Chapter – II

REVIEW OF RELATED LITERATURE

For all investigations, the literature in the concerned area forms the basis for the study. After going through the available literature, the investigator has presented some of the observations and findings of the experts in the area.

The literature in any field forms the foundation upon which all future work will build. The study of relevant literature is an essential step to get a full picture of what has been done and said with regard to the problem under study. A review of literature is the basis for most of research projects in physical science, natural science, social science and humanities. Such a review brings about a deep insight and a clear perspective of the overall field.

The review of literature was confined to the libraries of Annamalai University, Pondicherry University, Lakshmibai National Institute of Physical Education, Gwalior, National Science Institute, New Delhi, Lakshmibai National Institute of Physical Education, Thiruvanandhapuram and, Sports Authority of India (Southern Centre), Bangalore.
The present study is to find out the effect of yogic practices on selected physical fitness, physiological and biochemical parameters among women diabetes patients. After outlining the problem the next step will be to examine the literature, to identify properly the extent of the problem, to develop an understanding of the various techniques available for such a study and to develop ideas that will contribute to the overall rational and interpretation of results.

Yoga, a form of physical activity, is rapidly gaining in popularity and has many health benefits. Yet healthcare providers have been slow to recognize yoga for its ability to improve health conditions, and few interventions have been developed that take full advantage of its benefits. The purpose of this article is to review published studies using yoga programs and to determine the effect of yoga interventions on common risk factors of chronic diseases (overweight, hypertension, high glucose level and high cholesterol). A systematic search yielded 32 articles published between 1980 and April 2007. The studies found that yoga interventions are generally effective in reducing body weight, blood pressure, glucose level and high cholesterol, but only a few studies examined long-term
adherence. Additionally, not enough studies included diverse populations at high risk for diabetes and its related common health problems.\textsuperscript{51}

The state of the mind and that of the body are intimately related. If the mind is relaxed, the muscles in the body will also be relaxed. Stress produces a state of physical and mental tension. Yoga, developed thousands of years ago, is recognized as a form of mind-body medicine. In yoga physical postures and breathing exercises improve muscle strength, flexibility, blood circulation and oxygen uptake as well as hormone functions. In addition, the relaxation induced by meditation helps to stabilize the autonomic nervous system with a tendency towards parasympathetic dominance. Physiological benefits, which follow, help yoga practitioner become more resilient to stressful conditions and reduce a variety of important risk factors for various diseases, especially cardio-respiratory diseases.\textsuperscript{52}


The objective of the study was to determine the effects of dynamic suryanamaskar (sun salutations) on the flexibility of selected physical education students at Banaras Hindu University, Varanasi. The subjects for this study were selected from the Department of physical education at Banaras Hindu University. A total of 20 male subjects were selected and used as one practice group. Dynamic suryanamaskar was considered the independent variable and flexibility was considered the dependent variable. Test was for flexibility. The repeated measures design was used for this study. Only one group of 20 participants was created. Tests were administered in equal intervals of two weeks. The tests started four weeks prior to the dynamic suryanamaskar (DSN) treatment and took place every two week thereafter, for a total of, three times. Tests took place every two weeks during the treatment and after the completion of the treatment, they were continued for the following four week period. To determine the effect of dynamic suryanamaskar on flexibility of selected physical education students at Banaras Hindu University, Varanasi, one way ANOVA was used at 0.05
levels of significance. In relation to flexibility, a significant (p<0.05) effect of dynamic suryanamaskar was found.53

Eighty subjects (females, n = 37) with CLBP, who consented were randomly assigned to receive yoga or physical exercise if they satisfied the selection criteria. The intervention consisted of a 1-week intensive residential yoga program comprised of asanas (physical postures) designed for back pain, pranayamas (breathing practices), meditation, and didactic and interactive sessions on philosophical concepts of yoga. The control group practiced physical exercises under a trained physiatrist and also had didactic and interactive sessions on lifestyle change. Both of the groups were matched for time on intervention and attention. Pain-related outcomes were assessed by the Oswestry Disability Index (ODI) and by spinal flexibility, which was assessed using goniometer at pre and post intervention. Data were analyzed using repeated measures analysis of variance (RMANOVA). Data conformed to a Gaussian distribution. There was a significant reduction in ODI scores in the yoga group compared to the control group (p < 0.01; effect size

Spinal flexibility measures improved significantly in both groups but the yoga group had greater improvement as compared to controls on spinal flexion ($p < 0.008; \text{effect size } 0.146$), spinal extension ($p < 0.002; \text{effect size } 0.251$), right lateral flexion ($p < 0.059; \text{effect size } 0.006$); and left lateral flexion ($p < 0.006; \text{effect size } 0.171$). Seven (7) days of a residential intensive yoga-based lifestyle program reduced pain-related disability and improved spinal flexibility in patients with CLBP better than a physical exercise regimen.\(^{54}\)

