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Therapeutic Effects of Yoga in Managing Anthropometric Measures, Signs and Symptoms in Hypothyroid Patients

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ABSTRACT

Objective: The aim of the study was to see the effect of yoga therapy on symptoms and anthropometric parameters in patients suffering from hypothyroidism.

Design: This is a randomized controlled trial.

Subjects*:* Out of 100 patients, 83 completed the trial [41 in control (6 Male 35 Female) and 42 in yoga group (4 Male 38 Female)].

Intervention: Yoga session was for 45 minutes and was given thrice a week for first 2 months and twice in a week for next 4 months. Thyroxine medication was given to both the groups as per individual need.

Outcome measures: Effect of yoga therapy was studied on ten Symptoms by measuring Fatigue, Sleepiness, Cold intolerance, Dry skin, Decreased appetite, Constipation, Bradycardia, Hyporeflexia, Myxedema and Menstrual disturbances. The signs and symptoms were assessed in a scale of 0-3 (0=Normal; 1=mild; 2=moderate; 3=severe). Anthropometric parameters studied were weight, BMI, waist circumference, waist-hip ratio and fat%.

Results: Hypothyroid patients in both Control and the yoga groups showed a significant reduction in levels of TSH (P= 0.000 for both groups), fT4(P=0.001 and 0.004 for control and the yoga group respectively). However in the yoga group the TSH levels reached the normal physiological range (3.97±3.18) but in the control group it was still in overt hypothyroid range (7.74±8.08). In yoga group a significant reduction in weight ($p \leq 0.001$), BMI ($p \leq 0.001$), waist circumference ($p \leq 0.001$) was observed after 3 and 6 months. Level of significance for decrease in fat% in yoga group was p=0.003 after 3 months and $p \leq 0.001$ after 6 months. Severity of all symptoms other than Bradycardia and Hyporeflexia were found to be decreased by yoga treatment. More percentage of patients in the yoga group were found to be having less severe symptoms as compared to the baseline levels.

Conclusions The results suggest that yoga can be a successful complementary treatment for the management of anthropometric indicators and in controlling signs and symptoms associated with hypothyroidism.

KEYWORDS: *Anthropometric parameters; Hypothyroidism; TSH; Yoga.*

INTRODUCTION

Primary hypothyroidism is invariably accompanied by increased secretion of Thyrotropin releasing hormone (TrH) from the hypothalamus which stimulates the release of thyroid stimulating hormone (TSH) from the anterior lobe of the pituitary gland. In areas where iodine intake is adequate, the most common causes are chronic autoimmune thyroiditis[1]. Symptoms of hypothyroidism can include fatigue, weight gain, hair thinning, dry skin and depression [2, 3] but none of them is a very sensitive or a specific indicator to diagnose hypothyroidism[4]. Therefore, from the clinical perspective hypothyroidism is a syndrome manifested by signs and symptoms. These are influenced by the age of the patient, the rate at which the hypothyroidism develops, and the presence of other disorders[5]. Hypothyroidism and obesity frequently co-exist. Hypothyroidism leads to increased body weight and extreme obesity can result in increased TSH levels[6].

The conventional medical treatment by thyroid hormone supplementation is somewhat effective in bringing up thyroid hormone levels but there can be a fluctuation of symptoms while trying to find the correct dosage. Some people may never find the correct dosage thus resulting in frustration. So there is a great need for patients to do additional activities so as to control the overall impact of hypothyroidism on their lives. Evidence suggests that yoga when combined with a program of good medical care may provide additional health benefits for controlling hypothyroidism. Yoga has been found to have a role in revitalizing thyroid function as well as improving psycho-neuro-endocrine function on the whole[7,8]. This study was undertaken to see therapeutic effect of yoga in alleviating the signs and symptoms of hypothyroidism and in controlling anthropometric measurements.

MATERIAL AND METHODS

The study was a randomized control trial carried out at the Bapu Nature Cure Hospital and Yogashram, Mayur Vihar Phase 1, Delhi. Duration of the study was two years (March 2017-March 2019) and the study was conducted after due approval from the Ethical Committee of Bapu Nature Cure Hospital and Yogashram. Biochemical investigations were carried out at GIPMER, New Delhi.

