fluorescence immunoassay method), Finecare, wondfo, India, as per manufacturer's manual of instructions.

### 2.6. Protocol of Measurement of Parameters Like Serum Adipokines-leptin and Adiponectin and Lipoprotein (a) Levels in the Present Study

Serum leptin was measured by Human Leptin Quantikine ELISA Kit DLP00, Bio-Techne India Private Limited, India, and serum adiponectin levels by Human HMW Adiponectin/Acrp30 ELISA Kit, Bio-Techne India Private Limited, India, and serum lipoprotein (a), by Lipoprotein A kit (latex-enhanced immunoturbidimetry method), Genuine Biosystem Private Limited, Chennai, India. All the tests were carried out as per manufacturer's manual of instructions.

### 2.7. Statistical Analysis

The collected data were entered into master Excel chart. The data were analyzed using Smith's Statistical Software version 2.80, developer-Gary Smith, and parametric variables were expressed as means ± standard deviations, and non-parametric variables were expressed as medians and interquartile ranges, within the group pre- and post-assessment were done using Student's paired t test for paired data and *P* value below 0.01 was considered as statistically significant.

### 2.8. Drop Outs

During the study, out of the total 20 patients involved, four (two males and two females) of them dropped out due to personal reasons.

## 3. RESULTS

Table 1 shows a statistically significant reduction ($P < 0.01$) between baseline versus after 6 months in parameters such as serum leptin (23.94 ± 12.96 vs. 11.88 ± 10.32 ng/mL); serum lipoprotein (a) (28.45 ± 3.12 vs. 12.98 ± 3.56 mg/dL); BMI (29.42 ± 3.01vs. 25.36 ± 2.41 kg/m$^2$); and significant improvement ($P < 0.01$) in serum adiponectin (3.44 ± 2.32 vs. 8.86 ± 4.88 ug/mL); systolic blood pressure (147.24 ± 7.39 vs. 126.88 ± 6.34 mmHg); diastolic blood pressure (DBP) (95.76 ± 6.32 vs. 82.04 ± 4.56 mmHg); and TSH (13.41 ± 3.34 vs. 2.83 ± 2.62 mIU/L).

## 4. DISCUSSION

Our present study depicted a statistically significant reduction ($P < 0.01$) in serum leptin levels and beneficially raised serum adiponectin levels after 6 months of yoga and pranayama practice. Similar results were demonstrated in a study involving a total of 97 Hong Kong Chinese individuals aged (57.6 ± 9.1) years with metabolic syndrome and high-normal BP randomly assigned to control ($n$ = 45) and yoga groups ($n$ = 52) with patients of yoga group subjected to a yoga training program with three 1-h yoga sessions weekly for 1 year, showed that 1-year yoga training decreased pro-inflammatory adipokines and increased anti-inflammatory adipokine among patients suffering from metabolic syndrome with high-normal BP.[21]

Another study conducted among 16 healthy postmenopausal Korean women aged 54.50 ± 2.75 years with more than 36% of body fat, randomly assigned to either a yoga exercise group ($n$ = 8) or to a "no exercise" control group ($n$ = 8), after 16 weeks indicated that yoga exercise improved adiponectin levels, decreased serum lipids, and metabolic syndrome risk factors in obese postmenopausal women and consequently, concluded that yoga exercise would be effective in preventing cardiovascular disease caused by obesity in obese postmenopausal Korean women.[22]

A comparative study involving 50 healthy women (mean age=41.32 years, range=30–65 years), 25 novices and 25 yoga experts, provided fasting blood samples for analysis of serum leptin and adiponectin, during three separate visits. Leptin was 36% of higher among novices compared to yoga experts. Longer years of yoga practice were significantly associated with lower leptin, raised adiponectin levels among yoga experts.[23]

There was a significant ($P < 0.01$) reduction in BMI and lipoprotein (a) levels and improvement in TSH levels after 6 months of yoga and pranayama practices in the present study, which are in accordance with a pilot study conducted to depict the effects of 6 months of intense yoga practice on lipid profile, thyroxine medication, and serum TSH level among 22 household females suffering from hypothyroidism, demonstrated that physical postures, Surya namaskar, and dynamic yogic breathing practices such as Bhastrika and Kapalabhati pranayama helped in the improvement of physical well-being and metabolic rate, and slow breathing practices such as Nadi Shuddhi pranayama, Ujjayi pranayama, and Bhramari pranayama helped in the improvement of physical and mental relaxation and there was a significant reduction in total cholesterol, low-density lipoproteins (LDLs), triglycerides, and significant improvement in protective high-density lipoproteins (HDLs) levels.[24]