Twenty-two participants ($M = 4; F = 17$), between the ages of 30 and 65, with chronic low back pain (CLBP) were randomized to either an immediate yoga based intervention, or to a control group with no treatment during the observation period but received later yoga training. A specific CLBP yoga protocol designed and modified for this population by a certified yoga instructor was administered for one hour, twice a week for 6 weeks. Primary functional outcome measures included the forward reach (FR) and sit

---

and reach (SR) tests. All participants completed Oswestry Disability Index (ODI) and Beck Depression Inventory (BDI) questionnaires. Guiding questions were used for qualitative data analysis to ascertain how yoga participants perceived the instructor, group dynamics, and the impact of yoga on their life. To account for dropouts, the data were divided into better or not categories, and analyzed using chi-square to examine differences between the groups. Qualitative data were analyzed through frequency of positive responses. Potentially important trends in the functional measurement scores showed improved balance and flexibility and decreased disability and depression for the yoga group but this pilot was not powered to reach statistical significance. Significant limitations included a high dropout rate in the control group and large baseline differences in the secondary measures. In addition, analysis of the qualitative data revealed the following frequency of responses (1) group intervention motivated the participants and (2) yoga fostered relaxation and new awareness/learning. A modified yoga-based intervention may benefit individuals with CLB, but a larger study is necessary to provide definitive evidence. Also, the impact on depression and disability
could be considered as important outcomes for further study. Additional functional outcome measures should be explored. This pilot study supports the need for more research investigating the effect of yoga for this population.55

Twenty-six healthy adults age 20–58 (Mean 31.8) participated in six weeks of either astanga yoga or hatha yoga class. Significant improvements at follow-up were noted for all participants in diastolic blood pressure, upper body and trunk dynamic muscular strength and endurance, flexibility, perceived stress, and health perception. The improvements differed for each group when compared to baseline assessments. The astanga yoga group had decreased diastolic blood pressure and perceived stress, and increased upper body and trunk dynamic muscular strength and endurance, flexibility, and health perception. Improvements for the hatha yoga group were significant only for trunk dynamic muscular

---

strength and endurance, and flexibility. The findings suggest that the fitness benefits of yoga practice differ by style.\(^{56}\)

In recent times, medical fraternity is attracted towards yoga. Suryanamaskar is a part of yogic practices and is believed to be an all-round exercise. The present study tested efficacy of regular practice of ‘suryanamaskar’ in improving the cardio-respiratory fitness. The present study was conducted on 78 subjects, (48 males and 30 females). It was observed that 6 months of suryanamaskar practice decreases resting pulse rate and blood pressure. At the same time it increases cardio-respiratory efficiency and respiratory capacity as evaluated by bicycle ergometry and various lung functions tests, in both male and female subjects. From this study we conclude that suryanamaskar practice can be advocated to improve cardio-respiratory efficiency for patients as well as healthy individuals.\(^{57}\)


The objective of this study was to evaluate the immediate effect of slow pace bhatrika pranayama (respiratory rate 6/min) for 5 minutes on heart rate and blood pressure and the effect of the same breathing exercise for the same duration of time (5 minutes) following oral intake of hyoscine-N-butylbromide (Buscopan), a parasympathetic blocker drug. Heart rate and blood pressure of volunteers (n = 39, age = 25-40 years) was recorded following standard procedure. First, subjects had to sit comfortably in an easy and steady posture (sukhasana) on a fairly soft seat placed on the floor keeping head, neck, and trunk erect, eyes closed, and the other muscles reasonably loose. The subject is directed to inhale through both nostrils slowly up to the maximum for about 4 seconds and then exhale slowly up to the maximum through both nostrils for about 6 seconds. The breathing must not be abdominal. These steps complete one cycle of slow pace bhatrika pranayama (respiratory rate 6/min). During the practice the subject is asked not to think much about the inhalation and exhalation time, but rather was requested to imagine the open blue sky. The pranayama was conducted in a cool, well-ventilated room (18-20 degrees C). After 5 minutes of this breathing
practice, the blood pressure and heart rate again were recorded in the aforesaid manner using the same instrument. The other group (n = 10) took part in another study where their blood pressure and heart rate were recorded following half an hour of oral intake of hyoscine-N-butylbromide 20 mg. Then they practiced the breathing exercise as stated above, and the above mentioned parameters were recorded again to study the effect of parasympathetic blockade on the same pranayama. It was noted that after slow bhasrika pranayamic breathing (respiratory rate 6/min) for 5 minutes, both the systolic and diastolic blood pressure decreased significantly with a slight fall in heart rate. No significant alteration in both blood pressure and heart rate was observed in volunteers who performed the same breathing exercise for the same duration following oral intake of hyoscine-N-butylbromide. Pranayama increases frequency and duration of inhibitory neural impulses by activating pulmonary stretch receptors during above tidal volume inhalation as in Hering Bruer reflex, which bring about withdrawal of sympathetic tone in the skeletal muscle blood vessels, leading to widespread vasodilatation, thus causing decrease in peripheral resistance and thus decreasing the
diastolic blood pressure. Vagal cardiac and pulmonary mechanisms are linked, and improvement in one vagal limb might spill over into the other. Baroreceptor sensitivity can be enhanced significantly by slow breathing (supported by a small reduction in the heart rate observed during slow breathing and by reduction in both systolic and diastolic pressure). Slow pace bhastrika pranayama (respiratory rate 6/min) exercise thus shows a strong tendency to improving the autonomic nervous system through enhanced activation of the parasympathetic system.\textsuperscript{58}

