Effect of combined yoga programme on blood levels of thyroid hormones: 
A quasi-experimental study

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There are marked variations in thyroid axis function with advancing age. Yoga is a comprehensive mind-body approach, regular practice of which claim to delay the onset of aging process. The aim of the present study was to examine the effect of combined graded yoga program on the basal level of thyroid hormones in healthy middle-aged adults. Forty five healthy men and women were divided into two groups, that is, yoga practicing (experimental: male 15, age 42.80 ± 7.43 yrs; female 8, age 44.75 ± 8.40 yrs) and waitlisted control group (male 15, age 41.67 ± 7.87 yrs; female 7, age 45.43 ± 7.00 yrs). The experimental group underwent combine yogic practices daily in the morning for 6 days/week for 12 weeks, whereas control group continued their usual routine activities. Basal level of serum thyrotropin (TSH), Triiodothyronine (T3) and Thyroxine (T4) were measured before commencement and after 6 and 12 weeks of yogic training. The repeated measure ANOVA was used for data analysis. Percentage (%) was also calculated from the mean value to see the quantitative changes of yogic training. Twelve weeks of yogic training produces a significant (least significant difference, p < 0.05) increase in serum TSH level for male and decrease in T3 and T4 for both male and female groups as compared to their baseline data, whereas no such changes were observed in the control group during these 12 weeks. Combine approach of graded yogic training modulates the secretion and function of thyroid hormones, identified as one of the regulatory factor associated with aging process.

Keywords: Middle-aged, TSH, T3, T4

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The biological process of normal aging is progressive in nature and following a complex unidirectional pattern. In general with other systems, the endocrine system is also affected by normal aging process. The hypothalamic-pituitary-thyroid axis undergoes a significant number of complex physiological alterations associated with aging. Physical activity has been reported to affect endocrine function. Any mode of exercise or physical activity corresponds to a physical stress on the endocrine system that challenges homeostasis. The influence of exercise on thyroid function is controversial and seems to depend on the intensity and the duration of the training protocol. Yoga is an ancient Indian mind-body technique intended to stabilize and reconditioning the psycho-physiological make-up which influence the natural endocrinal homeostasis within the body. Yoga offers a unique combination of mild to moderate physical exercise (asana), cleansing process (pranayama), breathing control (kriya), and meditation (dhyana). Seldom scientific research on the effect of yoga (single or combined interventions) on thyroid hormones relating to aging, are available. Werner et al. investigated the effect of long term practice of transcendental meditation (TM) and TM-sidhi programme on some endocrine variables. TSH, T3, T4, prolactin, GH and cortisol in serum were taken on five consecutive days (initial and after 5, 49, 115 and 167 weeks). All samples were drawn one hour following 30-60 min of practice of meditation. A progressive decrease in serum TSH, GH and prolactin levels occurred over the three years while no consistent change in cortisol, T3 and T4 levels were observed. Maclean et al. studied the effect of transcendental meditation programme in hormonal levels. Healthy male volunteers, ages 18-32 yrs were screened through the use of health questionnaires and a medical examination. Following the first laboratory stress session
(pre-test) subject were assigned randomly to participate in 4 months either the transcendental meditation programme or a stress education control programme. After 4 months, there was a second laboratory stress session. Blood samples were collected before and after transcendental meditation. Cortisol and TSH were decreased, whereas growth hormone increased after 4 months of transcendental meditation. In a prospective randomized control trial Gorden et al. evaluated the effects of yoga and traditional physical training exercise regimens on fasting blood glucose, serum insulin, TSH, T3 and T4 at baseline, after three months and six months in individuals with type 2 diabetic mellitus. They reported that there is no significant change in TSH, T3 and T4 level after the practice of yoga or traditional physical exercise and control groups during three different (at 0, 3 and 6 months) periods. The hypothalamus-pituitary-thyroid axis plays an important role in metabolism of almost all body tissues, energy homeostasis, growth and tissue differentiation as well as gene expression and thermoregulation in the body throughout the life. Moreover growing bodies of animal and human studies indicate thyroid hormones also play a role in cardiovascular, nervous, immune and reproductive system development and function. Adequate thyroid function is essential for normal development and retention of cognitive function throughout life. Therefore, balanced functioning of this hypothalamus-pituitary-thyroid axis is essential for longevity and thus promotes successful aging. Whereas, it is reported in the ancient *hatha yogic* texts that regular practice of yoga delay the onset of normal aging process and thus, sound health is secured. However, no systematic attempt has been made so far as to examine the effect of combine graded yogic training on pituitary-thyroid axis. Therefore, in the present study an attempt has been made to observe the effect of combine graded yogic training on the basal level of TSH, T3 and T4.

