Original Article

Efficacy of Standardized Yoga Asanas as Add-on Therapy in the Management of Hypothyroidism: A Randomized, Open-label, Controlled Clinical Study

Abstract

Background: Hypothyroidism is an endocrine disorder in which the thyroid gland does not produce an adequate amount of thyroid hormones. This study aimed to determine the efficacy of yoga asanas as an add-on therapy for the management of hypothyroidism. **Materials and Methods:** For this interventional clinical study, a total of 450 study participants were screened for eligibility. Out of this, 170 study participants were found fit for preliminary eligibility following stringent inclusion and exclusion criteria. Further, 58 participants were excluded before randomization. A total of 112 hypothyroidism patients (57 in the control group and 55 in the yoga group) participated in this study. The study participants were further followed up for 8 weeks in both the yoga practice (yoga+ standard care of treatment) and control group (standard care of treatment only). The markers of oxidative stress, inflammation, and thyroid hormones were assessed at baseline and after 8 weeks of follow-up/intervention. **Results:** After 8 weeks, the study participants in yoga group showed a significant reduction in serum thyroid-stimulating hormone and malondialdehyde levels as compared to baseline ($P < 0.05$). There was also a positive trend of improvement in other oxidative markers (catalase, superoxide dismutase, and glutathione), and a significant reduction in interleukin-6 levels ($P < 0.05$) was found in the yoga group as compared to the baseline. However, there was no significant change found in the control group of subjects. **Conclusion:** Frequent yoga practice can be an effective lifestyle intervention for hypothyroidism, reducing oxidative stress, inflammation, and potentially improving overall well-being.

Keywords: *Add-on therapy, clinical study, hypothyroidism, inflammation, oxidative stress, yoga practice*

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Introduction

Hypothyroidism is a common condition and is more prevalent in women, the elderly, and certain ethnic groups and is associated with a deficiency in the thyroid hormones; thyroxine and triiodothyronine.[1] The prevalence of hypothyroidism in developed countries is around 4%–5%, whereas it is about 11% in India.[2] Furthermore, the prevalence of subclinical hypothyroidism ranges between 4% and 15% worldwide.[3] Iodine deficiency, aging, women, family history of thyroid disease, overweight, consumption of goitrogenic foods, diabetes, dyslipidemia, sedentary lifestyle, chronic constipation, pregnancy, smoking status, ethnicity, and endocrine disruptors are the potential risk factors that contribute to the development of hypothyroidism.[4] The most common symptoms in adults include fatigue, lethargy, cold intolerance, and weight gain, but the clinical presentation can differ with age and sex, among other factors.[5] The wide array of symptoms of hypothyroidism indicates an effect on metabolism and dysfunction in multiple organ systems. Levothyroxine (Levo-T, Synthroid, etc.), a thyroid hormone medication, is often taken daily as the part of hypothyroidism treatment.

Type 2 diabetes mellitus (T2DM) and thyroid dysfunction are prevalent endocrine conditions that are frequently seen in the clinical setting.[6] Both conditions have a multifactorial etiology and have been linked to endothelial dysfunction, dyslipidemia, dermatological conditions, atherosclerosis, and cardiac dysfunction. The prevalence of hypothyroidism in patients with T2DM is 24.8% in India.[7] The thyroid hormone itself alters intermediary metabolism, which changes glucose homeostasis.

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Reduced glucose absorption, prolonged peripheral glucose accumulation, augment gluconeogenesis, reduced hepatic glucose synthesis, and reduced glucose clearance are the characteristics of hypothyroidism thus predisposing to hyperglycemia.[8] The thyroid is affected by diabetic medication use as well.[9] Thyroid disorders are more likely to develop in people with T2DM. Over time, many diabetes people acquire the symptoms of thyroid dysfunction.

Yogis developed a form of mind-body fitness that involves a combination of muscular activity and an internally directed mindful focus on the awareness of the self, the breath, and energy. It serves as a method for balancing and harmonizing the body, mind, and emotions. There is evidence that hypothyroidism, T2DM, and other lifestyle disorders can be managed with the help of yoga.[10] While there are a few validated yoga modules for managing obesity, back pain, and other lifestyle disorders. There are no validated yoga modules for treating/managing hypothyroid conditions. In this study, our aim is on studying the efficacy of standardized yoga asanas as an add-on therapy in patients with hypothyroidism and also determining the beneficial effect of yoga practice on reducing inflammation and oxidative stress.

Materials and Methods

Research design

A randomized, open-label, two-arm, parallel-group clinical study was conducted to assess the efficacy of standardized yoga asanas as an add-on therapy in hypothyroidism patients. The study is ethically approved by the institutional Ethics Committee of Hamdard Institute of Medical Sciences and Research, New Delhi (HIMSR/IEC/0014/2022), and conducted as per the guidelines of the Declaration of Helsinki and Tokyo for humans. The study is also registered in Clinical Trial Registry of India (CTRI No: CTRI/2022/11/047128 dated November 9, 2022).

