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Original Article

# Effect of Yogic Intervention on Anthropometric Variables and Oxidative Stress in Obese Adults

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ABSTRACT

**Background:** Obesity, a social problem worldwide, is associated with chronic low grade inflammation with increased oxidative stress (OS). Over-expression of oxidative stress damages cellular structures leading to the development of obesity-related complications. Practice of yoga has shown decrease in oxidative stress in diabetes mellitus and other chronic diseases. So, the aim of this study was to find out the effect of yoga on oxidative stress in obese adults.

**Materials and Methods:** A total of 124 subjects, of which 59 male (age 28.9±3.0yrs.) and 65 female (age 31.2±3.1yrs.) with BMI, ≥25 to ≤40 were recruited for the study. The changes in serum malondialdehyde (MDA) and total antioxidant status (TAS) were assessed at 1st day (Pre), at the end of 3 months (post-1) and 6 months (post-2) of yoga intervention.

**Results:** The data obtained was analysed by ANOVA for repeated measures which has shown significant reduction in serum MDA level (<0.001)and TAS (<0.01) following yoga intervention of obese adults in both the genders. Mann-Whitney test was performed to see the difference in MDA and TA Sacross the gender which indicated that there are significant changes between the genders when pre assessment values were compared with post-2 following yoga intervention.

**Conclusion:** Reduction in the level of oxidative stress marker, MDA and improvement in TAS suggest that yogic practices have therapeutic and protective effects on obesity by decreasing oxidative stress.

**Keywords:** Obesity, Yoga, Oxidative stress, MDA

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## 1. INTRODUCTION

Obesity is defined as an excess accumulation of fat due to positive energy balance, resulting from energy intake that exceeds the energy expenditure, leading to adipocyte hypertrophy and hyperplasia, stress and inflammation within the adipose tissue[1]. Obesity is a global epidemic and poses a significant health threat to humans. The prevalence of obesity is increasing not only in adults, but also among children[2]. A recent study reported that the prevalence of adult overweight and obesity increased by 27.5 per cent with a number of overweight and obese individuals increasing from 857 million to 21 billion from 1980 to 2013[3]. The link between obesity, poor health outcomes and all-cause mortality is very well established[4].

Epidemiological, clinical, and animal studies have shown that obesity is coupled with altered redox state and increased metabolic risk[5]. Studies with obesity also found that, it is associated with a low-grade chronic systemic inflammation in adipose tissue. This condition is influenced by the activation of the innate immune system in adipose tissue that promotes pro-inflammatory status and oxidative stress (OS), triggering a systemic acute-phase response. Several chronic diseases are also the result of obesity (e.g., metabolic syndrome, diabetes mellitus, liver and cardiovascular diseases, and cancer) and associated with OS[6].

Oxidative stress plays critical roles in the pathogenesis of various diseases. In the diabetic condition, oxidative stress impairs glucose uptake in muscle and fat and decreases insulin secretion from pancreatic β cells. Increased oxidative stress also underlies the pathophysiology of hypertension and atherosclerosis by directly affecting vascular wall cells[7]. Earlier studies have shown that Yoga has been found to be beneficial in reducing oxidative stress in type 2 diabetes and other diseases[8,9]. Hence this study was undertaken to assess the effect of yogic practices on anthropometric variables and oxidative stress in obese adults.

## 2. MATERIALS AND METHODS

### Participants

A total of 124 subjects of both the genders with the group average age in years, 29.81±3.10 and BMI, ≥25 to ≤40 were recruited for a single group study. The selection criteria included: a). BMI ≥25 to ≤40 kg/m²), b). Without medication for obesity and other ailments c) Subjects with the absence of a disease which can contribute to obesity (e.g., hypothyroidism, polycystic ovarian syndrome). The study design was explained to the subjects and they gave their signed consent to participate. The study was approved by the ethics committee of the institution(Ethical clearance Ref. No:EC-165).