Twenty Type 2 diabetic subjects between the age group of 30-60 years were studied to see the effect of 40 days of Yoga asanas on the nerve conduction velocity. The duration of diabetes ranged from 0-10 years. Subject suffering from cardiac, renal and proliferative retinal complications were excluded from the study Yoga asanas included Suryanamaskar. Tadasan, Konasan, Padmasan Pranayam, Paschimottansan Ardhmatsyendrasan, Shavasan, Pavanmukthasan, Sarpasan and Shavasan. Subjects were called to the cardio-respiratory laboratory in the morning time and were given training

by the Yoga expert. The Yoga exercises were performed for 30-40 minutes every day for 40 days in the above sequence. The subjects were prescribed certain medicines and diet. The basal blood glucose, nerve conduction velocity of the median nerve was measured and repeated after 40 days of Yogic regime. Another group of 20 Type 2 diabetes subjects of comparable age and severity, called the control group, were kept on prescribed medication and light physical exercises like walking. Their basal & post 40 days parameters were recorded for comparison. Right hand and left hand median nerve conduction velocity increased from 52.81 +/- 1.1 m/sec to 53.87 +/- 1.1 m/sec and 52.46 +/- 1.0 to 54.75 +/- 1/1 m/sec respectively. Control group nerve function parameters deteriorated over the period of study, indicating that diabetes is a slowly progressive disease involving the nerves. Yoga asanas have a beneficial effect on glycaemic control and improve nerve function in mild to moderate Type 2 diabetes with sub-clinical neuropathy.\textsuperscript{59}

Yoga has become increasingly popular in western cultures as a means of exercise and fitness training; however, it is still depicted as

trendy as evidenced by an April 2001 Time magazine cover story on “The Power of Yoga”. There is need to have yoga better recognized by the health care community as a complement to conventional medical care. Over the last 10 years, a growing number of research studies have shown that the practice of Hatha Yoga can improve strength and flexibility, and may help control such physiological variables as blood pressure, respiration and heart rate, and metabolic rate to improve overall exercise capacity. This review presents a summary of medically substantiated information about the health benefits of yoga for healthy people and for people compromised by musculoskeletal and cardiopulmonary disease.60

Harinath et al61 conducted a study to find out the effects of Hatha yoga and Omkar meditation on cardio-respiratory performance, psychological profile, and melatonin secretion. For this thirty healthy men in the age group of 25-35 years volunteered for the study. They were randomly divided in two groups of 15

each. Group I subjects served as control and performed body flexibility exercises for 40 minutes and slow running for 20 minutes during morning hours and played games for 60 minutes during evening hours daily for 3 months. Group II subject’s practices selected yogic asanas (postures) for 45 minutes and pranayama for 15 minutes during the morning, whereas during the evening hours these subjects performed preparatory yogic postures for 15 minutes, pranayama for 15 minutes, and meditation for 30 minutes daily, for 3 months. Orthostatic tolerance, heart rate, blood pressure, respiratory rate, dynamic lung function (such as forced vital capacity, forced expiratory volume in 1 second, forced expiratory volume percentage, peak expiratory flow rate and maximum voluntary ventilation), and psychological profile were measured before and after 3 months of yogic practices. Serial blood samples were drawn at various time intervals to study effects of these yogic practices and omkar meditation on melatonin levels. Yogic practices for 3 months resulted in an improvement in cardio-respiratory performance and psychological profile. The plasma melatonin also showed an increase after three months of yogic practices. The systolic blood
pressure, diastolic blood pressure, mean arterial pressure, and orthostatic tolerance did not show any significant correlation with plasma melatonin. However the maximum right time melatonin levels in yoga group showed a significant correlation with well-being score.