Considering a power of 80% and an α level of 0.05, a total of 83 subjects were required to generate the statistically significant data. For this prospective clinical study, a total of 450 study participants were screened for eligibility between November 11, 2022 and December, 2022, in the outpatient department of Medicine, HAH Centenary Hospital, New Delhi, India. Adult patients aged 18 years and above with overt hypothyroidism associated with or without other comorbidities such as T2DM are the inclusion criteria for the present study. Out of this, 170 study participants were found fit for preliminary eligibility. Further, 58 participants were excluded before randomization following stringent inclusion and exclusion criteria [detail given in Figure 1]. The subjects with the following conditions were excluded from the study: (a) Those patients who refused to participate in the study, (b) women who were pregnant and lactating, (c) Patients with any type of tumor or malignancy or any history of malignancy, or any recent surgery within the last 2 months, (d) Without access to technology (smart phone and internet connection), and (e) Patients with pain in neck/body movement.

Randomization

Participants found eligible as per the inclusion/exclusion criteria were randomized either to the yoga group (n = 55) or the control group (57) according to a computer-generated randomization schedule (1:1, block randomization). Stratified sampling was also used for randomization and the factors considered were as follows: (a) Sex: -Male and female, (b) Age: -18–40 years and >40 years, (c) thyroid-stimulating hormone (TSH) level: Mild (TSH 5–10), moderate (TSH 10.1–20), and severe (>20.1).

Blinding

After randomization, the samples were collected for the baseline analysis. As it was a yoga-based practice where both participants and practice providers cannot be "blinded" to group allocation, the outcome assessor was an independent person not related to the trial. To avoid contamination, participants recruited from the same household, close relatives, or friends were co-randomized to the same group.

Intervention

Finally, 83 study participants (yoga group [n = 36] and control group [n = 47]) were completed 8 weeks of yoga practice/follow-up. Yoga asanas were practiced daily (at least 5 days a week) by yoga practice group during an online yoga session led by a certified yoga teacher, in parallel with receiving standard medical treatment. The subjects of the control group were under standard care of treatment only as prescribed by the treating physician. Quality assessment of yoga has vital importance to justify adequacy in the modern system of medicine. Yoga protocol was developed with the assistance of Morarji Desai National Institute of Yoga, New Delhi and a certified instructor guided the patients in the successful execution of the yoga protocol. Further, hypothyroidism participants in both groups were also categorized into hypothyroidism with T2DM and analyzed the effect of yoga practice in the subgroup analysis.

Outcome measures

The primary outcome of this study was to evaluate the efficacy of yoga practices as an add-on therapy for patients with hypothyroidism. Specifically, we aimed to assess the impact of yoga as add on therapy on thyroid hormone levels in this patient population. Further, fT3, fT4, TSH, and body mass index (BMI) were the primary endpoints of the study. The secondary outcomes focused on determining the effect of yoga practice on reducing inflammation and oxidative stress. We measured oxidative markers (catalase, superoxide dismutase [SOD], glutathione [GSH], and MDA) and the inflammatory marker (interleukin-6 [IL-6]) in the study subjects. The study parameters were assessed in both the control and yoga groups at baseline and after 8 weeks of yoga practice/follow-up.