### Assessments

The subjects recruited for the study were assessed for the variables at Day -1(Pre- assessment), at the end of 3 months (Post-1 assessment) and at the end of six months (Post-2 assessment) of yoga intervention.

**Body Mass Index**: The body mass index (BMI) was calculated as the body weight (in kg), in light clothing and without shoes, divided by height (in metres) squared. Body weight was measured to 0.05 kg using an electronic balance (GTEP Essae, Eeroka Ltd). Height was measured to the nearest 0.1 cm (Anthropometric tape, Global medical devices, Maharashtra.).

**Waist circumference**: The waist circumference was measured to the nearest 0.1 cm in a horizontal plane midway between the inferior costal margin and the iliac crest.

**Hip circumference:** The hip circumference was measured around the pelvis at the point of maximal protrusion of the buttocks.

**Biochemical Variables**: For biochemical estimations, about 5 ml of venous blood was collected from all the participants before and after the yoga practice and the serum was used for the estimation. The serum total antioxidant status was measured by adopting Benzie*et al*[10] and serum MDA was measured by fluorometric method of Yagi [11].

### Intervention

Participants of the study underwent one hour of yoga practice session for three months. First ten days at the yoga camp under the supervision of yoga instructor followed by a minimum of 6 sessions per week at home. Each one hour of yoga session included yoga postures, breathing techniques and meditation[12]. All the participants were asked to have three meals per day of low calorie (1750 to 2000 Kcal/day) vegetarian diet during the period of yoga intervention.

### Statistical Analysis

The present study was conducted to assess the efficacy of yoga practice on anthropometric variables, total antioxidant status and malondialdehyde level in obese adults. Out of 124 subjects, which included 59 males and 65 females, 57 male subjects and 65 female subjects completed the first three months of yoga practice with not less than 75 sessions of one hour and 41 males and 52 females completed six months of yoga practice who were included for analysis. To compare the variables across different time point ANOVA for repeated measures was used, further Post hoc analysis was performed by Bonferroni test. Comparison of the effect between the genders was performed by Mann-Whitney U test. Level of significance in the present study was 0.05. P-value <0.05 was considered as significant and p-value <0.001, was considered as highly significant. Statistical analysis of the data was done using IBM SPSS Statistics (Version 19 Release 19.0.0) software package.

## 3. RESULTS

Comparison of variables following yoga intervention assessed at baseline (Pre), 3 months (Post1) and 6 months (Post2) of the participants using ANOVA for repeated measures**,** has shown highly significant changes in body weight, BMI, hip circumference and serum MDA levels in both the genders and waist circumference in females and total antioxidant status in males.

**Table 1: Comparison of variables following yoga intervention assessed at baseline (Pre), 3 months (Post1) and 6 months (Post2) of the participants using ANOVA for repeated measures**