A study was undertaken to observe any beneficial effect of yogic practices during training period on the young trainees. 54 trainees of 20-25 years age group were divided randomly in two group i.e., yoga and control group. Yoga group (23 males and 5 females) was administered yogic practices for the first five months of the course while control group did not perform yogic exercises during this period. From the 6th to 10th month of training both the groups performed the yogic practices. Physiological parameters like heart rate, blood pressure, oral temperature, skin temperature in resting condition, responses to maximal and sub maximal exercise, body flexibility were recorded. Psychological parameters like personality, learning, arithmetic and psychomotor ability, mental well being was also recorded. There was improvement in performance at sub maximal level of exercise and in anaerobic
threshold in the yoga group. Shoulder, hip, trunk and neck flexibility improved in the yoga group. There was improvement in various psychological parameters like reduction in anxiety and depression and a better mental function after yogic practices.\textsuperscript{62}

The short-term effects of 4 weeks of intensive yoga practice on physiological responses in six healthy adult female volunteers were measured using the maximal exercise treadmill test. Yoga practice involved daily morning and evening sessions of 90 minutes each. Pre and post-yoga exercise performance was compared. Maximal work output (Wmax) for the group increased by 21% with a significant reduced level of oxygen consumption per unit work but without a concomitant significant change in heart rate. After intensive yoga training it was found that significant lower heart rate, reduced minute ventilation, reduced oxygen consumption per unit work and significantly lower respiratory quotient. The implication of the intensive yoga on cardio-respiratory efficiency, with the

suggestion, that yoga has some transparently different quantifiable physiological effects to other exercises.63

The present study aims at finding out the effect of yoga nidra on hypertension and other psychological co-relates. The study conducted at Patliputra Seva Sansthan Patna City, Patna. Practice time was 30 minutes and the duration was fifteen days. Forty people suffering with mild hypertension (30 males and 10 females) were taken for the study. Where the males were businessman and females were house wives. The result shows a significant change as yoga nidra positively decrease the blood pressure (both systolic and diastolic) as well as pulse rate, respiration rate, stress, anger and fear. Whereas no significant change shown at the depression level.64

Twenty five patients of essential hypertension were studied. Of these, 20 patients were not given any antihypertensive drug treatment (Group A); other 5 had to be put on antihypertensive drugs before including them in the study (Group B). These patients were demonstrated "Shavasana" and trained to perform it correctly.

---

Shavasana therapy was continued for six months. There was a statistically significant fall in both mean systolic and diastolic pressure of both groups. Further, there was a significant reduction in doses of antihypertensive drugs, being given to patients of group B. In 65% patients of group A, blood pressure could be controlled with Shavasana only and no drug was needed in them at all. Blood pressure rose significantly to pre-Shavasana levels in patients who left practising yoga. Thus, with use of yoga (Shavasana) in therapy of hypertension, requirement of antihypertensive drugs may be significantly decreased and in some cases may be totally dispensed with and it may be an useful adjunct in treatment of hypertension.65

The purpose of the study is to analyze the impact of yogic practices and physical exercises on selected physiological variables among the intercollegiate soccer players. To achieve this purpose, sixty (60) male intercollegiate soccer players from various colleges, Chennai were selected at random. Their age ranged between 17 to 22. The selected subjects were divided into three equal groups of 20 each, namely yogic practice group (Group A), physical exercises

group (Group B) and control group (Group C). The experimental
groups have underwent 12 weeks of training namely; yogic practices
and physical exercises respectively, whereas the control group
(Group C) maintained their daily routine activities and no special
training was given. The subjects of the three groups were tested
using standardized tests and procedures on selected physiological
variables before and after the training period to find out the training
efforts in the following test items: Resting pulse rate through
stethoscope, Breath holding time through digital stop watch, Peak
flow rate through Wright's peak flow meter. The collected data were
analyzed statistically through Analysis of Co-variance (ANACOVA)
and Scheffé S post - hoc test to find out the pre and post training
performances, compare the significant difference between the
adjusted final means and the better group. The yogic practice group
showed significant improvement due to 12 weeks training on resting
pulse rate, breath holding time and peak flow rate compared to the
physical exercise and control group. In the overall training effects in
terms of improved number of physiological variables and their
magnitude of improvement through training, yogic practice group is
found to be the better group when compared to the other two groups.\footnote{J. Rajkumar, “The Impact of Yogic Practices and Physical Exercises on Selected Physiological Variables Among Inter-collegiate Soccer Players”, \textit{Journal for Bloomers of Research}, 2:2, (February 2010), 160 - 164.}