**Methodology**

**Subjects**

To meet the purpose of the study a “Yoga Awareness Camp” was organized in Bolpur Municipality area through a local advertisement. Fifty middle-aged male and female willingly registered their names to attend this yoga camp. Five subjects were excluded from the study due to major injury and illness. Finally a group of 45 age and sex matched untrained volunteers, between 35-55 yrs of age were recruited in this study. All the subjects were from almost same socio-economic background and recreationally active but not specifically acquainted with the yogic practices prior to training.

**Study designed**

The study was a quasi-experimental, pre-test, mid-test and post-test comparison group designed. Two groups (yoga and wait list control) by three times (pre-test, mid-test and post-test) interaction were used. Subjects were divided into two groups in respect to the serial of their registration. On the basis of serial of the registration first group (n = 23) was represented as yoga group (Male 15; age 42.80 ± 7.43 yrs; Female 8, age 44.75 ± 8.40 yrs) Whereas the second group (n = 22) served as a waitlist control group (Male 15, age 41.67 ± 7.87 years; Female 7, age 45.43 ± 7.00 yrs). The ‘Board of Studies’, Department of Physical Education, Visva-Bharati University, Santiniketan, West Bengal, India, went through the whole procedure of this study and forwarded this to the Institutional Research Board. Finally, the University Research Board approved the study. The subjects were familiarized with the aims and objectives of the study as well as laboratory environment and their written consent obtained. They were normally healthy. Subjects were free from any metabolic ailments and were not on any medication prior to the study. Both groups were assessed three times each, under similar conditions. Baseline assessments were made prior to beginning of the yoga training (pre-test). After this the experimental group received training in yoga, while the control group carried on with their routine activities. Subsequent assessments for both the groups were done after 6 (mid-test) and 12 weeks (post-test) accordingly.

**Variables studied**

In this study, chronological age, standing height, body weight, body mass index (BMI), basal level of plasma Thyroid Stimulating Hormone (TSH), Triiodothyronine (T3) and Thyroxine (T4) were measured by Enzyme-Linked Immunosorbent Assay (ELISA) method.

**Yoga training protocol**

The combination of yoga practices are adopted for this study. The yoga group (experimental) pursued
training in *suryanamaskar* (dynamic physical posture), *asanas* (static physical postures), *kriyas* (cleansing practices), *pranayamas* (breathing control) and *dhyana* (meditation) for a period of 12 weeks. Progressive training load were applied in terms of time, degree of difficulty and repetitions from the first week to 12 weeks of the training period. In the initial stage of training, first one week, duration of practice was 45 min. Practiced time was increased gradually and reached 90 min at the beginning of 6 week, mid stage of training. Finally one hour 45 min practice time was fixed in the 8 week and continued for 12 weeks. From 8th week onward 3 types of practice combination were used. Each of this combination was practiced 2 days in a week. There are few yogic techniques which cannot be practiced regularly, whereas other technique needs longer time to practice. Therefore to justify the training load and maintain it accordingly the present researcher adopted this combination schedule. In the initial stage of training very simple techniques were introduced whereas, advance techniques were given in between 6-8 week of the training period. The subjects were practiced yoga session in the morning for 6 days in a week for 12 weeks with an individual attendance of 83 – 87 %. Waitlist control group was given no specific intervention and continued with their routine activities. They attend “health and positive mental attitude awareness” class in a day per week. A general record book was also maintained to note their daily activity level and lifestyle. The detailed protocol of yoga training followed was reported elsewhere.

