

A Brief but Comprehensive Lifestyle Education Program Based on Yoga Reduces Risk Factors for Cardiovascular Disease and Diabetes Mellitus

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ABSTRACT

Objectives: The objective of the study was to study the short-term impact of a brief lifestyle intervention based on yoga on some of the biochemical indicators of risk for cardiovascular disease and diabetes mellitus.

Design: The variables of interest were measured at the beginning (day 1) and end (day 10) of the intervention using a pre–post design.

Setting: The study is the result of operational research carried out in our Integral Health Clinic (IHC). The IHC is an outpatient facility which conducts 8-day lifestyle modification programs based on yoga for prevention and management of chronic disease. A new course begins every alternate week of the year.

Subjects: The study is based on data collected on 98 subjects (67 male, 31 female), ages 20–74 years, who attended one of our programs. The subjects were a heterogeneous group of patients with hypertension, coronary artery disease, diabetes mellitus, and a variety of other illnesses.

Intervention: The intervention consisted of *asanas* (postures), *pranayama* (breathing exercises), relaxation techniques, group support, individualized advice, lectures and films on the philosophy of yoga and the place of yoga in daily life, meditation, stress management, nutrition, and knowledge about the illness.

Outcome measures: The outcome measures were fasting plasma glucose and serum lipoprotein profile. These variables were determined in fasting blood samples, taken on the first and last day of the course.

Results: Fasting plasma glucose, serum total cholesterol, low-density lipoprotein (LDL) cholesterol, very-LDL cholesterol, the ratio of total cholesterol to high density lipoprotein (HDL) cholesterol, and total triglycerides were significantly lower, and HDL cholesterol significantly higher, on the last day of the course compared to the first day of the course. The changes were more marked in subjects with hyperglycemia or hypercholesterolemia.

Conclusions: The observations suggest that a short lifestyle modification and stress management education program leads to favorable metabolic effects within a period of 9 days.

INTRODUCTION

An improper diet, inadequate physical activity, and mental stress are considered to be major components of an unhealthy lifestyle that contributes significantly to the pathogenesis of cardiovascular disease (CVD), diabetes mellitus (DM), and several other disorders. Among the approaches

to prevention and management of these diseases has been the search for healthy lifestyles and better strategies for overcoming mental stress. These explorations have led us to ancient disciplines such as yoga, which combine the physical elements of a healthy lifestyle with potent prescriptions for abiding mental peace (Bijlani, 2003). Further, the growth of psychoneuroimmunology has strengthened the scientific

foundations of mind–body medicine (Kiecolt-Glaser et al., 2002) and an emphasis on the behavioral aspects of healthy lifestyles. Considerable evidence exists for the place of mind–body medicine in the treatment of hypertension, coronary artery disease, insomnia, incontinence, headache, chronic pain, stress-related symptoms in cancer, anxiety disorders, and premenstrual syndrome (Astin et al., 2003; Barrows and Jacobs, 2002).

The efficacy of lifestyle interventions incorporating elements of yoga or other similar disciplines has been widely reported in CVD (Damodaran et al., 2002; Jatuporn et al., 2003; Kennedy et al., 2002; Koertge et al., 2003; Mahajan et al., 1999; Manchanda et al., 2000; Ornish et al., 1998; Sebregts et al., 2003; Yogendra et al., 2004; Zamarra et al., 1996) and DM (Jain et al., 1993; Knowler et al., 2002; Malhotra et al., 2002; Monro et al., 1992; Rugmini and Sinha, 1995; Sahay, 1986). But few previous studies have looked at the outcomes of lifestyle interventions lasting less than 4 weeks. The present study evaluates the changes seen in fasting plasma glucose and serum lipoprotein profile while completing a comprehensive but brief lifestyle modification educational program based on the principles of yoga.

MATERIALS AND METHODS

The study is based on data collected on 98 subjects (67 male, 31 female), ages 20–74 years (mean, 46.3 ± 12.5 years), who attended one of our programs between May 2001 and November 2002. The disease conditions of the patients is given in Table 1.