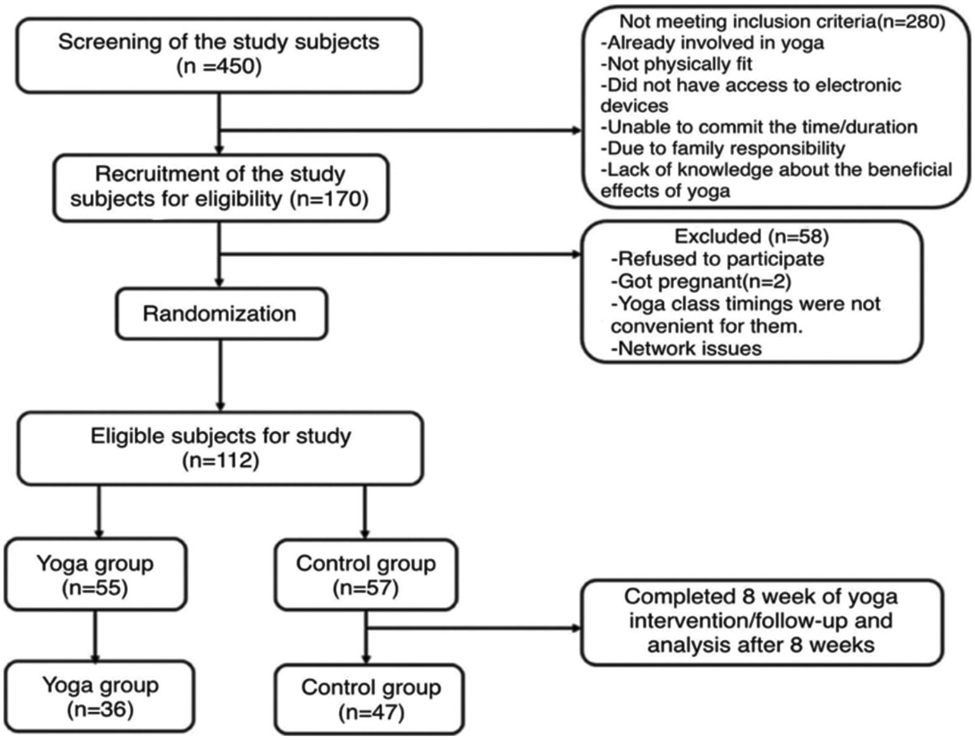

Figure 1: Consort diagram of the study group (control group-hypothyroidism patients without yoga practice/study group-hypothyroidism patients with yoga practice)

Study assessment

Serum TSH, free triiodothyronine (fT3), and free thyroxine (FT4) levels were measured in Architect$_{1000}$ CMIA analyze by the kits supplied by M/S Abbott, USA. Plasma glucose and oxidative markers, i.e., reduced GSH, malondialdehyde (MDA), SOD, and catalase were measured by the standard spectrophotometric method.[11] The inflammatory marker; IL-6 was assessed by the sandwich ELISA using kits of M/S Abbkine scientific, USA. The HbA1c test was analyzed in D-10 HPLC based HbA1c analyzer by using the kits of M/S Bio-Rad, India. Adherence to the study protocol was determined by the class attendance rates. Yoga is known to be safe, but data were recorded from study participants on any serious adverse events occurring in participants during the yoga practice period.

Statistical analysis

All the analyses were performed in duplicate, and data have been expressed as mean ± standard error of the mean (SEM) or indicated otherwise. Descriptive statistics were applied in presenting the demographic data. The comparison of the study groups was investigated using unpaired *t*-test. The assessment of primary and secondary end points between baseline and after 8 weeks of yoga practice/follow-up was investigated using the paired *t*-test. If the $P < 0.05$, it was considered the statistical significant difference.

Results

In the present study, we have assessed the efficacy of yoga practice in hypothyroidism patients. The study subjects of yoga group performed yoga asanas [Table 1], daily (minimum 5 days a week) along with standard care of treatment. The participants of the control group were under the standard care of treatment only. The average age (mean ± SEM) of study participants in the yoga and control group was 44.22 ± 3.37 and 46.58 ± 3.81 years, respectively. Further, the BMI of the yoga group was 26.34 ± 1.25 kg/m^3 and of the control group was 28.12 ± 4.25 kg/m^2. The values in the control and yoga group are comparable and the difference is not statistically significant ($P > 0.05$) [Table 2].

The parameters of the thyroid profile (fT3, fT4, and TSH) were analyzed before and after the 8 weeks of yoga practice/follow-up and observed a significant reduction in the TSH level after the 8 weeks of yoga practice in the yoga group when compared to the baseline (9.02 ± 1.03–5.80 ± 0.75 µIU/ml; $P = 0.016$). However, TSH in the control group was not significantly changed when compared to the baseline (8.63 ± 0.84–9.20 ± 0.80 µIU/ml; $P = 0.622$). Further, fT3 and fT4 level were not significantly decreased after 8 weeks of yoga practice in the yoga group as compared to baseline ($P > 0.05$). A similar observation was found in the control group also. Further BMI in the yoga group was decreased after 8 weeks of yoga practice; however, the difference was not statistically significant (26.50 ± 1.30–25.03 ± 1.23 kg/m^2; $P = 0.81$) [Figure 2]. Further, we have also not found any change in BMI after 8 weeks of follow-up in the control group ($P > 0.05$). The oxidative markers (catalase, SOD, GSH, and MDA) and anti-inflammatory markers (IL-6)

Table 1: Standardized yogic practices for the management of hypothyroidism as an add-on therapy