Subjects and Study design

100 hypothyroidism patients, in the age group 21-65 years, having TSH level >10 mIU/L and satisfying the eligibility criteria as per American Association of Clinical Endocrinologists (AACE), were randomly divided into two Groups of 50 each i.e. Group I (control group) and Group II (yoga group). Out of 100 patients, 83 completed the trial [41 in control (6 Male 35 Female) and 42 in yoga group (4 Male 38 Female)]. Written consents were obtained and patients were educated about the disease associated risk factors and benefits of yoga. At the time of registration, complete clinical history of each patient was recorded. Patients were provided with a daily diary to record the compliance.

Yoga training protocol- The intervention group received yoga therapy along with Thyroxine. Control group was given only Thyroxine therapy. Parameters were recorded for both the groups at baseline, after 3 months and 6 months.

Participants attended 45 minutes of yoga training sessions (Table 1) between 6 AM to 9AM. The frequency of sessions were thrice a week for the first 2 months and twice in a week for next 4 months. On days without session, patients were advised to do yoga at home for 20-25 minutes. The daily adherence was evaluated by analyzing patient diary at the end of every month. In case of any joint inflammation, the movements and postures were modified or omitted. Doses of Thyroxine were modified according to the activity of disease.

Estimations

Thyroid profile: Thyroid function tests were performed using Roche CLIA-cobas-e411 analyzer. ***Signs and Symptoms***:

a) Symptoms: Fatigue Sleepiness, Cold intolerance, Dry skin, Decreased appetite, Constipation, Menstrual disturbances.

b) Signs**:** Bradycardia, Myxedema, Hyporeflexia. The signs and symptoms were assessed on a scale of 0-3 (0= Normal; 1 = mild; 2 = moderate; 3 = Severe)

Anthropometric measurements:

Body weight, BMI, Fat percentage**:** Fat percentage was determined by the bio-electrical impedance analysis method using Omron HBF-375 Karada Scan Digital Body Composition Monitor. The standard method of recording fat percentage was followed. The patients were made to stand barefoot on the main unit. All relevant parameters, i.e. age, sex, height were entered in the display unit. Subsequently, the patient were asked to hold the display unit and extend arms at 90° angle to their body. The patients held this position for approximately one minute while the machine recorded measurements. Assessments were recorded on empty stomach in the morning. The Body composition monitor recorded body weight, fat percentage and BMI of the patient.

Waist and hip circumference (inches)**:** Patients were lightly clothed and stood upright with feet 25 to 30 cm apart. The measuring tape was fitted around the abdominal girth without compressing the soft tissue. The waist circumference was measured to the nearest 0.1 inches in a horizontal plane midway between the inferior costal margin and the iliac crest. Similarly, hip circumference was measured around the pelvis at the point of maximal protrusion of the buttocks[9].

Waist - hip ratio: The ratio of the waist circumference to the hip circumference was derived.

BP measurements were also recorded.

Statistical Analysis

Data were expressed as mean ± standard deviation and analyzed by paired *t*-test (Student's *t*-test). $P \leq 0.05$ was considered statistically significant. Data were analyzed using SPSS 16.0 software.

RESULTS

Baseline, 3 and 6 months symptom score of participants of Control (group I) (Table 2) and Yoga (group II) (Table 3) were recorded. At baseline 4.9% of patients in the control group and 4.8% patients in the yoga group were normal. After 6 months, patients without fatigue in the control group were 22% and in the yoga group were 69%. Severity of fatigue was reduced from 39% to 7.3% in the control group and 28.6% to 0% in the yoga group .

At baseline 34.1% of patients in the control group and 47.6% patients in the yoga group had normal sleep pattern. After 6 months patients with normal sleep in the control group were 63.4% and in the yoga group were 81%. Severity of was reduced from 9.8% to 2.4% in the control group and 14.3% to 0% in the yoga group.

At baseline 34.1% of patients in the control group and 40.5% patients in the yoga group had a normal tolerance to cold. After 6 months, patients with normal cold tolerance in the control group were 68.3% and in the yoga group were 90.5%. Severity of cold intolerance was reduced from 4.9% to 0% in the control group and 2.4% to 0% in the yoga group.

At baseline 26.8% of patients in the control group and 33.3% patients in the yoga group had normal skin. After 6 months, patients with normal skin in the control group were 41.5% and in the yoga group were 81%. Severity of dry skin was reduced from 4.9% to 2.4% in the control group and 7.1% to 0% in the yoga group .