The program

The program consisted of an integrated package of theory and practice sessions, 3–4 hours each day of an 8-day outpatient course, interrupted by a 2-day weekend break. The course was given to groups of 6–8 patients at a time. A typical day in the course started with a set of simple *asanas* (physical postures) and *pranayama* (breathing exercises) for approximately one hour. The next activity, after a short interval for breakfast, was a lecture or a video. Besides providing elementary facts about nutrition and the specific diseases of the patients, these sessions introduced the patients to the principles of yoga and yogic techniques.

Although group as well as individual nutrition education was imparted, meals were not provided as part of the program, so making dietary changes in light of what they learned from the program was left to the individuals. The diet recommended was predominantly vegetarian, consisting of a combination of cereals and pulses, preferably unrefined, as the staple food; moderate amounts of judiciously chosen fat; about 500 g of vegetables and fruits daily, vegetables predominantly of the leafy green variety and at least

TABLE 1. DISTRIBUTION OF CONDITIONS IN 98 PATIENTS IN THE STUDY

<i>Condition</i>	<i>Number</i>
Hypertension	26
Coronary heart disease	25
Diabetes mellitus	20
Psychologic problems (including anxiety, stress, depression, and insomnia)	8
Tension headache	6
Backache	13
Osteoarthritis	8
Cervical spondylosis	6
Peptic ulcer/acid dyspepsia	6
Constipation	1
Obesity	8
Bronchial asthma	5
Miscellaneous	16
Total (some patients had more than one condition)	148

some eaten raw; moderate amounts of milk and milk products (yogurt was suggested); and spices in moderation.

One full session was devoted to the principles and practice of meditation, and two to stress management. Questions and unstructured discussion were encouraged. Each day's program ended with relaxation through either *shavasana* (a relaxation technique) or meditation. Autosuggestion and imagery were encouraged during relaxation to promote self-healing.

The patients were also given a few booklets to reinforce what was discussed in the lectures. On one of the days, the patients received individualized advice in a one-to-one session with a doctor. This session included advice on diet, physical activity, smoking, drinking, mental relaxation, and also provided the patient with a good listener for his or her personal problems. The spouse and other members of the patient's family were encouraged to attend the course to facilitate compliance. Attending the course cost the patient (including the accompanying members of the family) a nominal registration fee of 200 Rupees (about \$5). The protocol of the course is given in Appendix 1, and the set of *asanas* and *pranayama* included in the course in Appendix 2.

Study design

Fasting blood samples were drawn from the antecubital vein for determination of fasting plasma glucose (FPG) and serum lipid profile on the first day (day 1) to assess baseline values, and on the last day (day 10) of the course to assess the effects, if any, of the intervention. Complete FPG data could be collected for only 77 of the patients: the incomplete data on the remaining 21 patients was due to inadequate blood samples, or the patients having had tea that morning. The data analysis for plasma glucose is based on the values obtained from the 77 patients who provided complete data.

TABLE 2. MEAN FASTING PLASMA GLUCOSE ($N = 77$) AND SERUM LIPID PROFILE ($n = 98$) AT THE BEGINNING AND END OF THE COURSE

Variable	Initial (Day 1)	Final (Day 10)	p
Fasting plasma glucose (mg/dL)	106.7 $\pm$ 32.6	100.2 $\pm$ 29.7	<0.001
Total cholesterol (mg/dL)	193.2 $\pm$ 36.4	185.8 $\pm$ 32.7	<0.001
LDL cholesterol (mg/dL)	119.3 $\pm$ 30.1	114.9 $\pm$ 27.1	<0.01
HDL cholesterol (mg/dL)	43.1 $\pm$ 8.6	44.3 $\pm$ 9.0	<0.001
VLDL cholesterol (mg/dL)	29.4 $\pm$ 14.7	26.3 $\pm$ 13.8	<0.01
Total:HDL cholesterol	4.6 $\pm$ 1.2	4.3 $\pm$ 1.0	<0.001
Triglycerides (mg/dL)	130.2 $\pm$ 50.9	120.3 $\pm$ 45.1	<0.01

LDL, low-density lipoprotein cholesterol; HDL, high-density lipoprotein cholesterol VLDL, very low-density lipoprotein cholesterol.