### 4.1. Possible Physiological Mechanisms of Yoga and Pranayama Resulting in Beneficial Effects on Obesity, Lipids, and Adipokines

The sequential slow and non-strenuous movements of yoga positively affect the hypothalamic-pituitary axis response, to stress and this could be the main basis for the reduction in weight among obese individuals.[25] The improvement in the lipid profile among obese patients could be due to increased hepatic lipase and lipoprotein lipase at cellular level, which alters the metabolism of lipoprotein and thus increases the uptake of triglycerides by adipose tissues and further, meditation also brings about a balanced metabolic state and decreases the stress-induced sympathetic over activity which leads to overcome stress that ultimately results in lowered cortisol levels and inflammatory lipoproteins, it can also be a possible mechanism for beneficial effects on lipid profile among patients practicing yoga/meditation and pranayama.[26,27] Yoga practice can induce secretion of anti-adipogenic adipokines and suppress adipogenic/inflammatory adipokines by regulating transcription of microRNA(miRNAs).[28]

In a recently conducted and randomized study in Tamil Nadu, India, involving 120 hypothyroidism patients wherein 60 patients were allocated to yoga group and another 60 to control group, with yoga group subjected to 90 days of ujjayi pranayama, revealed that practice of Ujjayi pranayama decreased the BMI and improved thyroid function in the yoga group in comparison to that of the control group.[29]

Another study conducted at a nature cure hospital, Shantivana, Dharmasthala, involving 60 obese hypothyroid subjects, 29 males (age 44.2 ± 7.0 years) and 31 females (age 40.6 ± 7.4 years) with BMI, ≥30 were randomly assigned to case group ($n$ = 30) and waitlist control group ($n$ = 30). The subjects of case group underwent naturopathy and yoga intervention for 10 days. The result showed a significant

reduction in body weight, BMI, waist circumference, total cholesterol, LDL-cholesterol, and TSH along with significant improvement in HDL-cholesterol in case group compared with control group and suggested that naturopathy and yoga have therapeutic and protective effects in the management of obese hypothyroid patients.[30]

Similarly, another study in 2020 also showed that ujjayi pranayama would be one of the most recommended breathing exercises which would be effective in helping the hypothyroidism patients to control their hypothyroid-related symptoms.[31]

Our present study also demonstrated a significant reduction of both systolic as well as DBPs after 6 months of yoga practice.

Concordantly, in a study conducted at Bengaluru, India, involving 45 hypertensive patients depicted a statistically significant decrease in both systolic as well as DBP with $P < 0.05$, and reduction in inflammatory markers like high-sensitive CRP following 6 months of yoga practice.[32]

Another study conducted by Thiyagarajan *et al*. also demonstrated SBP reduction by 4 and 6 mmHg with lifestyle changes alone and lifestyle changes plus yoga therapy respectively. Further, yoga also resulted in reduction of heart rate, waist circumference, and lipid levels, which in turn could reduce cardiovascular disease prevalence and mortality.[33]

### 4.2. Possible Physiological Mechanisms of Yoga and Pranayama Resulting in Beneficial Effects on Thyroid Functions and BP

Yogasanas such as shoulder stand (Saravangasana), plow pose (Halasana), fish pose (Matsyasana), camel pose (Ustrasana), cobra pose (Bhujangasana), bridge formation pose (Sethubandhasana), and bow pose (Dhanurasana) help balance and regulate the functions of the thyroid gland by improving its blood circulation, squeezing out stagnant colloid secretions and strengthening neck muscles. Pranayama like Ujjayi results in constriction of glottis and throat region thereby causing stimulation and relaxation of the thyroid gland and other pranayama like Bhramari causes voluntary prolongation of breath, leading to stretching of the thyroid gland and also by rebalancing metabolism and improving reflex pathways within the throat could cure thyroid imbalance.[20,34,35] The mechanism by which yoga and pranayama/meditation reduces BP could be by reduction in sympathetic activity, facilitating autonomic balance, enhancing baroreflex sensitivity, and alteration of chemoreceptor responses.[36-38]