On the basis of medical officers diagnosis, thirty three (N = 33) hypertensives, aged 35-65 years, from Govt. General Hospital, Pondicherry, were examined with four variables viz, systolic and diastolic blood pressure, pulse rate and body weight. The subjects were randomly assigned into three groups. The exp. group-I underwent selected yoga practices, exp. group-II received medical treatment by the physician of the said hospital and the control group did not participate in any of the treatment stimuli. Yoga imparted in the morning and in the evening with 1 hr/session. day-1 for a total period of 11-weeks. Medical treatment comprised drug intake every day for the whole experimental period. The result of pre-post test with ANCOVA revealed that both the treatment stimuli (i.e., yoga and drug) were effective in controlling the variables of hypertension.\footnote{R. Murugesan, N. Govindarajulu and T.K. Bera, “Effect of Selected Yogic Practices on the Management of Hypertension”, \textit{Indian J Physiol Pharmacol}, 44:2, (April 2000), 207 – 10.}
Madanmohan et al\textsuperscript{68} conducted a study on the effect of yoga training on visual and auditory reaction times (RTs), maximum expiratory pressure (MEP), maximum inspiratory pressure (MIP), 40 mmHg test, breath holding time after expiration (BHT exp), breath holding after inspiration (BHT insp) and hand grip strength (HGS). Twenty-seven student volunteers were given yoga training for 12-weeks. There was a significant decrease in visual RT, as well as auditory RT, while MIP increased from $72.23 \pm 6.45$ to $90.92 \pm 6.03$ mmHg both these changes being statistically significant ($P<0.05$). 40 mmHg test and HGS increased significantly ($P<0.001$). BHT exp and BHT insp also increased. Their results show that yoga practice for 12 weeks results insignificant reduction in visual and auditory RTs and significant increase in respiratory pressures breathe holding times and HGS.

This study was conducted to examine the effect of yoga on cardiovascular function in subjects above 40 yrs of age. Pulse rate, systolic and diastolic blood pressure and Valsalva ratio were studied in 50 control subjects (not doing any type of physical exercise) and

50 study subjects who had been practicing yoga for 5 years. From the study it was observed that significant reduction in the pulse rate occurs in subjects practicing yoga (P<0.001). The difference in the mean values of systolic and diastolic blood pressure between study group and control group was also statistically significant (P<0.01 and P<0.001 respectively). The systolic and diastolic blood pressure showed significant positive correlation with age in the study group (r1 systolic = 0.631 and r1 diastolic = 0.610) as well as in the control group (r2 systolic = 0.981 and r2 diastolic = 0.864). The significance of difference between correlation coefficient of both the groups was also tested with the use of Z transformation and the difference was significant (Zsystolic = 4.041 and Zdiastolic = 2.901). Valsalva ratio was also found to be significantly higher in yoga practitioners than in controls (P<0.001). Our results indicate that yoga reduces the age related deterioration in cardiovascular functions.69

Oak and Bhole\textsuperscript{70} in their experiment on the effect of pranayama on pulse rate, found that very slight decrease in pulse rate was observed during three attempts of Bahya Kumbaka with relaxed and sucked in condition as (Uddiyana) while it was found to increase slightly into protracted condition of the abdominal wall. It almost remained unchanged during the first minutes after three cycle of pranayamic breathing.

Udupa \textit{et al}\textsuperscript{71} selected twelve subjects and gave hatha yoga practices for a period of three months and they found that the lower level of pulse rate was maintained for three months it was concluded that physical stress of fast running had increased the pulse rate, however the difference was not statistically significant.

Gore and Bhole\textsuperscript{72} conducted a study to find out the effect of different muscular activity on pulse rate. One of the activities given for the subjects during the experimental period was asanas. It was concluded that the pulse rate had differed significantly due to

\textsuperscript{70} J.P. Oak and M.V. Bhole, “Pulse Rate During and After Bahya Kumbaka with Different Conditions of Abdominal Wall”, \textit{Yoga Mimamsa}, 22, (March - April 1983), 31.


\textsuperscript{72} M.M. Gore and M.V. Bhole, “Influence of Patchimottanasana and Similar Type of Muscular Activity on Pulse Rate – A Preliminary Study”, \textit{Yoga Mimamsa}, 21, (July 1982), 21.
different types of muscular activity. Any activity of isometric nature increases muscle tension, while in asanas the tensions in muscles have to be released by withdrawing one’s effort to its optimum level. Naturally relaxed muscles will put less strain and demands on the heart.

