



endogenous as well as dietary antioxidants. The level of oxidative stress depends on the balance between production of ROS and their quenching by antioxidant mechanisms. Psychosocial stress increases oxidative stress (4), possibly by increasing the production of ROS. Correspondingly, a few recent studies have shown that relaxation techniques reduce oxidative stress (5–7). Since only a few studies of this type are available, more studies are needed to establish the place of various relaxation techniques in mitigating the biochemical effects of psychosocial stress. Our study is an attempt in that direction. One of the indicators of oxidative stress is the degree of lipid peroxidation. Lipid peroxidation is thought to be a major factor in pathogenesis of many human diseases (8). Lipid peroxidation may be assessed from the blood concentration of lipid peroxidation products as measured by thiobarbituric acid reactive substances (TBARS), of which malondialdehyde (MDA) is a principal constituent. We have measured the concentration of TBARS in the blood of patients undergoing a comprehensive yoga-based lifestyle modification program at the beginning and end of the program.

## METHODS

The study is the result of data collected on patients attending a yoga-based lifestyle modification program (YLMP) at the Integral Health Clinic (IHC) of All India Institute of Medical Sciences, New Delhi.

### Subjects

The data was collected on 104 subjects (59 male, 45 female) who attended one of

the YLMs conducted between January and October 2003. The subjects included those having hypertension, coronary artery disease, diabetes, bronchial asthma, headache, backache, anxiety, stress, premenstrual syndrome, irritable bowel syndrome, peptic ulcer, and a variety of other conditions; a few subjects went through the intervention also for prevention of disease although they had no significant health problem.

### Study design

The study was based on a before-after design. Fasting venous blood samples were collected between 8.15 and 8.45 a.m. at the beginning (day 1) and end (day 10) of the YLMP for estimation of TBARS.

### The intervention

Each YLMP consists of a 9-day educational out-patient course on the theory and practice of yoga. About 8 patients are enrolled for each course, and a new course begins every alternate week. The patients spend 3–4 hours each day on the course. A typical day in the course starts with a set of asanas and pranayama for one hour. After a short break for breakfast, there is a lecture or a film, following which the patients relax in shavasana or meditation for about 20 min. Two of the patients stay back each day for individualized counseling, so that by the end of the course, each patient has had at least one session on a one-to-one basis with the doctor. An outline of the protocol, and the list of asanas included in the course, have been given in appendices 1 and 2 respectively. The protocol of the intervention has been described in detail earlier (9).

**Appendix 1****Protocol of the Course at IHC**

<b>Day 0</b>	History
<b>Day 1: Wednesday</b>	<i>Fasting blood sample</i> Introduction to one another Lecture: Introduction to yoga Practice: Shavasana
<b>Day 2: Thursday</b>	Practice: Asanas & Pranayama* Break Lecture: Meditation Practice: Meditation Individualized advice (2 patients)
<b>Day 3: Friday</b>	Practice: Asanas & Pranayama Break Lecture: Fundamentals in nutrition Practice: Meditation Individualized advice (2 patients)
<b>Day 4: Saturday</b>	Practice: Asanas & Pranayama
<b>Day 5: Sunday</b>	Off
<b>Day 6: Monday</b>	Practice: Asanas & Pranayama Break Film: Samattvam (Equanimity) Practice: Meditation/Shavasana
<b>Day 7: Tuesday</b>	Practice: Asanas & Pranayama Break Film: Stress management Practice: Meditation/Shavasana
<b>Day 8: Wednesday</b>	Practice: Asanas & Pranayama Break Lecture: About your illness Practice: Meditation/Shavasana Individualized advice (2 patients)
<b>Day 9: Thursday</b>	Practice: Asanas & Pranayama Break Lecture: Yogic attitude in daily life Practice: Meditation / Shavasana Individualized advice (2 patients)
<b>Day 10: Friday</b>	<i>Fasting blood sample</i> Practice: Asanas & Pranayama Break Lecture: Stress management Practice: Meditation/Shavasana Closing session