Thus, the various health benefits of yoga and pranayama among obese hypothyroid patients with hypertension could be related to changes in the level of various hormones, enzymes, neurotransmitters, autonomic balance, and reduction of inflammatory markers by complex physiological mechanisms.[26-28,39-41]

### 4.3. Limitations of Present Study

1. Diet patterns of patients were not monitored.
2. Sample size was relatively small.
3. There was no control group; instead within yoga group (pre/post) comparison was assessed.
4. Other adipokines such as resistin, visfatin, interleukin-6, and tissue necrosis factor were not estimated and T3 and T4 were not compared.

## 5. CONCLUSION

Yoga and pranayama practiced for a period of 6 months have shown a beneficial impact by reduction of serum leptin, and lipoprotein (a) levels, BMI, BP, and improved serum adiponectin levels, and thyroid functions among obese hypothyroid patients with hypertension, by complex physiological mechanisms and thus, can be considered as an important adjuvant therapy in these patients, which could be explored with research projects in future to elucidate its molecular mechanisms.

## 6. ACKNOWLEDGMENT

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## 7. AUTHORS' CONTRIBUTIONS

All the authors contributed equally in design and execution of the research article.

## 8. FUNDING

None.

## 9. ETHICAL APPROVALS

This study got Ethical clearance number: EC/PR/2022-156, was received from institutional ethics committee, Dr. B R Ambedkar Medical College and hospital, Bangalore. India.

## 10. CONFLICTS OF INTEREST

None.

## 11. DATA AVAIBALITY

This is an original manuscript and all data are available for only research purposes from principal investigators.

## 12. PUBLISHERS NOTE

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## REFERENCES

1. Kinlen D, Cody D, O'Shea D. Complications of obesity. QJM 2018;111:437-43.
2. Kirichenko TV, Markina YV, Bogatyreva AI, Tolstik TV, Varaeva YR, Starodubova AV. The role of adipokines in inflammatory mechanisms of obesity. Int J Mol Sci 2022;23:14982.
3. Zorena K, Jachimowicz-Duda O, Ślęzak D, Robakowska M, Mrugacz M. Adipokines and obesity. Potential link to metabolic disorders and chronic complications. Int J Mol Sci 2020;21:3570.
4. Chaldakov GN, Fiore M, Stankulov IS, Hristova M, Antonelli A, Manni L, *et al.* NGF, BDNF, leptin, and mast cells in human coronary atherosclerosis and metabolic syndrome. Arch Physiol Biochem 2001;109:357-60.
5. Mraz M, Haluzik M. The role of adipose tissue immune cells in obesity and low-grade inflammation. J Endocrinol 2014;222:R113-27.
6. Reyes-Soffer G, Ginsberg HN, Berglund L, Duell PB, Heffron SP, Kamstrup PR, *et al*. Lipoprotein(a): A genetically determined, causal, and prevalent risk factor for atherosclerotic cardiovascular disease: A scientific statement from the American heart association. Arterioscler Thromb Vasc Biol 2022;42:e48-60.
7. Gregor MF, Hotamisligil GS. Inflammatory mechanisms in obesity. Annu Rev Immunol 2011;29:415-45.
8. Ouchi N, Walsh K. Adiponectin as an anti-inflammatory factor. Clin Chim Acta 2007;380:24-30.