**Statistical analysis**

In the present study the repeated measures analysis of variance (ANOVA) was used for data analysis. Repeated measures “Analysis of Variances” (RM ANOVA) is one in which multiple measurements on the same experimental subjects comprise the replicate data. Here, RM ANOVA was used to test for (i) significant differences between the assessments, i.e., at baseline (pre-test), after 6 weeks (mid-test) and 12 weeks (post-test) and this was a within subjects factor denoted by time and (ii) differences between the groups (Yoga and Wait list control), this was a between subjects factor, and the test for a time by group interaction provide a global test for an intervention effect. Post data were compared to pre- and mid data of respective group using post-hoc analysis with bonferroni adjustment. The level of significant was set at 0.05 levels (p < 0.5). Simple percentages (%) were also calculated from the mean value to see the quantitative changes of the yogic training.

**Results**

**Baseline characteristics**

Before commencement of the yogic training baseline difference between experimental (yoga) and control group for the selected variables were calculated (Independent ‘t’ test) and insignificant difference were observed for both male and female groups (Table 1). This insignificant values of independent ‘t’ test established the homogeneity between the experimental (yoga group) and control group before application of combined yoga training.

**Physical characteristics**

The body weight and BMI of experimental group (male & female) decreased significantly (p < 0.001) after 12 weeks of graded yogic training in comparison to baseline where as in the control group no such changes were observed during these 12 weeks (Table 2).

**Endocrine variables**

In the present study the basal level of serum TSH was increased significantly after 12 weeks of graded yogic training compared to base line in the male group, whereas in the female group the insignificant increment was observed. In contrast no such changes were observed in the control group for both male and female during these 12 weeks. The improvements were recorded 8.59 % (p > 0.05, paired t-test, pre-test versus mid-test) after 6 and 24.85 % (p < 0.05, paired t-test, pre-test versus post-test) after 12 weeks in male group. In the female group improvements were recorded as 20.76 % (p > 0.05, paired t-test, pre-test versus mid-test) after 6 and 33.47 % (p > 0.05, paired t-test, pre-test versus post-test) after 12 weeks.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Variables</th>
<th>Male (Experimental pre-test vs Control pre-test)</th>
<th>Female (Experimental pre-test vs Control pre-test)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Body weight (Kg)</td>
<td>P = 0.49</td>
<td>P = 0.99</td>
</tr>
<tr>
<td>2.</td>
<td>Body Mass Index (Kg/Mt²)</td>
<td>P = 0.40</td>
<td>P = 0.76</td>
</tr>
<tr>
<td>3.</td>
<td>TSH (ng/ml)</td>
<td>P = 0.99</td>
<td>P = 0.95</td>
</tr>
<tr>
<td>4.</td>
<td>T₃ (ng/ml)</td>
<td>P = 0.90</td>
<td>P = 0.98</td>
</tr>
<tr>
<td>5.</td>
<td>T₄ (ng/ml)</td>
<td>P = 0.57</td>
<td>P = 0.77</td>
</tr>
</tbody>
</table>
The basal level of serum T₃ was decreased significantly after 12 weeks of graded yogic training compared to baseline in the male and female group, where no such changes were observed in the control group for both male and female during these 12 weeks. The basal T₃ level in the serum was declined 10.45 % (p > 0.05, paired t-test, pre-test versus post-test) after 12 weeks in the female group, whereas no such changes were observed in the control group for both male and female (Figs. 1&2).

The basal level of serum T₄ was decreased significantly after 12 weeks of graded yogic training compared to baseline in the male and female group, where no such changes were observed in the control group for both male and female during these 12 weeks. The basal T₄ level in the serum was declined 4.23 % (p > 0.05, paired t-test, pre-test versus post-test) after 12 weeks. The basal TSH level in the serum was declined 10.45 % (p > 0.05, paired t-test, pre-test versus post-test) after 12 weeks (Figs. 5&6).