Name of the practice	Duration (min)
Yoga prayer	1
Sukshma Vyayama (5 rounds each)	5
Vaksha-sthala Shakti Vikasaka 1and 2	
Udara Shakti Vikasaka 6 and 7	
Kati Shakti Vikasaka 1–5	
Buddhi tatha dhriti shakti vikasaka	
Yoga asanas	24
Tadasana	
Trikonasana	
Ardhacakraasana	
Marjari asana	
Bhadrasana	
Janusirsasana	
Paschimottanasana	
Sasakasana	
Bhujangasana	
Dhanurasana	
Makrasana	
Ardhahalasana	
Pawanamuktasana	
Sethubandhasana	
Viparitakarani asana initially then shift to Sarvangasana	
Halasana	
Saral Matsyasana	
Shav asana	
Pranayama	10
Nadi Shodana (5 rounds)	
Surya Veda (5 rounds)	
Ujjayi (5 rounds)	
Bhramari (5 rounds)	
Dhyana (meditation)	5
Om meditation/mindfulness meditation	
Total duration	45

were analyzed in the baseline and after 8 weeks of follow-up in both yoga and control groups. The lipid peroxidation product and MDA levels were significantly decreased in the yoga group after 8 weeks of yoga practice as compared to baseline (11.07 ± 0.75–7.89 ± 0.80 μmol; P = 0.011). Further a beneficial effect of yoga practice was observed in the other oxidative markers (SOD, catalase, and GSH), however, the difference was not statistically significant (SOD 80.28 ± 6.73–83.04 ± 5.57 U/ml, P = 0.74; catalase 18.38 ± 1.29–20.67 ± 1.52 KU, P = 0.19; and GSH 26.93 ± 4.16–30.22 ± 3.88 μmol, P = 0.52). We have not found any change of oxidative makers in control group after 8 weeks of follow-up. The study of oxidative markers in the study group showed that yoga practice reduces oxidative stress in hypothyroid patients. IL-6, a pleiotropic pro-inflammatory cytokine that is mainly secreted by monocytes was analyzed, which significantly decreased in the yoga group after the 8 weeks of yoga practice as compared to the baseline (8.07 ± 0.80–5.31 ± 0.81 pg/ml, P = 0.017) [Figure 3]. Hypothyroidism is well known as an inflammatory disorder; hence, the anti-inflammatory effects of yoga practice in the yoga group substantiated the beneficial claim of yoga practice in hypothyroid patients.

The study subjects were further categorized (mild [TSH 5–10 μIU/ml], moderate [TSH 10.1–20 μIU/ml], and severe [TSH >20.1 μIU/ml]) as per the levels of thyroid stimulating hormone (TSH) and assess the efficacy of yoga practices as an add-on therapy [Table 3]. The results suggest that yoga therapy is effective in reducing TSH levels in patients with mild (5.98 ± 0.44–4.27 ± 0.36 μIU/ml; P = 0.03) and moderate (13.37 ± 0.82–8.56 ± 1.44 μIU/ml; P = 0.01) thyroid dysfunctions but does not significantly affect fT3 and fT4 levels (P > 0.05). In the severe group, a decreasing levels of TSH (28.17 ± 1.94–22.81 ± 2.44 μIU/ml; P = 0.11) were observed as compared to the baseline; however, the difference is not statistically significant (P > 0.05). Further, the study subjects in the control group did not show any significant improvement in thyroid hormones in each category of thyroid dysfunction (mild, moderate, and severe) after 8 weeks of follow-up (P > 0.05). Further, yoga practices showed significant effects in reducing inflammation (IL-6) in individuals with mild, moderate, and severe levels of TSH (P < 0.05). However, no change in IL-6 was observed in the control group after 8 weeks of follow-up (P > 0.05). Besides, yoga practices revealed an improved levels of oxidative stress markers (SOD, catalase, GSH, and MDA) across all TSH categories as compared to the control group, with significant improvements for catalase level in the moderate group (P < 0.05).

T2DM and hypothyroidism are commonly associated with each other, and further, we have also analyzed the effect of yoga practice on hypothyroidism associated with T2DM. In the present study, 16 and 25 study participants were diagnosed as T2DM associated with hypothyroidism in yoga and the control groups, respectively. In this subgroup analysis, TSH levels were significantly decreased after 8 weeks of yoga practice in the yoga group as compared to baseline (10.31 ± 2.03–5.01 ± 1.16 μIU/ml; P = 0.041). On the other hand, there was no statistically significant difference in the control group found after 8 weeks of follow-up (7.31 ± 1.81–7.04 ± 1.65 μIU/ml; P = 0.92). Further, we have not found any significant change in HbA1c and glucose in both groups (P > 0.05) after 8 weeks of follow-up/practice. Oxidative markers (catalase, SOD, GSH, and MDA) were further analyzed. The beneficial trend on these markers was observed in the subjects in the yoga group as compared to the baseline (Catalase-15.93 ± 3.65–20.50 ± 5.23 KU; P = 0.46; SOD 75.91 ± 2.56–78.73 ± 3.43 U/ml; P = 0.50; GSH 28.51 ± 7.31–32.84 ± 7.21 μmol; P = 0.69; MDA 12.00 ± 1.19–9.86 ± 1.18 μmol; P = 0.41). However, the difference is not statistically significant (P > 0.05). A similar observation in inflammatory marker IL-6 was observed