At baseline 51.2% of patients in the control group and 71.4% patients in the yoga group had normal appetite. After 6 months, patients with normal appetite in the control group were 68.3% and in the yoga group were 90.5%.

At baseline 48.8% of patients in the control group and 38.1% patients in the yoga group had no constipation. After 6 months, patients without constipation in the control group were 63.4% and in the yoga group were 90.5%.

At baseline 37.1% of patients in the control group and 28.9% patients in the yoga group had no menstrual disturbance. After 6 months, patients without menstrual disturbances in the control group were 40% and in the yoga group were 47.3%. Severity of menstrual disturbance was reduced from 11.4% to 2.85% in the control group and 2.6% to 0% in the yoga group .

At baseline 75.6% of patients in the control group and 66.7% patients in the yoga group had no Myxedema. After 6 months, in control group there was no change however in the yoga group patients without Myxedema were 88.1%. At baseline and after six months Bradycardia and Hyporeflexia were found to be normal in all the patients in both the groups.

Baseline anthropometric parameters recorded during the study included Weight, BMI, Waist, Waist hip ratio and body fat percentage. The subjects were found to be matched for anthropometric parameters and there was no statistical significant difference at the beginning of the study (Table 4).

Comparison of changes in anthropometric variables after 3 and 6 months in Control and the yoga group is presented in Table 5**.** In the control group there was no change in any of the parameters. In the yoga group a significant reduction ($p \leq 0.000$) was observed in Weight, BMI, Waist circumference and Fat% as compared to baseline values, however, Waist hip ratio remained unchanged.

In the yoga group , the pair wise mean effect between the test intervals, using Bonferroni comparison, (Table 6) showed that the decrease in weight, BMI, waist circumference was significant p≤0.001from 0 to 3rd month, 0 to 6th month and 3rd to 6th month. For decreased Fat% the level of significance was p=0.003 for 0 to 3rd month, p=0.000 for 0 to 6th month and p= 0.002 for 3rd to 6th month.

Baseline characteristics of Thyroid function tests were recorded (Table 7) and the subjects were found to be matched for Thyroid function tests and there was no statistical significant difference at the beginning of the study.

Thyroid function tests (fT3, fT4 and TSH) were estimated at baseline, after 3 months and after 6 months (Table 8). In fT3 levels no significant change was observed in any of the three groups. Post intervention there was significant improvement in fT4 levels in both groups (P=0.001, P=0.004 in control and the yoga groups respectively). At baseline the mean serum TSH concentrations of both groups were in the overt hypothyroid range. After 6 months, serum TSH concentration showed a significant reduction (p= 0.000) in both the groups. Levels of TSH only in the yoga group were found to be in euthyroid range.

In the control group, using Bonferroni comparison (Table 9), the pair wise mean effect between the test intervals, showed that level of significance for the decrease in fT4 from 0 to 3rd month was p=0.016 and from 0 to 6th month was p=0.003. For TSH level, the decrease observed was p=0.000 for both 0 to 3rd and 0 to 6th month.

In the yoga group, using Bonferroni comparison (Table 10), the pair wise mean effect between the test intervals showed that level of significance for the decrease in fT4 from 0 to 3rd month was p=0.023 and from 0 to 6th month was p=0.015. For TSH level, the decrease observed was for 0 to 3rd (p=0.000) and 0 to 6th month (p=0.000) and for 3rd to 6th month (p= 0.05).

DISCUSSION

Thyroid problems are among the most common medical conditions and have many signs and symptoms that have great effect on normal day to day activities. Patients with hypothyroidism have been found to have changes in anthropometric parameters and timely identification opens the possibility of specific therapeutic intervention[10]. Yoga offers a unique combination of mild to moderate physical exercise (*Suryanamaskar* and *Asana*), cleansing process (*Kriya*), breathing control (*Pranayama*) and meditation (*Dhyana*)[11] and has been increasingly used as a preventive therapy to overcome and treat thyroid disorders. It intends to stabilize and recondition the psycho-physiological make-up that influences the natural endocrinal homeostasis within the body and thus has therapeutic potential[12].