\*Details in Appendix 2

**Appendix 2****The set of asanas and pranayama included in the course**

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- I. Humming in meditative posture-Vajrasana (Thunderbolt Pose)/Padmasana (Lotus Pose)/Sukhasana (Easy Pose)
  - II. BREATHING TECHNIQUES
    1. Dog breathing
    2. Tiger breathing
    3. Hands in and out breathing
    4. Hands interlocked, kept on chest, stretching, in three positions
    5. Ankle stretch breathing
  - III. LOOSENING EXERCISES  
Warm ups: starting from the head, working towards the toes.
    1. Neck rolls
    2. Shoulder rotation
    3. Arm rotation
    4. Elbow movements
    5. Wrist movements
    6. Finger movements
    7. Waist movements
    8. Knee rotation
    9. Ankle rotation
    10. Toe movements
  - IV. QUICK RELAXATION IN SHAVASANA (CORPSE POSE)
  - V. ASANAS
    - (a) Standing
      1. Ardhakatichakrasana (lateral arc pose)
      2. Padahasthasana (forward bend pose)
      3. Ardhashchakrasana (backward bend pose)
      4. Vrikshasana (tree pose)
    - (b) Sitting
      1. Ardhamatsyendrasana (half-spinal twist pose)
      2. Paschimatanasana (back stretch pose)
      3. Konasana (angular pose)
    - (c) Lying on stomach (prone)
      1. Makarasana (crocodile pose)
      2. Bhujangasana (cobra pose)
      3. Dhanurasana (bow pose)

- (d) Lying on back (supine)
1. Uttitapadasana (straight leg raising)
  2. Sarvangasana (shoulder stand pose)
  3. Matsyasana (fish pose)
  4. Pavanmuktasana (wind relieving pose)
  5. Setubandhasana (bridge pose)

VI. DEEP RELAXATION IN SHAVASANA (CORPSE POSE)

VII. PRANAYAMA (BREATHING PRACTICES)

1. Bhastrika (rapid breathing)
2. Nadi shuddhi (alternate nostril breathing)
3. Bhramari (honeybee sound during expiration)

VIII. QUICK RELAXATION IN SHAVASANA (CORPSE POSE)

IX. Humming in meditative posture-Vajrasana (Thunderbolt Pose)/Padmasana (Lotus Pose)/Sukhasana (Easy Pose)

## RESULTS & DISCUSSION

The physical characteristics of the subjects have been summarized in Table I. The serum concentration of TBARS at the beginning of the intervention was  $1.72 \pm 0.72$  nmoles/ml and at the end was  $1.57 \pm 0.72$  nmoles/ml ( $P < 0.05$ ).

TABLE I: Physical characteristics of subjects.

	<i>Mean±SD</i>	<i>Range</i>
Age (years)	41.24±14.61	19 – 71
Weight (kg)	66.13±11.97	45 – 114
Height (cm)	163.33±9.15	143 – 184
BMI (kg/m <sup>2</sup> )	24.81±4.13	16.30 – 38.39

### Measurements

Serum was separated from the blood samples within 2 hours and was stored at  $-16^{\circ}\text{C}$  till analysis. Samples were analyzed within a week after blood collection. TBARS were measured by the colorimetric method at 535 nm (10). Calibration was done using 1,1,3,3-tetraethoxypropane (Sigma) as standard. The inter-assay variability (same sample run in 10 different assays on different days) and intra-assay variability (same sample run 10 times in same assay on same day) in our laboratory was checked. The inter assay coefficient of variation was 7.8% and intra assay coefficient of variation was 1.8%. All the samples were run in duplicates.

### Statistical analysis

The mean values on day 1 and day 9 were compared using Student's *t*-test for paired observations. The differences were considered significant if  $P < 0.05$ .

We have earlier demonstrated the efficacy of the intervention in reducing fasting plasma glucose and improving lipid profile (11), and also in reducing anxiety levels (12) and improving subjective well-being (13).

The present study now suggests that a yoga-based short-term intervention reduces oxidative stress in a sample that includes healthy subjects as well as those having a variety of chronic diseases. It thus confirms the results of the very few similar studies already available (5–7). The significance of the study lies in the brief duration and low cost of the intervention. After attending the structured program at IHC, the patient can continue the physical practices, relaxation techniques, dietary regulation and positive thinking in his everyday life without spending anything. On the contrary, reduction in the expenditure on medication, hospital visits, high fat or non-vegetarian foods, cigarettes and alcohol, is likely to save the patient some money.

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