Table 2: Demographic characteristics of the study participants

Characteristics and biochemical parameters	Control group (*n*=47)	Yoga group (*n*=36)	*P*
Sex (male/female) (*n*)	4/68	2/50	0.90
Age (years)	46.58±3.81	44.22±3.37	0.62
BMI (kg/m^2)	28.12±4.25	26.34±1.25	0.60
Plasma glucose (mg/dL)	126.07±6.17	130.46±5.11	0.60
HbA1c (%)	6.52±0.72	6.80±0.48	0.76
fT3 (ng/mL)	2.78±0.09	2.84±0.08	0.87
fT4 (ng/mL)	0.91±0.07	0.93±0.06	0.83
TSH (µIU/mL)	8.63±0.84	9.02±1.03	0.76
Levothyroxine (µg)	36.4±6.0	34.1±6.4	0.79
Smoker/nonsmoker (*n*)	1/71	0/52	0.63
Alcoholic/nonalcoholic (*n*)	0/72	1/51	0.89
With diabetes/without diabetes (*n*)	25/47	16/36	0.47
Employment (job holders or self-employed/housewives) (*n*)	14/58	16/36	0.26

Data were expressed as mean±SEM and (*n*). Un-paired *t*-test and Chi-square test were performed between baseline and after 8 weeks of yoga practice in both the control and yoga group to obtain the *P* value. *P*>0.05 (not significant) *P*<0.05 (significant). fT4: Free triiodothyronine, fT3: Free triiodothyronine, TSH: Thyroid stimulating hormone, BMI: Body mass index, HbA1C: Glycosylated hemoglobin, SEM: Standard error of the mean

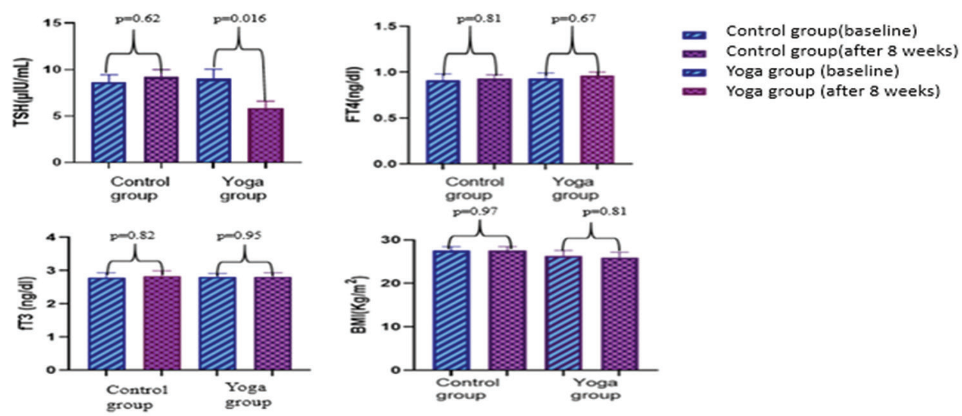

Figure 2: Comparison of serum thyroid-stimulating hormone, serum free thyroxine, serum free triiodothyronine and body mass index in yoga and control group at baseline and after 8 weeks of yoga practice in patients of hypothyroidism. Paired *t*-test and Chi-square test were performed between baseline and after 8 weeks of Yoga practice in both the control and yoga group to obtain the *P* value. *P* >0.05 (not significant) *P* < 0.05 (significant). TSH = Thyroid stimulating hormone, fT4 = Free thyroxine, fT3 = Free triiodothyronine, BMI = Body mass index

(11.27 ± 1.74–8.06 ± 2.02 pg/ml *P* = 0.56). This may be due to the limited sample size in the subgroup analysis. Further, no serious event or complication was reported in either the yoga group or the control group during 8 weeks of the study.

Discussion

One of the most prevalent endocrine conditions that affect individuals is hypothyroidism. Taking medication for hypothyroidism is a regular affair, and it may last for the rest of a person's life.[12] Yogasanas or yoga poses may offer numerous benefits for individuals with thyroid disease. The risk of hypothyroidism is higher in women and older individuals (>65 years). Patients with different disease conditions, such as T2DM, autoimmune gastric atrophy, and coeliac disease, are more likely to experience hypothyroidism.[5] Yoga is an ancient Indian mind-body practice aimed to restore equilibrium and improve the psycho-physiological constitution that affects the body's natural endocrine homeostasis. The practice of specific asanas, such as Sarvangasana (Shoulder Stand) and Halasana (Plow Pose), stimulates the thyroid gland and enhances its functioning.[13] These poses promote blood flow to the thyroid, aiding in the release of hormones and improving overall thyroid health. In addition, certain inverted poses, like Sirsasana (Headstand) and Viparita Karani (Legs-up-the-Wall Pose), help regulate metabolism and balance hormone levels, which can be particularly beneficial for individuals with thyroid imbalances.[13] Furthermore, practicing yoga can reduce stress and promote relaxation, which is crucial since stress has been linked to thyroid dysfunction. Overall, incorporating yogasanas into a holistic approach for managing thyroid disease can contribute to improved thyroid function, hormonal balance, and overall well-being. In addition to the benefits mentioned earlier, practicing yogasanas can have a positive