Measurements

Plasma glucose was determined by the glucose oxidase method. Total cholesterol, high density lipoprotein (HDL) cholesterol, low density lipoprotein (LDL) cholesterol, and triglycerides were determined by the enzymatic method. Briefly, cholesterol or triglycerides in the sample were oxidized enzymatically, releasing hydrogen peroxide. Hydrogen peroxide, in the presence of peroxidase, interacts with 4-chlorophenol and 4-aminoantipyrene to yield quinoneimine, which can be measured colorimetrically from absorbance at 546 nm. HDL cholesterol was measured after precipitating LDL and very-LDL (VLDL) cholesterol by addition of phosphotungstic acid in the presence of magnesium ions. LDL was measured after precipitating it with heparin at pH 5.04. Thus the LDL fraction was determined directly; it was not calculated by the Friedwald formula. The intra-assay and inter-assay variation was < 3% for glucose, and < 5% for total cholesterol, HDL cholesterol, and triglycerides. For LDL cholesterol, the intra-assay variation was < 5% but the inter-assay variation was < 10%. For all measurements, kits from Randox Laboratories (Antrim, UK) were used. VLDL cholesterol and total cholesterol/HDL cholesterol ratio were calculated

mathematically from the above measurements (VLDL = total cholesterol – LDL – HDL).

Statistical analysis

The levels of the variables measured on day 1 were compared with the levels on day 10 using Student's *t*-test for paired observations. Differences were considered significant if $p < 0.05$.

RESULTS

The levels of the variables measured at the beginning (day 1) and end (day 10) of the course are given in Table 2. At the end of the course, fasting plasma glucose, serum total cholesterol, LDL cholesterol, VLDL cholesterol, total cholesterol/HDL cholesterol ratio, and triglycerides were significantly lower, and HDL cholesterol significantly higher, than at the beginning. The changes were more marked in subjects having hyperglycemia or hypercholesterolemia. The cut-off levels chosen for subset analysis were 104 mg/dL for initial fasting plasma glucose and 200 mg/dL for initial total cholesterol (Table 3, Figs. 1, 2). In

TABLE 3. MEAN SERUM LIPID PROFILE AT THE BEGINNING AND END OF THE COURSE

	Normocholesterolemic group ($n = 55$) (initial total cholesterol <200 mg/dL)			Hypercholesterolemic group ($n = 43$) (initial total cholesterol $\geq$ 200 mg/dL)		
	Initial (Day 1)	Final (Day 10)	p	Initial (Day 1)	Final (Day 10)	p
Total cholesterol (mg/dL)	166.7 $\pm$ 20.5	163.6 $\pm$ 19.3	0.003	227.2 $\pm$ 20.2	214.3 $\pm$ 22.8	<0.001
LDL cholesterol (mg/dL)	98.5 $\pm$ 17.0	96.6 $\pm$ 17.1	0.265	145.9 $\pm$ 20.7	138.3 $\pm$ 17.9	<0.001
HDL cholesterol (mg/dL)	43.1 $\pm$ 8.4	44.1 $\pm$ 9.2	0.003	43.0 $\pm$ 8.9	44.5 $\pm$ 8.8	<0.005
VLDL cholesterol (mg/dL)	23.7 $\pm$ 12.8	23.2 $\pm$ 12.5	0.676	36.7 $\pm$ 13.8	30.2 $\pm$ 14.6	<0.001
Total:HDL cholesterol	3.97 $\pm$ 0.76	3.83 $\pm$ 0.78	0.001	5.48 $\pm$ 1.09	4.96 $\pm$ 0.96	<0.001
Triglycerides (mg/dL)	113.6 $\pm$ 46.5	110.5 $\pm$ 38.1	0.426	151.5 $\pm$ 48.9	132.7 $\pm$ 50.5	<0.001

LDL, low-density lipoprotein cholesterol; HDL, high-density lipoprotein cholesterol VLDL, very low-density lipoprotein cholesterol.