The results from our study showed that in both the groups there was a significant increase in fT4 levels and significant reduction in serum TSH levels. In the yoga group the levels of TSH were better controlled and were found to be in the euthyroid range. This clearly shows that yoga intervention along with thyroxine replacement was more effective in controlling hypothyroidism when compared to Thyroxine replacement alone. The effective treatment of Hypothyroidism is restoring the elevated serum TSH to the normal physiological range[13]. The effectiveness of yoga intervention in our study is in accordance with earlier studies which have shown improvement in serum TSH after Yoga training[14,15]. Yoga practices may help to

normalize thyroid function and also improve neuro-endocrine feedback mechanisms. This may also be accentuated by the *pranayama* practices which may bring about such benefit through central action on either the hypothalamus or the limbic cortex[16].

Hypothyroidism is strongly associated with weight gain as well as difficulty in losing weight. In this study, yoga therapy resulted in significantly reduction of body weight, BMI, waist circumference and body fat percentage post 3 and 6 months. Significantly decreased BMI may be mainly because of yoga *Asanas* which might have reduced the deposited fat on adipose tissue. There was no reduction in waist hip ratio indicating an even reduction in fat stored centrally inside the abdomen (waist circumference) and in fat stored peripherally (hip circumference). Exercising by yoga increases metabolic activity, which helps burn more calories and helps keep weight down. One of the markers of physical well-being in adults is body mass index.

In our study, improvement in anthropometric parameters is in accordance with earlier studies. Study by Chauhan et al concluded that yoga practice has potential to control BMI and BP without taking any medication[17]. Other study has reported that an increase in BMI throughout the study period was positively correlated with increases in TSH[18]. Medium-intensity aerobic exercise produced the best results for improving TSH and improved thyroid function may be through better perfusion of the gland[19]. Study conducted by Telles et al.[20] reported similar reduction in anthropometric variables after 15 days of yoga intervention on obese adults. Yoga training for 12 weeks has been found to significantly reduce waist circumference among participants[21]. It has been observed that lifestyle changes by integration of specific yoga intervention for 6 weeks is useful in the management of metabolic syndrome[22]. *Pranayama* and meditation rejuvenate thyroid gland. The regular practice of *pranayama* and meditation may send a positive stimulus to the hypothalamus and pituitary[23]. Specific yogic poses can stimulate the throat area by squeezing and stretching or massaging the thyroid gland placed in the neck region. These are beneficial not only for hypothyroidism but also for the health of the overall endocrine system.

Effect of yoga therapy was studied on ten Symptoms by measuring Fatigue, Sleepiness, Cold intolerance, Dry skin, Decreased appetite, Constipation, Bradycardia, Hyporeflexia, Myxedema and Menstrual disturbances. Severity of all symptoms other than Bradycardia and Hyporeflexia were found to be decreased in the group given yoga treatment. After 6 months more percentage of patients in yoga group had reached normal symptom score i.e. patients feeling no fatigue were 22% in the control group whereas the percentage was 69% in the yoga group. Research suggests that yoga can produce an invigorating effect on mental and physical energy that improves fitness and reduces pain and fatigue[24]. The integrated approach of yoga help to manage psychological stress thereby leading to the physical benefits[25]. Stress tends to have a negative impact on the immune system and makes a person more vulnerable to diseases. Managing stress, especially chronic or long-term stress, by practising various relaxation techniques, may help people overcome other co-morbidities associated with diseases and lead a better quality of life even during periods of stress[26].

After the study period, the normal sleep was 63.4% in the control group and 81% in the yoga group. Study by Manjunath et al.[27] shows that regular practice of yoga resulted in a significant decrease in the time taken to fall asleep, an increase in the total number of hours slept. Pharmacological treatment of insomnia is often associated with hazardous side effects especially in older adults. Therefore, alternative forms of therapy for improving sleep are

becoming utilized more frequently because of its ability to increase relaxation and induce a balanced mental state[27, 28]. Increase in cortisol hormone during stress or imbalance of thyroid hormone make it difficult to drop off to sleep because the body believes that it is still daytime. So insomnia is a common symptom of hypothyroidism caused by poor cortisol balance. Yogic practices probably inhibit the activity of the paraventricular nuclei of the hypothalamus, which in turn affects the anterior pituitary gland to produce less ACTH. The decrease in ACTH decreases the synthesis of cortisol from the adrenal glands. The decrease in cortisol levels with yoga has been observed in various studies[29, 30].