9. Rosenbaum M, Hirsch J, Murphy E, Leibel RL. Effects of changes in body weight on carbohydrate metabolism, catecholamine excretion, and thyroid function. Am J Clin Nutr 2000;71:1421-32.
10. Sanyal D, Raychaudhuri M. Hypothyroidism and obesity: An intriguing link. Indian J Endocrinol Metab 2016;20:554-7.
11. Laurberg P, Knudsen N, Andersen S, Carlé A, Pedersen IB, Karmisholt J. Thyroid function and obesity. Eur Thyroid J 2012;1:159-67.
12. Danforth E Jr., Horton ES, O'Connell M, Sims EA, Burger AG, Ingbar SH, *et al.* Dietary-induced alterations in thyroid hormone metabolism during overnutrition. J Clin Invest 1979;64:1336-47.
13. Landsberg L, Aronne LJ, Beilin LJ, Burke V, Igel LI, Lloyd-Jones D, *et al.* Obesity-related hypertension: Pathogenesis, cardiovascular risk, and treatment: A position paper of The Obesity Society and the American Society of Hypertension. J Clin Hypertens (Greenwich) 2013;15:14-33.
14. Garrison RJ, Kannel WB, Stokes J 3rd, Castelli WP. Incidence and precursors of hypertension in young adults: The Framingham Offspring Study. Prev Med 1987;16:235-51.
15. Faulkner JL, Belin de Chantemèle EJ. Sex differences in mechanisms of hypertension associated with obesity. Hypertension 2018;71:15-21.
16. Shariq OA, McKenzie TJ. Obesity-related hypertension: A review of pathophysiology, management, and the role of metabolic surgery. Gland Surg 2020;9:80-93.
17. Asvold BO, Bjøro T, Nilsen TI, Vatten LJ. Association between blood pressure and serum thyroid-stimulating hormone concentration within the reference range: A population-based study. J Clin Endocrinol Metab 2007;92:841-5.
18. Streeten DH, Anderson GH Jr., Howland T, Chiang R, Smulyan H. Effects of thyroid function on blood pressure. Recognition of hypothyroid hypertension. Hypertension 1988;11:78-83.
19. Drivsholm A, Lund MA, Hedley PL, Jespersen T, Christiansen M, Hansen T, *et al.* Associations between thyroid-stimulating hormone, blood pressure and adiponectin are attenuated in children and adolescents with overweight or obesity. J Pediatr Endocrinol Metab 2019;32:1351-8.
20. Venkatesh T, Ravikumar I, Mani TA. Development of a yoga module for hypothyroidism. J Clin Diagn Res 2021;15:LC25-31.
21. Supriya R, Yu AP, Lee PH, Lai CW, Cheng KK, Yau SY, *et al.* Yoga training modulates adipokines in adults with high-normal blood pressure and metabolic syndrome. Scand J Med Sci Sports 2018;28:1130-8.
22. Lee JA, Kim JW, Kim DY. Effects of yoga exercise on serum adiponectin and metabolic syndrome factors in obese postmenopausal women. Menopause 2012;19:296-301.
23. Kiecolt-Glaser JK, Christian LM, Andridge R, Hwang BS, Malarkey WB, Belury MA, *et al.* Adiponectin, leptin, and yoga practice. Physiol Behav 2012;107:809-13.
24. Nilakanthan S, Metri K, Raghuram N, Hongasandra N. Effect of 6 months intense Yoga practice on lipid profile, thyroxine medication and serum TSH level in women suffering from hypothyroidism: A pilot study. J Complement Integr Med 2016;13:189-93.
25. Carei TR, Fyfe-Johnson AL, Breuner CC, Brown MA. Randomized controlled clinical trial of yoga in the treatment of eating disorders. J Adolesc Health 2010;46:346-51.
26. Nagarathna R, Kumar S, Anand A, Acharya IN, Singh AK, Patil SS, *et al.* Effectiveness of yoga lifestyle on lipid metabolism in a vulnerable population-a community based multicenter randomized controlled trial. Medicines (Basel) 2021;8:37.
27. Shantakumari N, Sequeira S, El Deeb R. Effects of a yoga intervention on lipid profiles of diabetes patients with dyslipidemia. Indian Heart J 2013;65:127-31.
28. Abbott MJ, Killian TJ, Walsh CS, Yim VT. The effects of Ashtanga yoga on circulating adipokines and inflammatory associated miRNAs. FASEB J 2018;32:Lb267.
29. Vinudha S. Efficacy of Ujjayi Pranayama on Hypothyroidism in Adults: A Randomized Controlled Trial. Master Thesis, Government Yoga and Naturopathy Medical College, Chennai, India; 2019. Available from: https://repository-tnmgrmu.ac.in/10717 [Last accessed on 2023 Aug 02].
30. Shetty GB, Shetty B, Shetty P. Effect of short-term naturopathy and yoga intervention on anthropometric variables, lipid profile and thyroid profile in obese hypothyroid patients: A randomized controlled trial. Int J Basic Clin Pharmacol 2020;9:247-53.
31. Dinesh R, Sandeep KS, Rachana J, Rajeev KS. Method of Ujjayi pranayama in the management of hypothyroidism. World J Pharm Med Res 2020;6:213-6.
32. Balaji PA, Varne SR. High-sensitive CRP levels, Plasma renin activity and blood pressure among Hypertensive patients practicing Yoga exercises. Indian J Clin Anat Physiol 2017;4:431-4.
33. Thiyagarajan R, Pal P, Pal GK, Subramanian SK, Trakroo M, Bobby Z, *et al.* Additional benefit of yoga to standard lifestyle modification on blood pressure in prehypertensive subjects: A randomized controlled study. Hypertens Res 2015;38:48-55.
34. Apar AS, Raghavendra BR, Manjunath NK. Effects of yogic breath regulation: A narrative review of scientific evidence. J Ayurveda Integr Med 2019;10:50-8.
35. Top 8 Yoga Poses and Pranayama for Thyroid Problems. Available from: https://www.curejoy.com/content/yogaand-pranayama-for-thyroid-problems/#sarvangasana [Last accessed on 2023 Jul 19].
36. Selvamurthy W, Sridharan K, Ray US, Tiwary RS, Hegde KS, Radhakrishan U, *et al.* A new physiological approach to control essential hypertension. Indian J Physiol Pharmacol 1998;42:205-13.
37. Goyal R, Lata H, Walia L, Narula MK. Effect of pranayama on rate pressure product in mild hypertensives. Int J Appl Basic Med Res 2014;4:67-71.
38. Balaji PA, Smitha RV. Integrated review of management of hypertension by lifestyle changes, yoga, exercise, acupressure, plant/herbal and allopathic medications, and newer interventions. Indian J Integr Med 2023;3:1-8.
39. Balaji PA, Varne SR, Ali SS. Physiological effects of yogic practices and transcendental meditation in health and disease. North Am J Med Sci 2012;4:442-8.
40. Ghazvineh D, Daneshvar M, Basirat V, Daneshzad E. The effect of yoga on the lipid profile: A systematic review and meta-analysis of randomized clinical trials. Front Nutr 2022;9:942702.
41. Yazdanparast F, Jafarirad S, Borazjani F, Haghighizadeh MH, Jahanshahi A. Comparing between the effect of energy-restricted diet and yoga on the resting metabolic rate, anthropometric indices, and serum adipokine levels in overweight and obese staff women. J Res Med Sci 2020;25:37.