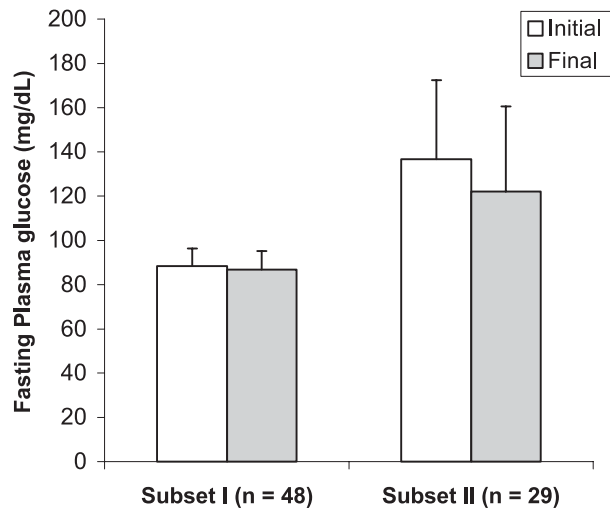


FIG. 1. Fasting plasma glucose levels on the first day (day 1) and last day (day 10) of the program in patients having initial (day 1) values < 104 mg glucose/dL (Subset I) and $\geq$ 104 mg/dL (Subset II). Bars represent mean $\pm$ standard deviation.

subjects who had initial fasting plasma glucose levels of 104 mg/dL or higher, the reduction was much greater than the inter-assay variation of < 3%. Similarly, in the case of subjects having initial total serum cholesterol level of 200 mg/dL or higher, the reduction in VLDL cholesterol and triglyceride levels was much greater than the inter-assay variation of < 5%.

DISCUSSION

The present study shows that measurable improvement in biochemical indices occurs within 9 days as the result of an intervention that combines daily practice of asanas, pranayama, relaxation techniques (shavasana and meditation), and advice about diet, stress management, and other aspects of lifestyle. Each of these measures individually can influence the biochemical profile favorably. Asanas led to a reduction in fasting and postprandial blood glucose in patients with DM (Sahay, 1986). *Pranayama* has also been reported to lower fasting blood glucose and serum cholesterol (Naruka et al., 1986). Appropriate dietary changes are an established component in the management of DM and CVD because of their demonstrated effects on glucose tolerance

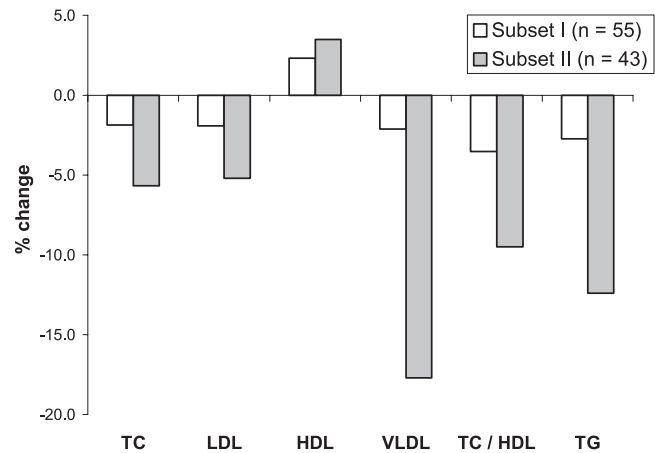


FIG. 2. Percentage change in various constituents of lipoprotein profile over the 9-day program in patients having initial (day 1) values < 200 mg total cholesterol/dL (Subset I; initial VLDL [mean] 23.7 mg/dL; final 23.2 mg/dL, % change -2.1%) and $\geq$ 200 mg/dL (Subset II; initial VLDL 36.7 mg/dL; final, 30.2 mg/dL; % change -17%). TC, total cholesterol; LDL, low-density lipoprotein (cholesterol); HDL, high-density lipoprotein (cholesterol); VLDL, very-low-density lipoprotein (cholesterol); TC/HDL, total cholesterol/high-density lipoprotein (cholesterol) ratio; TG, triglycerides.

and lipoprotein profile (Anderson, 1999; NCEP, 2001). There is ample theoretical basis (Bijlani and Manchanda, 1981; Surwit and Feinglos, 1988) and some clinical evidence (Aikens and Mayes, 1997) indicating that prolonged mental stress might be a risk factor for DM. The diabetogenic effect of stress is mediated primarily by the sympathetic nervous system (Bruce et al., 1992). Sympathetic overactivity can be checked by yogic relaxation (Vempati and Telles, 2002); relaxation improves glucose tolerance (Surwit and Feinglos, 1983), and alpha-adrenergic blockade has been shown to improve glucose-potentiated insulin secretion in non-insulin-dependent DM (Broadstone et al., 1987). Mental stress, including examination stress, has been shown to raise serum cholesterol (Bijlani et al., 1986; Francis, 1979), and mental relaxation through meditation and other relaxation techniques has been shown to lower serum cholesterol (Cooper and Aygen, 1979; Helminen et al., 1999). Therefore it is not surprising that the biochemical profile of the patients improved when attention was paid to physical activity, stress reduction, and diet. The reduction in the risk factors investigated is modest but significant because it was achieved in a very short time by a very simple and inexpensive intervention.