Improvement in other signs and symptoms showed that normal cold tolerance was 68.3% in the control group and 90.5%. in the yoga group. Patients without dry skin were 41.5% in the control group and 81% in the yoga group. Patients with normal appetite were 68.3% in the control group and 90.5%.in the yoga group. Patients without constipation were 63.4% in control group and were 90.5% in the yoga group. Women without menstrual disturbances were 40% in the control group and were 47.3% in the yoga group. Patients without Myxedema were 75.6% in control group and 88.1%.in the yoga group. So in our study overall effect of yoga was improvement in quality of life. Literature report also shows that yoga creates a sense of well being, improved efficiency, increased attentiveness, lowered irritability, and an optimistic outlook in life[31]. Yogic practices inhibit the areas responsible for fear, aggressiveness, and rage, and stimulate the rewarding centres in the median forebrain and other areas, leading to a state of bliss and pleasure. This results in lower anxiety, heart rate, respiratory rate, blood pressure, and cardiac output in students practicing yoga and meditation than in controls[32,33,34]. In the treatment of Hypothyroidism proper absorption of orally administered Thyroxine in the intestine is a critical step. It is also possible that the adjunct therapy like yoga may improve our digestive efficiency. Studies on the effects of yoga for patients with thyroid disorders are very few.

Yoga as an adjunct therapy seems to have great potential. Nowadays many patients are opting for yoga therapy either before starting medications, or in combination with medication so as to handle the disease in a better way. Yoga is also cost effective and may not have any complications when practiced in a proper manner. *Asanas* and *pranayama* help maintain proper function of the thyroid glands and prevent problems from getting worse. Therefore, this healthy lifestyle intervention program can be used not only for curtailing the progression of hypothyroidism but also keeping symptoms of the disease at bay. Such studies can make people aware in adopting yoga in their daily routine for better physical and mental health.

CONCLUSION

Six months of yoga as an adjunct intervention was comparatively more effective in controlling hypothyroidism as compared to Thyroxine replacement alone. The efficacy of yoga therapy on body weight, BMI, waist circumference, body fat and many signs and symptoms may have direct impact on its use as a safe therapeutic modality in combating obesity and in maintaining good health. More such studies are required to be done on bigger group of hypothyroid patients for validating the effect of yoga practice on their health.

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AUTHOR DISCLOSURE STATEMENT

No competing financial interests exist.

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Table 1: Details of Yoga module for intervention group

S. No	Practice	Details	Duration
1	*Om* Chanting		3 times
2	Loosening exercises		12 minute
3	*Suryanamaskara*	12 steps minimum 1 to maximum 4 rounds	8 minutes
4	Asana practices	*Simhasan, Saralamatsyasan, Vipareetakarani, Setubhandha, Sahavasana*	15 minutes
5	*Bandha*	*Jalandharabandha*	
6	*Pranayama & kriyas*	*Kapalabhati* (30 to 60 strokes) *Ujjayi* (10 breaths) *Naadishodhana* (10 rounds) *Surya anulomaviloma* (20 breaths) *Chandra anulomaviloma*(20breaths)	10 minutes
7	*Om* chanting		3 times
Total Time			45 Minutes

Symptom	Time	Group I			
		Normal	Mild	Moderate	Severe
	Baseline	4.9	29.3	26.8	39
	3 month	9.8	41.5	31.7	17.1
Fatigue	6 month	22	41.5	29.3	7.3
	Baseline	34.1	24.4	31.7	9.8
	3 month	43.9	34.1	19.5	2.4
Sleepiness	6 month	63.4	24.4	9.8	2.4
	Baseline	34.1	36.6	24.4	4.9
	3 month	53.7	26.8	17.1	2.4
Cold intolerance	6 month	68.3	22	9.7	0
	Baseline	26.8	36.6	31.7	4.9
	3 month	31.7	36.6	26.8	4.9
Dry Skin	6 month	41.5	36.6	19.5	2.4
	Baseline	51.2	36.6	12.2	0
	3 month	63.4	29.3	7.3	0
Loss of Appetite	6 month	68.3	6.8	4.9	0
	Baseline	48.8	29.3	22	0
	3 month	61	31.7	7.3	0
Constipation	6 month	63.4	34.1	2.4	0
	Baseline	37.1	17.1	11.4	11.4
	3 month	31.4	25.7	17.1	2.85
Menstrual Disturbance	6 month	40	20	14.3	2.85
	Baseline	100	0	0	0
	3 month	100	0	0	0
Bradycardia	6 month	100	0	0	0
	Baseline	75.6	17.1	7.3	0
	3 month	80.5	17.7	2.4	0
Myxedema	6 month	75.6	24.4	0	0
	Baseline	100	0	0	0
	3 month	100	0	0	0
Hyporeflexia	6 month	100	0	0	0