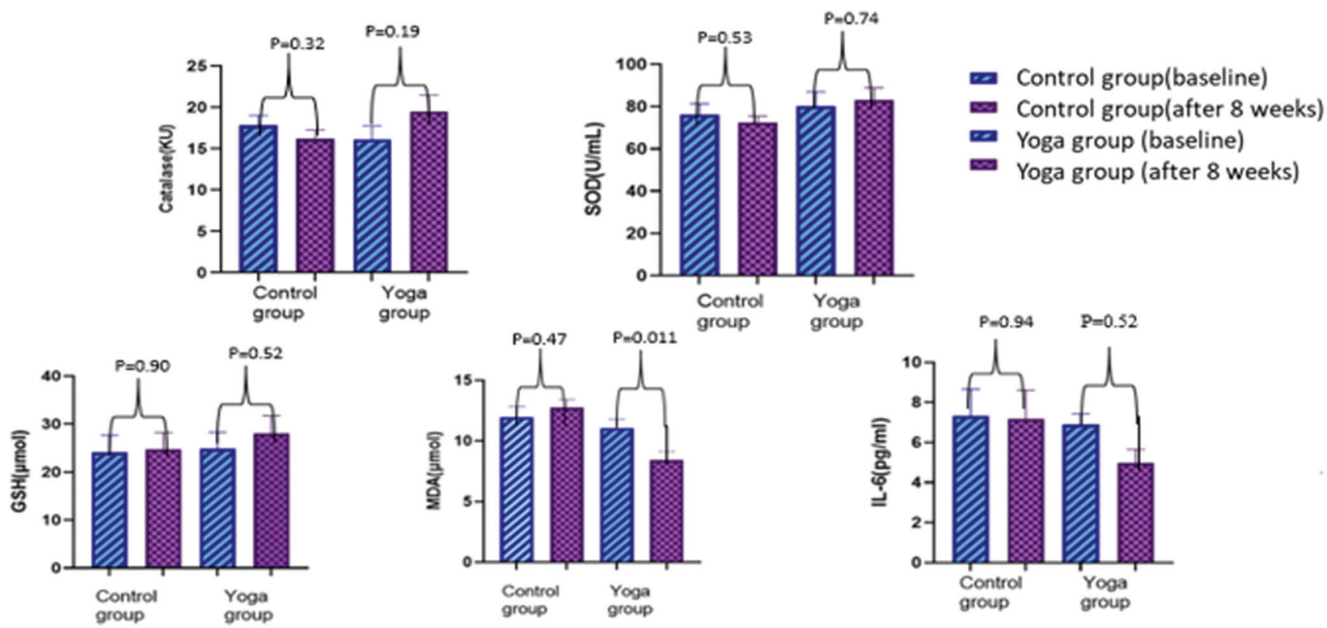

Figure 3: Comparison of Serum Catalase; superoxide dismutase; glutathione; malondialdehyde and interleukin-6 level in yoga and control group at baseline and after 8 weeks of practice/follow-up in patients of hypothyroidism. Paired *t*-test was performed between baseline and after 8 weeks of Yoga practice in both the control and yoga group to obtain the *P* value. *P* >0.05 (not significant) *P* < 0.05 (significant). SOD = Superoxide dismutase, GSH = Glutathione, MDA = Malondialdehyde, IL-6 = Interleukin-6

impact on the symptoms associated with thyroid disease.[13] Many individuals with thyroid disorders experience fatigue, muscle weakness, and weight fluctuations. Regular practice of yoga poses such as Bhujangasana (Cobra Pose) and Setu Bandhasana (Bridge Pose) can strengthen the muscles, increase energy levels, and promote healthy weight management.[13] Yoga provides a special blend of mild-to-moderate physical exercises such as Surya namaskar and asana, kriya, respiration control (pranayama), and the practice of Dhyana.[14] Yoga poses such as marjaryasana, bitilasna, Makarasana, saruangasana, Halasana, and pranayama such as Bhramari pranayama have great response in hypothyroidism conditions.[12] This is impacted by improved physical flexibility as well as heightened consciousness of breathing and posture. Yoga emphasizes the awareness of the effects of changing emotional states on the body through an ongoing concentration on body posture and breathing.[15] Stress is known to disrupt hormone balance and contribute to thyroid dysfunction. By incorporating asanas such as Shavasana (Corpse Pose) and Balasana (Child's Pose), individuals can activate the relaxation response, lower cortisol levels, and promote a sense of calmness, thereby supporting overall thyroid function. The yoga experts of the study team have designed the different asanas, pranayama, and practice of Dhyana and assessed their efficacy in the present study for the beneficial effect in hypothyroidism patients with or without T2DM as add-on therapy.