This study included 98 participants (males=67; females = 31), ages 20 – 74 years of age. Each participant attended this intervention program between May 2001 and November 2002. The theory and applied program lasted 3-4 hours a day, for the 8-day intervention, which did not include the two weekend days. Participants were placed into small groups of 6-8 persons. The program consisted of asanas (physical postures) and pranayama (breathing exercises) for one hour, followed by a breakfast, and then the viewing of an educational video or a lecture. Thus, an interesting aspect of this study was the self-responsibility placed upon subjects. Fasting blood samples were taken on day 1 for baseline values and on day 10 to compare the effects of change in glucose, cholesterol and triglycerides. Fasting glucose, total cholesterol, LDL cholesterol (lousy type), VLDL cholesterol, total cholesterol/HDL ratio, and
triglycerides were significantly lower, while HDL cholesterol (healthy type) was significantly higher on day 10 as compared to day 1.\textsuperscript{73}

Yoga has been shown to be a simple and economical therapeutic modality that may be considered as a beneficial adjuvant for type 2 diabetes mellitus. This study investigated the impact of Hatha yoga and conventional physical training (PT) exercise regimens on biochemical, oxidative stress indicators and oxidant status in patients with type 2 diabetes. This prospective randomized study consisted of 77 type 2 diabetic patients in the Hatha yoga exercise group that were matched with a similar number of type 2 diabetic patients in the conventional PT exercise and control groups. Biochemical parameters such as fasting blood glucose (FBG), serum total cholesterol (TC), triglycerides, low-density lipoprotein (LDL), very low-density lipoproteins (VLDL) and high-density lipoprotein (HDL) were determined at baseline and at two consecutive three monthly intervals. The oxidative stress indicators (malondialdehyde -

MDA, protein oxidation - POX, phospholipase A2 - PLA2 activity) and oxidative status [superoxide dismutase (SOD) and catalase activities] were measured. The concentrations of FBG in the Hatha yoga and conventional PT exercise groups after six months decreased by 29.48% and 27.43% respectively (P < 0.0001) and there was a significant reduction in serum TC in both groups (P < 0.0001). The concentrations of VLDL in the managed groups after six months differed significantly from baseline values (P = 0.036). Lipid peroxidation as indicated by MDA significantly decreased by 19.9% and 18.1% in the Hatha yoga and conventional PT exercise groups respectively (P < 0.0001); whilst the activity of SOD significantly increased by 24.08% and 20.18% respectively (P = 0.031). There was no significant difference in the baseline and 6 months activities of PLA2 and catalase after six months although the latter increased by 13.68% and 13.19% in the Hatha yoga and conventional PT exercise groups respectively (P = 0.144). The study demonstrate the efficacy of Hatha yoga exercise on fasting blood glucose, lipid profile, oxidative stress markers and antioxidant status in patients with type 2 diabetes and suggest that Hatha yoga exercise
and conventional PT exercise may have therapeutic preventative and protective effects on diabetes mellitus by decreasing oxidative stress and improving antioxidant status.\textsuperscript{74}

The objective of the study was to investigate the short-term impact of a brief lifestyle intervention of yoga and traditional Physical Training (PT) exercise regimens on: serum insulin, percentage insulin binding receptor, internalization of insulin-receptor complex, T3, T4, TSH and cortisol at baseline, 3 months and 6 months in patients with type 2 diabetes mellitus. A total of 231 patients completed this prospective randomized study with 77 type 2 diabetic patients in the yoga group (62 females and 15 males) that were matched with the same number of patients in the traditional Physical Training (PT) exercise and control groups. Biochemical parameters such as fasting Blood Glucose (FBG), serum insulin, percentage insulin binding receptor and internalization of insulin-receptor complex were determined at the beginning (baseline) and two consecutive three monthly intervals. The effect of the

lifestyle interventions on hormones such as cortisol, TSH, T4 and T3 were also investigated. The FBG concentration in the yoga and the traditional PT exercise groups were markedly decreased compared with control (P < 0.05). The percentage of insulin binding receptor increased in the yoga and traditional PT exercise groups at the sixth month when compared to baseline and this parameter in the traditional PT exercise group differs significantly from that of the control group at the six month (P = 0.024). There was no significant difference in the percentage of internalization of the insulin receptor complex amongst the three groups (P = 0.465). There was no significant change in T3, T4, TSH or cortisol in any of the three groups over the six month period (P > 0.05). The findings indicates the beneficial effects of yoga and traditional PT exercise regimens in improving glycaemic control by increasing percentage insulin binding receptor in type 2 diabetic patients with no significant change in cortisol and thyroid hormones.  