Table 2: Comparison of symptom scores (%) of normal group at different time intervals

Table 3: Comparison of symptom scores (%) of Yoga group at different time intervals

Symptom	Time	Group II			
		Normal	Mild	Moderate	Severe
Fatigue	Baseline	4.8	19.0	47.6	28.6
	3 month	19	50	23	7
	6 month	69	26.2	4.8	0
Sleepiness	Baseline	47.6	14.3	23.8	14.3
	3 month	69	23.8	7.1	0
	6 month	81	16.6	2.4	0
Cold intolerance	Baseline	40.5	38.1	19.0	2.4
	3 month	69	26.2	4.8	0
	6 month	90.5	7.1	2.4	0
Dry Skin	Baseline	33.3	33.3	26.2	7.1
	3 month	50	40.5	9.5	0
	6 month	81	19	0	0
Loss of Appetite	Baseline	71.4	9.5	16.7	2.4
	3 month	78.6	19.	2.4	0
	6 month	90.5	9.5	0	0
Constipation	Baseline	38.1	35.7	23.8	2.4
	3 month	64.3	23.8	9.5	2.5
	6 month	90.5	7.1	2.4	0
Menstrual Disturbance	Baseline	28.9	18.4	2.6	2.6
	3 month	39.5	10.5	2.6	0
	6 month	47.3	10.5	0	0
Bradycardia	Baseline	100	0	0	0
	3 month	100	0	0	0
	6 month	100	0	0	0
Myxedema	Baseline	66.7	19.0	14.3	0
	3 month	81	14.3	4.8	0
	6 month	88.1	9.5	2.4	0
Hypoflexia	Baseline	100	0	0	0
	3 month	100	0	0	0
	6 month	100	0	0	0

Table 4: Baseline values for anthropometric variables of Control (Group I) and Yoga (Group II) group

Parameters	Group I (Mean±SD)	Group II (Mean±SD)	P-Value
Age (Years)	39.9±10.53	40.71±9.45	0.7131
Weight (Kgs)	65.30+11.16	69.77+12.04	0.08
BP Systolic (mm of Hg)	120.63+14.88	123.07+20.18	0.53
BP Diastolic (mm of Hg)	79.48+9.89	78.59+11.48	0.70
BMI (Kg/m^2)	26.64+4.13	28.37+5.33	0.102
Waist – Hip ratio	0.92+0.07	0.91+0.06	0.48
Waist circumference (inch)	37.05+3.41	37.89+4.40	0.334
Fat %	35.09+5.45	37.15+6.17	0.111

* p≤0.05, ** p≤0.01, *** p≤0.001

Table 5: Comparison of changes in anthropometric variables in Control (Group I) and Yoga (Group II) group

		Baseline	3rd Month	6th Month	RM ANOVA	
	Groups	Mean+SD	Mean+SD	Mean+SD	F-stat	P-Value
Weight (Kg)	I	65.30±11.16	64.91±11.04	64.95±10.96	1.484	0.235
	II	69.77±12.04	67.98±10.68	66.89±10.01	20.64	0.00***
BP (SYS) (Mm of Hg)	I	120.63±14.88	119.12±13.52	119.95±12.78	0.305	0.725
	II	123.07±20.18	124.43±16.10	122.52±11.65	0.383	0.661
BP(DIA) (Mm of Hg)	I	79.48±9.89	78.80±8.15	78.29±7.75	0.458	0.608
	II	78.59±11.48	80.09±7.73	79.76±5.39	0.58	0.508
BMI (Kg/m^2)	I	26.64±4.13	26.58±3.94	26.60±3.87	0.117	0.829
	II	28.37±5.33	27.70±4.96	27.23±4.66	20.14	0.00***
W/H	I	0.92±0.07	0.93±0.08	0.92±0.07	1.31	0.273
	II	0.91±0.06	0.90±0.14	0.90±0.07	0.188	0.730
Waist (inch)	I	37.05±3.41	36.67±3.04	36.57±3.46	2.51	0.09
	II	37.89±4.40	37.09±4.14	36.49±3.94	23.57	0.000*
Fat (%)	I	35.09±5.45	34.95±5.88	35.47±5.80	0.490	0.541
	II	37.15±6.17	35.93±6.31	35.03±5.95	21.64	0.00***