Discussion
All endocrine glands are subject to the effect of aging process. An age dependent reduction of TSH secretion rate has been reported earlier. The reason for such age dependent reduction of TSH secretion is uncertain, whereas serum T₃ and T₄ concentrations increased with age or unchanged. TSH production and secretion are stimulated by hypothalamic thyrotrophin-releasing hormone (TRH) and suppressed by thyroid hormones (T₃ & T₄) in a negative feedback control system. The decreased thyroid levels observed in normal aging process are due to lower TSH concentrations. TRH also decreased with advancing age, which may reduce the secretion of TSH. Therefore, the Imbalance in thyroid hormones in humans associated with aging arises from dysfunction of the thyroid gland itself, the pituitary gland and the hypothalamus. On the contrary, yoga is a profound ancient technique, one way which reduced resting heart rate, respiratory rate, metabolic activity and energy expenditure as observed during the practice of dhyana (meditation) and few meditative and

Table 2 — General and Endocrine variables of experimental and waitlist control group (Mean ± SD)

<table>
<thead>
<tr>
<th>Components</th>
<th>Experimental group (yoga)</th>
<th>Control group (wait list)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre- Test (Pre vs Mid)</td>
<td>Mid Test (Pre vs Mid)</td>
</tr>
<tr>
<td>Body weight (Kg)</td>
<td>70.36 ± 14.14</td>
<td>69.93 ± 13.64</td>
</tr>
<tr>
<td>[Male]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Body weight (Kg)</td>
<td>64.26 ± 8.87</td>
<td>63.27 ± 8.68**</td>
</tr>
<tr>
<td>[Female]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BMI (Kg/M²)</td>
<td>24.33 ± 4.33</td>
<td>24.17 ± 4.22</td>
</tr>
<tr>
<td>[Male]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BMI (Kg/M²)</td>
<td>25.89 ± 3.47</td>
<td>25.49 ± 3.66**</td>
</tr>
<tr>
<td>[Female]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TSH (ng/ml)</td>
<td>3.26 ± 2.09</td>
<td>3.54 ± 2.93</td>
</tr>
<tr>
<td>[Male]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TSH (ng/ml)</td>
<td>2.36 ± 1.01</td>
<td>2.85 ± 1.07</td>
</tr>
<tr>
<td>[Female]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T₃ (ng/ml)</td>
<td>1.34 ± 0.36</td>
<td>1.20 ± 0.20</td>
</tr>
<tr>
<td>[Male]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T₃ (ng/ml)</td>
<td>1.24 ± 0.56</td>
<td>0.90 ± 0.19</td>
</tr>
<tr>
<td>[Female]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T₄ (ng/ml)</td>
<td>8.26 ± 1.92</td>
<td>7.91 ± 0.91</td>
</tr>
<tr>
<td>[Male]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T₄ (ng/ml)</td>
<td>7.39 ± 0.98</td>
<td>6.70 ± 1.28</td>
</tr>
<tr>
<td>[Female]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*p<0.05, **p<0.01 and ***p<0.001, two tailed, t-test for paired data comparing the values at six weeks (midtest) versus baseline (pretest) and twelve weeks (posttest) versus baseline (pretest).
relaxation types of *asana* (postures). On the other way, *pranayamas* (specific breathing control practices) like *Ujjayi, Surya Anulome Vilome* and cultural *asanas* increased oxygen consumption, metabolic rate and energy expenditure\(^{30-31}\), thus produce a vitalizing effect in the mind-body system. The main findings of the present quasi-experimental study is that the combined approach of graded yogic training for 12 weeks significantly improved serum TSH level in male and near-significant increased (2.36 ± 1.01 ng/ml before training to 3.15 ± 0.96 ng/ml after 12 weeks; change 33.47 %) in female, whereas T3 and T4 decreased significantly. Our results indicate that the levels of serum TSH, T3 and T4 were within the normal range in both experimental and control groups. Our results are contradictory to results recorded by Werner et al.\(^ {12}\) and Maclean et al.\(^ {13}\) who reported that transcendental meditation decreased serum TSH level and no change in T3 and T4 level. In another study Gorden et al.\(^ {14}\) reported that there is no significant change in TSH, T3 and T4 level after the practice of yoga. Gorden et al.\(^ {14}\) did not give any clear explanation about the details of yoga regimen. A growing body of scientific research has been reported that transcendental meditation gives rise to a unique state of deep rest by marked reductions in resting heart rate, respiratory rate, oxygen consumption, metabolic activity, increased cerebral blood flow\(^ {32-33}\) may responsible for the decrease of serum TSH in the human body. These results of TM technique also suggest meditation may produce mental alertness with physiological relaxations. In contrast to these earlier studies, we adopted a combined approach of *yoga* program which is comprehensive and progressive in nature\(^ {24}\). This comprehensive yoga training module for a period of 12 weeks may have different effect on pituitary-thyroid axis function in the human body.