Moreover, the practice of yoga promotes relaxation and reduces stress levels, which can have a profound impact on thyroid health, TSH, fT3, FT4, oxidative markers- GSH, MDA, SOD, and catalase, and inflammatory marker IL-6 were assessed in both the control and yoga groups at baseline and after 8 weeks of the practice/follow-up. The outcome of this study shows a significant reduction in the TSH levels in the yoga group after 8 weeks of yoga practice when compared to the baseline (P = 0.016). On the other hand, the control group does not show any significant change in the TSH level before and after 8 weeks of the standard allopathic care of treatment. In a study, 22 household women with an age group of 30–50 years, with 4–5 years of history of hypothyroidism were included the yoga practices, which showed a significant reduction in serum TSH levels, lipid profile, and BMI in hypothyroidism patients.[16] Our study is different from the reported study in that we have designed the yoga protocol in a manner that balances endocrine as well as target oxidative stress and inflammatory conditions in the participants. Rani *et al*. 2021 conducted a study in which they studied the effect of yoga on depression in hypothyroidism and they also observed a significant reduction in serum TSH levels and found beneficial effect in depression.[17] We also observed a reduction in BMI followed by 8 weeks of standardized yoga practice; however, the difference is not statistically significant. In our study participants also experienced improvement in their quality of life, and felt energetic and positive. Oxidative stress and inflammation are associated with hypothyroidism.[18] In our study, we analyzed serum MDA levels and observed a statistically significant reduction (P = 0.011) in the yoga group after 8 weeks of yoga sessions when compared to the baseline, which is supported by a study conducted on the effect of yoga on oxidative stress in hypertensive subjects, their finding revealed the

Table 3: Beneficial effect of yoga practices as an add-on therapy at different levels of thyroid stimulating hormones (mild, moderate, and severe category)

	Control group			Yoga group		
	Baseline	**After 8 weeks**	***P***	**Baseline**	**After 8 weeks**	***P***
Mild group (TSH 5–10 (µIU/mL)						
Control group (*n*=26), Yoga group (*n*=21)						
fT3 (ng/mL)	2.80±0.09	2.47±0.06	0.52	2.90±0.11	3.01±0.29	0.93
fT4 (ng/mL)	0.89±0.07	1.04±0.09	0.169	1.01±0.09	1.08±0.06	0.24
TSH (µIU/mL)	5.39±0.5	5.80±0.51	0.54	5.98±0.44	4.27±0.36	0.03
GSH (µmol)	26.00±3.81	24.85±3.61	0.82	25.58±3.67	29.30±4.33	0.51
Catalase (KU)	14.85±1.88	15.27±1.71	0.86	19.44±2.16	23.05±2.57	0.28
SOD (U/mL)	65.26±9.15	64.06±8.34	0.92	90.45±11.03	91.37±9.53	0.95
MDA (µmol)	10.47±1.43	11.21±1.19	0.69	11.75±1.05	10.06±1.04	0.25
IL-6 (pg/mL)	6.34±1.54	5.15±1.60	0.59	7.59±0.70	4.82±0.64	0.005
Moderate group (TSH 10.1–20 (µIU/mL)						
Control group (*n*=15), Yoga group (*n*=9)						
fT3 (ng/mL)	3.66±0.12	3.41±0.11	0.13	2.76±0.94	2.64±0.9	0.93
fT4 (ng/mL)	0.72±0.07	0.83±0.08	0.30	0.69±0.09	0.83±0.07	0.22
TSH (µIU/mL)	14.13±0.72	15.02±0.60	0.35	13.37±0.82	8.56±1.44	0.01
GSH (µmol)	19.35±4.94	19.07±4.78	0.96	36.59±7.34	38.34±7.99	0.87
Catalase (KU)	13.31±3.96	12.55±3.57	0.88	18.57±1.62	23.80±1.74	0.04
SOD (U/mL)	58.27±15.47	57.25±16.03	0.96	67.83±8.03	71.79±4.65	0.67
MDA (µmol)	9.36±2.57	9.86±2.80	0.89	12.47±1.75	10.04±1.70	0.33
IL-6 (pg/mL)	5.75±1.41	5.19±1.31	0.74	9.76±2.89	7.12±2.02	0.05
Severe group (TSH >20.1 (µIU/mL)						
Control group (*n*=6), Yoga group (*n*=6)						
fT3(ng/mL)	3.25±0.08	3.15±0.09	0.13	2.11±0.10	2.01±0.11	0.5
fT4 (ng/mL)	0.89±0.06	1.04±0.09	0.19	0.95±0.07	1.01±0.09	0.61
TSH (µIU/mL)	29.81±2.79	27.21±2.26	0.50	28.17±1.94	22.81±2.44	0.11
GSH (µmol)	28.60±4.17	29.16±4.38	0.92	36.03±5.60	40.37±4.78	0.56
Catalase (KU)	18.85±0.78	17.10±1.50	0.32	15.64±1.29	16.55±3.08	0.79
SOD (U/mL)	71.95±5.06	70.19±5.05	0.81	74.81±5.45	78.76±5.78	0.62
MDA (µmol)	14.88±1.18	15.39±0.91	0.73	8.66±2.52	6.15±2.13	0.46
IL-6 (pg/mL)	7.23±0.70	8.05±0.74	0.43	13.10±3.09	10.23±1.85	0.05