* p≤0.05, ** p≤0.01, *** p≤0.001

Table 6: Pair wise mean effect between the test intervals using Bonferroni comparison in Yoga Group

Parameter	Time Interval		Mean Difference	SE	P-Value	95% Confidence Interval for Difference	
						Lower Bound	Upper Bound
Weight	Baseline	3rd Month	1.788	0.452	0.001***	0.659	2.918
		6th Month	2.871	0.581	.000***	1.421	4.322
	3rd Month	6th Month	1.083	0.262	.001***	0.429	1.738
BMI	Baseline	3rd Month	0.675	0.177	.001***	0.232	1.118
		6th Month	1.147	0.235	0.000***	0.561	1.733
	3rd Month	6th Month	0.471	0.111	0.000***	0.194	0.749
Waist	Baseline	3rd Month	0.805	0.194	0.001***	0.319	1.290
		6th Month	1.398	0.206	0.000***	0.884	1.911
	3rd Month	6th Month	0.593	0.153	0.001***	0.211	0.975
Fat%	Baseline	3rd Month	1.221	0.349	0.003**	0.350	2.092
		6th Month	2.117	0.364	0.000***	1.208	3.026
	3rd Month	6th Month	0.895	0.242	0.002**	0.290	1.500

* p≤0.05, ** p≤0.01, *** p≤0.001

Table 7: Baseline levels of Thyroid function tests for Control Group (I) and Yoga Group (II)

Parameters	Control Gp Mean±SD	Yoga Gp Mean±SD	p-value
fT3 (pg/ml)	2.9±0.44	2.87±0.66	0.73
fT4 (ng/dl)	1.04±0.23	1.02±0.42	0.70
TSH (uIU/ml)	14.53±9.58	16.36±10.05	0.40

* p≤0.05, ** p≤0.01, *** p≤0.001

Table 8: Comparison of changes in Thyroid function test in Control Group (I) and Yoga Group (II)

Parameters	Groups	Baseline	3rd Month	6th Month	RM ANOVA	
		Mean ± SD	Mean ±SD	Mean±SD	F-stat	P-Value
fT3 (pg/ml)	I	2.90±0.44	3.01±0.79	2.97±0.42	0.42	0.61
	II	2.87±0.66	3.01±0.43	3.09±0.53	2.60	0.09
fT4 (ng/dl)	I	1.04±0.23	1.18±0.24	1.19±0.25	7.48	0.001**
	II	1.02±0.42	1.20±0.26	1.21±0.23	6.68	0.004***
TSH (uIU/ml)	I	14.53±9.58	7.33±8.35	7.74±8.08	26.38	0.000***
	II	16.36±10.05	5.81±4.83	3.97±3.18	53.71	0.000***

* p≤0.05, ** p≤0.01, *** p≤0.001

Table 9: Pair wise mean effect between the test interval using Bonferroni comparison in Control Group

	Time Interval		Mean Difference	SE	P-Value	95% Confidence Interval for Difference	
						Lower Bound	Upper Bound
T4	Base Line	3rd Month	-0.140	0.047	0.016**	-0.258	-0.021
		6th Month	-0.154	0.043	0.003***	-0.261	-0.47
		6th Month	-0.014	0.041	1.00	-0.118	0.089
TSH	Base Line	3rd Month	7.204	1.150	0.000**	4.332	10.077
		6th Month	6.802	1.223	0.000***	3.746	9.859
		6th Month	-0.402	0.954	1.00	-0.2785	1.981

Table 10: Pair wise mean effect between the test intervals using Bonferroni comparison in Yoga Group

	Time Interval		Mean Difference	SE	P-Value	95% Confidence Interval for Difference	
						Lower Bound	Upper Bound
T4	Baseline	3rd Month	-0.189	0.68	0.023*	-0.358	-0.021
		6th Month	-0.191	0.64	0.015*	-0.352	-0.030
	3rd Month	6th Month	-0.002	0.46	1.00	-0.117	0.114
TSH	Baseline	3rd Month	10.553	1.53	0.000***	6.743	14.363
		6th Month	12.391	1.46	0.000***	8.752	16.030
	3rd Month	6th Month	1.838	0.736	0.050*	0.002	3.674

* p≤0.05, ** p≤0.01, *** p≤0.001

Table 10: Pair wise mean effect between the test intervals using Bonferroni comparison in Control Group

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