However the result of the present study is similar with the study done by Grandys et al.\(^ {34}\) who reported that after 5 weeks of moderate intensity and low volume endurance training increased TSH level (2.28 ± 1.09 Vs 2.52± 1.42 µIU. ml\(^{-1}\)) and decreased
free T₃ and T₄ concentrations. In another study Onsori & Galedari found that TSH and T₃ levels was slightly increased after 12 weeks of moderate-intensity aerobic exercise in middle aged females (n = 15) compared to the age-sex matched controls (n = 15). In the graded yogic training schedule there were suryanamaskara (dynamic physical posture), shitilikarana (loosening) practices and asanas (physical postures) which were reported as moderate aerobic type of exercises may positively increased the basal level of TSH and decreased T₃ & T₄ levels in the plasma blood. Moreover specific yogic poses (Sarvagasana, Halasana, Uthrasan, Matyasana, Bhujangasan) can stimulate the throat area by squeezing and stretching or massaging the thyroid gland placed in the neck region. Regular practice of pranayama (surya vedhana, ujjai, bhashrika, bhramari, sitali, sitkari) and meditation may send a positive feedback to the hypothalamus and pituitary. It has been observed by other researcher who reported that pituitary growth hormone Y-Aminobutaric Acid (GABA) and plasma melatonin were increased after yoga session.

Therefore, the changes observed in thyroid axis may be interpreted as: (i) increase the secretion of hypothalamic thyrotrophin-relesing hormone (TRH) which positively influences the TSH secretion pattern. (ii) A possible cause for the increase of TSH level may be, due to fulfill the exercise induced increase in peripheral need for T₃ & T₄. (iii) The function of T₃ & T₄ includes increasing the rate of the metabolism of carbohydrates and fats, as well as the synthesis and degradation of proteins inside the cell, utilization of thyroid hormones may be increased with yoga training which possibly decreases the T₃ & T₄ levels in the serum. (iv) The concentration of serum T₃ is negatively correlated with blood glucose level and the increase in T₃ receptor binding capacity reflects the compensatory mechanisms which are probably evoked by T₃ deficiency to maintain cellular homeostasis. (v) The hypothalamus-pituitary-thyroid axis undergoes a significant number of complexes physiological alterations associated with aging may be modified through yogic exercises.

Effects of any form of physical activity on thyroid hormones are controversial. Hence, the results of this study can also be used for the prevention of thyroid problems and provide an ideal neuroglandular adjustment within the individual. Yoga is one of the important mind-body techniques that efficiently works on thyroid imbalance, generally occur in the path of normal aging process. By nourishing the function of thyroid and pituitary glands, yoga prevents its progressive damage with advancing age.

**Conclusion**

Convenient sampling (not randomized control trial) and the fact that no residential camp was conducted can be considered, to a certain extent as limitations of the study. Within the limitations of the study, it may be concluded that combined approach of graded yogic training for a period of twelve weeks modulates the thyrotropin-thyroid hormones release and function in the body, thus promoting healthy aging.

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References