The data is represented as mean±SD. Paired *t*-test was performed between baseline and after 8 weeks of Yoga practice in both the control and yoga group to obtain the *P* value. $P>0.05$ (not significant) $P<0.05$ (significant). TSH: Thyroid stimulating hormone, fT4: Free thyroxine, fT3: Free triiodothyronine, GSH: Reduced glutathione, SOD: Superoxide dismutase, MDA: Malondialdehyde, IL-6: Interleukin-6, SD: Standard deviation

positive effect of yoga on serum MDA levels.[19] One more study showed a significant reduction in serum MDA levels followed by yoga practice.[20] There is broad acceptance that increased oxygen consumption during exertion causes excess production of ROS. However, it had been found that yoga-based relaxation techniques and meditation were linked to lower oxygen intake.[21] Thus, it can be hypothesized that the current study's yoga participants decreased serum MDA levels were likely caused by balanced oxygen consumption during their yoga practice. On the other hand, no beneficial effect was observed in the control group of study subjects after 8 weeks of follow-up. Further, in our study, the levels of antioxidants such as GSH, SOD, and catalase revealed an increase in the yoga group following the yoga practice when compared to baseline. Some studies also show a significant elevation in the antioxidant after the yoga practice.[22] Yoga can promote the upregulation of endogenous antioxidants such as SOD, catalase, and GSH and slow down their rate of utilization as oxidative stress is reduced.[23]

In addition, the efficacy of yoga practice on inflammation in hypothyroidism patients demonstrated a significant decrease in serum IL-6 levels in the yoga group after 8 weeks of yoga practice as compared to the baseline ($P = 0.029$). On the other hand, there is no effect on the control group after 8 weeks of follow-up. One of the study has provided evidence in support of the beneficial effect of yoga on the pro-inflammatory process.[24] Further the efficacy of yoga practice on hypothyroidism associated with T2DM showed the significant reduction of TSH in yoga group as compared to baseline. However, no statistically significant effect was observed in other markers in subgroup analysis. Sample size, the time period of yoga practice, and online session of yoga classes are the limitation of the present study.

Conclusion

The present study revealed that yoga has a beneficial effect on hypothyroidism patients as an add-on therapy. The study involved an 8-week yoga practice, which resulted in significant improvements in thyroid hormone levels and exhibited anti-oxidative and anti-inflammatory effects in hypothyroidism patients. These findings suggest that yoga can serve as an effective lifestyle practice for reducing inflammation, oxidative stress, and enhancing antioxidant defense, ultimately leading to favorable outcomes in thyroid hormone regulation. Consequently, regular yoga practice may be advantageous in reducing stress levels and promoting a disease-free lifestyle. In conclusion, the evidence strongly supports the notion that yoga practices have a broad range of beneficial effects on physical, mental, and emotional well-being.

Author contribution

Tanu Sharma, Bhavy Goyal: Investigation, Methodology, Data curation, Writing-Original draft, Writing-Reviewing and Editing. Khan Afreen Mustaq Ahmed, Vineet Jain, Dharmander Singh, and Sunil Kohli: Conceptualization, Supervision, Patient enrollment, Validation, Formal analysis, Resources, Writing-Reviewing and Editing. Guru Deo, Ishita Kaushik, Rohit Malik: Conceptualization, Methodology, intervention, Supervision, Visualization, Validation, Writing-Reviewing and Editing. Kailash Chandra: Conceptualization, Project administration, Supervision, Validation, Resources, Formal analysis, Writing-Reviewing and Editing. All the authors approved the final version of the manuscript for submission.

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Conflicts of interest

There are no conflicts of interest.

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