---

Diabetes is a metabolic disorder, which has become a major health challenge worldwide. South East Asian countries have a highest burden of diabetes. In India the prevalence of diabetes is rising rapidly especially in the urban population because of increasing obesity and reduced physical activity. An objective of this study is to evaluate the effect of Yoga-Nidra on blood glucose level in diabetic patients. This study was conducted on 41, middle aged, type-2 diabetic patients, who were on oral hypoglycaemic. These patients were divided into two groups: (a) 20 patients on oral hypoglycaemic with yoga-nidra, and (b) 21 were on oral hypoglycaemic alone. Yoga-nidra practiced for 30 minutes daily up to 90 days, parameters were recorded every 30th day. Results of this study showed that most of the symptoms were subsided (P<0.004, significant), and fall of mean blood glucose level was significant after 3-month of Yoga-Nidra. This fall was 21.3 mg/dl, P<0.0007, (from 159 ± 12.27 to 137.7 ± 23.15,) in fasting and 17.95 mg/dl, P=0.02, (from 255.45 ± 16.85 to 237.5 ± 30.54) in post prandial glucose level. Results of this study suggest that subjects on Yoga-Nidra with drug regimen had better control in their fluctuating blood
glucose and symptoms associated with diabetes, compared to those
were on oral hypoglycaemics alone.\textsuperscript{76}

Twenty NIDDM subjects (mild to moderate diabetics) in the age group of 30-60 years were selected from the outpatient clinic of G.T.B. hospital. They were on a 40 days yoga asana regime under the supervision of a yoga expert. 13 specific Yoga asanas \( \leq \) done by Type 2 Diabetes Patients included. Surya Namaskar, Trikonasana, Tadasana, Sukhasana, Padmasana, Bhastrika Pranayama, Pashimottanasana, Ardhmatsyendrasana, Pawanmuktasana, Bhujangasana, Vajrasana, Dhanurasana and Shavasana are beneficial for diabetes mellitus. Serum insulin, plasma fasting and one hour postprandial blood glucose levels and anthropometric parameters were measured before and after yoga asanas. The results indicate that there was significant decrease in fasting glucose levels from basal 208.3 +/- 20.0 to 171.7 +/- 19.5 mg/dl and one hour postprandial blood glucose levels decreased from 295.3 +/- 22.0 to 269.7 +/- 19.9 mg/dl. The exact mechanism as to how these postures and controlled breathing interact with

somatoendocrine mechanism affecting insulin kinetics was worked out. A significant decrease in waist-hip ratio and changes in insulin levels were also observed, suggesting a positive effect of yoga asanas on glucose utilization and fat redistribution in NIDDM. Yoga asanas may be used as an adjunct with diet and drugs in the management of Type 2 diabetes.\(^7\)

The effect of yoga on the body, psychological well being, and cardiovascular risk factors was studied in a group of middle aged patients. Twenty patients (16 males, 4 males) in the age group 35 to 55 years with mild to moderate high blood pressure underwent yogic practices daily for one hour for three months. High blood pressure is a risk factor for heart disease, stroke, and kidney damage. Biochemical and psychological parameters were studied prior and following period of three months of yoga. These biochemical parameters included blood sugar, lipid profile including cholesterol, and blood levels of catecholamine (stress chemicals like epinephrine or adrenaline). The overall results were quite positive. There was a decrease in blood pressure among with a decrease in blood sugar,

cholesterol and triglycerides. The patients also reported an improvement in overall well being and quality of life. There was also a decrease in the levels of catecholamine, suggesting a decrease in sympathetic activity. A decrease in sympathetic activity indicates that the patients were calmer and experienced less tension and stress, and that their blood pressure would be lower. The authors of the study conclude that yoga can play an important role in decreasing the risk factors for cardiovascular disease in those with mild to moderate hypertension.78

Electrophysiological evidence of delayed cognition as measured by P300, an evoked potential is observed in Diabetes mellitus. P300 (or P3) is a component of endogenous cerebral evoked response that assesses higher functions of the brain. Our study aims to see the role of pranayama and yoga-asana on P300 latency and amplitude in type 2 diabetic patients. Sixty patients of type 2 diabetes were recruited from diabetic clinic and divided into two groups - control group on only conventional medical therapy and yoga-group on conventional medical therapy along with pranayama

and yoga-asana. Basal recordings of P300 and blood glucose were taken at the time of recruitment and second recordings repeated after forty five days for both the groups. P300 was recorded on Nihon Kohden Neuropack µ MEB 9100 using auditory “odd-ball paradigm”. The data were analysed using repeated measures analysis of variance (ANOVA) followed by Tukey’s test at 5 per cent level of significance. Statistically significant improvement in the latency and the amplitude of N200, P300 was observed in the yoga group as compared to the control group. Our data suggest that yoga has a beneficial effect on P300 and thus can be incorporated along with the conventional medical therapy for improving cognitive brain functions in diabetes.79