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**Table 1**: Comparison of parameters baseline versus after 6 months of yoga/pranayama

| Parameters | Yoga group (baseline) *n*=16 | Yoga group (after 6 months) *n*=16 | *P*-value |
|---|---|---|---|
| Serum leptin (ng/mL) | 23.94±12.96 | 11.88±10.32 | <0.01 |
| Serum adiponectin (µg/mL) | 3.44±2.32 | 8.86±4.88 | <0.01 |
| Serum lipoprotein (a) (mg/mL) | 28.45±3.12 | 12.98±3.56 | <0.01 |
| BMI (KG/M2) | 29.42±3.01 | 25.36±2.41 | <0.01 |
| TSH (m IU/L) | 13.41±3.34 | 2.83±2.62 | <0.01 |
| SBP (mmHg) | 147.24±7.39 | 126.88±6.34 | <0.01 |
| DBP (mmHg) | 95.76±6.32 | 82.04±4.56 | <0.01 |

SBP: Systolic blood pressure, DBP: Diastolic blood pressure, TSH: Thyroid stimulating hormone, BMI: Body mass index

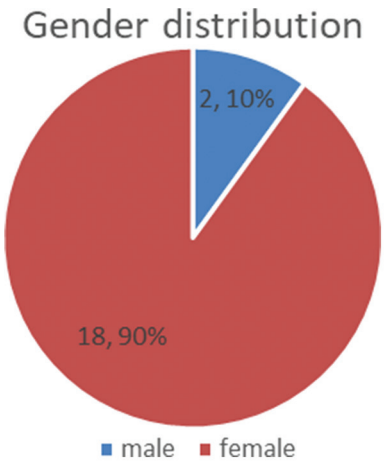


**Figure 1:** Chart shows gender distribution – females and males