| Variable | gender | Assessment (mean ± SD) | | | ANOVA F-value | p-value |
|---|---|---|---|---|---|---|
| | | Baseline n=(57#/65@) | Post-1 n=(57#/65@) | Post-2 n=(41#/52@) | | |
| Height (cm) | Male | 168.3±7.9 | | | | |
| | Female | 158.21±5.0 | | | | |
| Body weight(kg) | Male | 86.77±10.5 | 81.84±10.1 | 78.27 ± 7.74 | 432.55 | <0.001** |
| | Female | 78.84±11.9 | 73.15±10.1 | 69.84 ± 9.86 | 427.89 | <0.001** |
| BMI(kg/m$^2$) | Male | 30.55 ± 3.3 | 28.80 ± 3.06 | 26.88 ± 2.47 | 458.40 | <0.001** |
| | Female | 31.13 ± 4.04 | 28.84 ± 3.6 | 27.47 ± 3.7 | 450.93 | <0.001** |
| Waist circumference(cm) | Male | 97.48 ± 7.33 | 94.31 ± 6.48 | 92.36 ± 6.36 | 147.71 | <0.05* |
| | Female | 87.72 ± 6.04 | 84.76 ± 5.73 | 82.42 ± 5.57 | 164.45 | <0.001** |
| Hip circumference(cm) | Male | 107.9±5.5 | 106.05 ± 5.4 | 105.06 ± 4.3 | 177.37 | <0.001** |
| | Female | 101.1±6.2 | 98.73 ± 6.34 | 96.36 ± 6.45 | 254.67 | <0.001** |
| Waist-hip ratio | Male | 0.90±0.03 | 0.89 ± 0.03 | 0.88 ± 0.04 | 46.18 | <0.05* |
| | Female | 0.87±0.04 | 0.86 ± 0.04 | 0.87 ± 0.04 | 11.05 | <0.001** |
| Serum MDA(μ mol/L) | Male | 2.42 ± 0.28 | 2.21 ± 0.18 | 1.94 ± 0.15 | 106.88 | <0.001** |
| | Female | 2.38 ± 0.25 | 2.18 ± 0.22 | 1.98 ± 0.18 | 191.92 | <0.001** |
| Serum TAS(mol/L) | Male | 0.93 ± 0.16 | 1.08 ± 0.14 | 1.18 ± 0.13 | 93.02 | <0.001** |
| | Female | 0.83 ± 0.1 | 1.06 ± 0.13 | 1.21 ± 0.15 | 175.2 | <0.05* |

** p <0.001 - Highly significant, * p <0.05 – Significant, BMI-Body mass index, MDA-Malondialdehyde, TAS-Total antioxidant status, #-Male, @-Female

Results also indicated significant changes in all the variables, when measured differences of each variable were compared across different time point by Post-hoc analysis by Bonferroni test following yoga intervention on participants.

**Table 2: Comparison of observed changes in variables (Mean ±SD) across different time point following yoga intervention on participants of Post-hoc analysis by Bonferroni test**

| Variable | Gender | Observed difference in Variable (Mean ± SD) | | |
|---|---|---|---|---|
| | | Pre - Post 1 | Post 1 - Post 2 | Pre - Post 2 |
| Body weight(kg) | Male | 4.93 ± 1.3** | 4.1 ± 1.41** | 8.84 ± 2.1** |
| | Female | 5.7 ± 2.1** | 3.07 ±1.46** | 8.53 ± 2.54** |
| BMI(kg/m$^2$) | Male | 1.75 ± 0.51** | 1.4 ± 0.45** | 3.03 ± 0.73** |
| | Female | 2.29 ± 0.82** | 1.2 ± 0.55** | 3.39 ± 0.97** |
| Waist circumference(cm) | Male | 3.17 ± 2.56* | 2.51 ±1.08* | 4.99 ± 1.61* |
| | Female | 2.96 ± 2.15* | 5.06 ±2.32* | 1.95 ± 0.76** |
| Hip circumference(cm) | Male | 1.93 ± 1.03* | 0.92 ±0.94* | 2.53 ± 1.31* |
| | Female | 2.38 ± 1.13* | 1.64 ± 0.7* | 4.08 ± 1.09* |
| Waist-hip ratio | Male | 0.01 ± 0.02 | 0.01 ± 0.01 | 0.03 ± 0.02 |
| | Female | 0.01 ± 0.02 | 0.00 ± 0.01 | 0.01 ± 0.02 |
| Serum MDA(μ mol/L) | Male | 0.21 ± 0.16** | 0.45 ± 0.24** | 0.45 ± 0.24** |
| | Female | 0.2 ± 0.14 * | 0.38 ± 0.15* | 0.38 ± 0.15 * |
| Serum TAS(mol/L) | Male | -0.14 ± 0.07* | -0.26 ± 0.14** | -0.26 ± 0.14 ** |
| | Female | -0.23 ± 0.11* | -0.39 ± 0.18* | -0.39 ± 0.18 * |

** p <0.001 - Highly significant, * p <0.05 – Significant, BMI-Body mass index, MDA-Malondialdehyde, TAS-Total antioxidant status

Comparison of observed change in the variables across the gender using Mann-Whitney test indicated significant changes in BMI, hip circumference, waist-hip ratio and serum TAS across the gender whereas no significant changes were observed in body weight, waist circumference and MDA level between the genders.