TABLE 4. MEAN SUBJECTIVE WELLBEING AND ANXIETY LEVELS AT THE BEGINNING AND END OF THE COURSE

	Initial (Day 1)	Final (Day 10)	p
Subjective wellbeing score (n = 33)	70.9 $\pm$ 9.83	75.1 $\pm$ 8.97	<0.001
Anxiety score (n = 38)			
State	1.96 $\pm$ 0.54	1.78 $\pm$ 0.5	<0.05
Trait	2.02 $\pm$ 0.52	1.89 $\pm$ 0.43	0.08

But lifestyle is an integrated entity, and an intervention that aims at influencing the total lifestyle has much in its favor, compared to changing only one aspect at a time. First, the effects of the changes may be additive or synergistic. Second, a total change is sometimes easier to bring about than piecemeal changes. For example, giving up smoking is easier if the psychologic factors which make smoking seem necessary disappear (Ornish, 1996). Yoga goes to the roots of a poor lifestyle, and when presented in a comprehensive manner, tends to convince the patient that a good lifestyle is not only healthier, but also more enjoyable than a poor lifestyle. If the patients introduce lifestyle changes because they want to, rather than because they have to, the changes are less likely to be stressful. The stress resulting from a change adopted in isolation, such as a daily exercise regimen or withdrawal of cherished foods in favor of leafy green vegetables, can do more harm than the good that could result from the healthy practice (Chopra, 1998).

This study did not include a control group. Therefore it is difficult to rule out or assess the contribution of several subtle factors which might have contributed to the changes observed. Faith in the efficacy of the intervention (placebo effect), and the general improvement in psychologic well-being due to group support, as well as the opportunity to get away from a stressful environment at home or the workplace might be just as important as the specific measures for stress management. That the patients felt distinctly better at the end of the course than at the beginning has been confirmed from the responses to a subjective well-being inventory (Sell and Nagpal, 1992) and a state and trait anxiety inventory (Spielberger et al., 1970) administered at the beginning and end of the course to another set of patients who received the same intervention (Table 4).

The improvement in biochemical indices is clinically relevant in spite of the heterogeneous patient profile. The magnitude of the changes may be small but their significance lies in demonstrating that a simple, inexpensive, essentially educational intervention can make an appreciable contribution to primary prevention as well as management. Even for persons whose plasma glucose or serum lipoprotein profiles are in the normal range, a further improvement is valuable in terms of primary prevention of DM and CVD. Greater improvement was seen in patients with high glucose and cholesterol levels, possibly because the scope for reduction was greater, but it could also be partly due to regression to the mean. But the improvement remained statistically significant even after the results on these patients were pooled with those of patients with initial values in the normal range. This further adds to the physiologic and clinical relevance of the observations.

This study examines only the short-term impact of the educational program. There is need for further studies to examine the long-term compliance and impact of the intervention.

ACKNOWLEDGMENTS

The technical help rendered by Promila Kapoor, B.A., Dip. M.L.T. [Medical Laboratory Techniques], Suman Thakur, Pawan Kumar, and Rakesh Kumar is gratefully acknowledged.

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APPENDIX 1. PROTOCOL OF THE COURSE

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

 APPENDIX 2. THE SET OF ASANAS AND PRANAYAMA INCLUDED IN THE COURSE

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: Ardhakatichakrasana (lateral arc pose)
Padahasthasana (forward bend pose)
Ardhachakrasana (backward bend pose)
Vrikshasana (tree pose)
- (b) Sitting: Ardhamatsyendrasana (half-spinal twist pose)
Paschimatanasana (back stretch pose)
Konasana (angular pose)
- (c) Lying on stomach (prone): Makarasana (crocodile pose)
Bhujangasana (cobra pose)
Dhanurasana (bow pose)
- (d) Lying on back (supine): Uttitapadasana (straight leg raising)
Sarvangasana (shoulder stand pose)
Matsyasana (fish pose)
Pavanmuktasana (wind relieving pose)
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)