**Table 3: Comparison of observed change in the variables across the gender using Mann-Whitney test**

| Variable | Gender | Observed change (Mean±SD) | Mann-Whitney test Z-value | p-value |
|---|---|---|---|---|
| Body weight(kg) | Male | 8.84 ± 2.1** | 0.65 | 0.52 |
| | Female | 8.53 ± 2.54* | | |
| BMI(kg/m$^2$) | Male | 3.03 ± 0.73** | 2.03 | <0.05* |
| | Female | 3.39 ± 0.97* | | |
| Waist circumference(cm) | Male | 4.99 ± 1.61 | 0.16 | 0.872 |
| | Female | 1.95 ± 0.76 | | |
| Hip circumference(cm) | Male | 2.53 ± 1.31 | 6.30 | <0.001** |
| | Female | 4.08 ± 1.09 | | |
| Waist-hip ratio | Male | 0.03 ± 0.02 | 3.09 | <0.05* |
| | Female | 0.01 ± 0.02 | | |
| Serum MDA(μ mol/L) | Male | 0.45 ± 0.24** | 1.76 | 0.081 |
| | Female | 0.38 ± 0.15* | | |
| Serum TAS(mol/L) | Male | -0.26 ± 0.14** | 3.98 | <0.001** |
| | Female | -0.39 ± 0.18* | | |

** p <0.001 - Highly significant, * p <0.05 – Significant, BMI-Body mass index, MDA-Malondialdehyde, TAS- Total antioxidant status

## 4. DISCUSSION

The results of the study revealed that six months of yoga practice has significantly improved body weight, BMI and oxidative stress markers in both male and female subjects with obesity. It has been stressed that weight loss is the key contributor towards correction of dyslipidemia[13], especially by reduction in visceral fat[14]. Weight loss is related to the reduction in the risk for diabetes and cardiovascular disease through improvements in blood pressure, TG, and HDL-cholesterol in obese subjects[15,16]. In the present study, the body weight loss observed after yoga training is explained by the significant improvement in the waist circumference which may indicate the loss of visceral fat. Consistent with our findings, similar results have been reported after 8 weeks of exercise training in obese and lean adolescent[17,18]and Benavidses and Caballero reported that yoga training has significantly decreased body weight in children[19]. The decrease in body weight, BMI, FM, and BF % in the yoga group may have been related to an increase in BMR following yoga training. In this context, *yoga-asana* training provided an alternative option for increasing the physical activity levels required to improve body composition and BMR in obese adults, as shown with conventional exercise training programs[20].

Our study results showed significant reduction in serum malondialdehyde level and improvement in the total antioxidant status in obese subjects of both the genders following yoga practice. In obese humans, adipose tissue is characterized by increased local and systemic production of pro-inflammatory adipocytokines[21,] which induce the production of reactive oxygen species. Increased oxidative stress leads to important changes in adipose tissue that promotes a systemic low-grade inflammatory response with adverse effects throughout the body[22]. Earlier studies have also shown beneficial effects of yoga in reducing inflammation by reduction in stress level[23]. Decrease in serum malondialdehyde level and improvement in the total antioxidant status proves beneficial effects of yoga practice in combating oxidative stress and thereby preventing the complications caused by oxidative stress in obese adults.

## 5. CONCLUSION

Obesity, especially visceral adiposity, increases the secretion of various inflammatory cytokines and other biomolecules. Chronic elevation of these inflammatory mediators leads to cardiovascular morbidity and mortality. Yoga-based lifestyle intervention can effectively prevent and retard the progression of cardiovascular and metabolic disorders. The mechanism of action of such benefit may be attributed to a reduction in weight and stress, networking at mind and body levels, thereby leading to a reduction in inflammation, and causation and progression of the disease.

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