A distinguishable feature of type 2 diabetes besides hyperglycemia and deranged lipid profile is an impaired insulin secretion, peripheral insulin resistance and obesity, which has become a major health concern worldwide. India with an estimated 31million diabetics in 2000 and 79millions by the yr 2030 has the highest number of type 2 diabetics in the world. In this study, we

aimed to see if yoga-asanas and pranayamas have any influence in modifying certain biochemical parameters. Sixty patients of uncomplicated type 2 diabetes (age 35-60 yrs of 1-10 yrs duration) were divided into two groups: Group 1 (n=30): performed yoga along with the conventional hypoglycemic medicines and group 2 (n=30): patients who only received conventional medicines. Duration of the study was 45 days. Basal recordings of blood glucose (fasting and post-prandial), lipid profile and serum insulin were taken at the time of recruitment and the second reading after forty five days. Results showed a significant improvement in all the biochemical parameters in group 1 while group 2 showed significant improvement in only few parameters, thus suggesting a beneficial effect of yoga regimen on these parameters in diabetic patients.80

We conducted a controlled study on effect of selected yoga practice in the control and management of 50 cases of essential hypertension and equal number of healthy (nonhypertensive) controls. Free radical cellular damage is considered to be the underlying common biological factor in essential hypertension. We,

therefore, investigated lipid profile lipid peroxidation and Na\textsuperscript{+}K\textsuperscript{+} ATPase activities of plasma membrane of subjects with essential hypertension. It was found that hypertensive subjects had an elevated lipid peroxidation and decreased Na\textsuperscript{+}K\textsuperscript{+} ATPase activity in plasma membrane as compared to normotensive healthy controls, the specific yoga training protocol which was administered not only helped to decrease blood pressure but also retard the progression of cellular damage due to free radicals.\textsuperscript{81}

There is growing evidence that yoga may offer a safe and cost-effective intervention for Type 2 Diabetes mellitus (DM 2). However, systematic reviews are lacking. This article critically reviews the published literature regarding the effects of yoga-based programs on physiologic and anthropometric risk profiles and related clinical outcomes in adults with DM 2. We performed a comprehensive literature search using four computerized English and Indian scientific databases. The search was restricted to original studies (1970-2006) that evaluated the metabolic and clinical effects

of yoga in adults with DM 2. Studies targeting clinical populations with cardiovascular disorders that included adults with comorbid DM were also evaluated. Data were extracted regarding study design, setting, target population, intervention, comparison group or condition, outcome assessment, data analysis and presentation, follow-up, and key results, and the quality of each study was evaluated according to specific predetermined criteria. We identified 25 eligible studies, including 15 uncontrolled trials, 6 non-randomized controlled trials and 4 randomized controlled trials (RCTs). Overall, these studies suggest beneficial changes in several risk indices, including glucose tolerance and insulin sensitivity, lipid profiles, anthropometric characteristics, blood pressure, oxidative stress, coagulation profiles, sympathetic activation and pulmonary function, as well as improvement in specific clinical outcomes. Yoga may improve risk profiles in adults with DM 2, and may have promise for the prevention and management of cardiovascular complications in this population. However, the limitations characterizing most studies preclude drawing firm conclusions. Additional high-quality RCTs are needed to confirm and further
elucidate the effects of standardized yoga programs in populations with DM 2.\textsuperscript{82}

The aim of this study was to examine the effect of a yoga session on the production of nitrite, a nitric oxide (NO) metabolite, uric acid (UA), total antioxidant activity (TAA), and oxidative stress (OS) in human saliva. Twenty five healthy young adults, 10 men and 15 women (mean age: 23.4 ± 3.48) were evaluated during a HY session. The yoga session consisted of warm up exercises, asanas (postures), pranayama (breathing exercise) and relaxation technique for 75 min. Saliva samples were collected at 24 h and 1 h before and immediately after the HY session (IAHY). Subsequent to rinsing the mouth with water, stimulated whole saliva samples were placed into assay tubes and stored at -5°C. Before analysis saliva samples were centrifuged at 3,000 rpm for 10 min. Nitrite concentration was determined by the Griess reaction, UA by an enzymatic method, TAA by the ABTS method, lipid hydroperoxides, an OS marker, by the FOX method. One-way ANOVA with repeated measurements was used to determine changes in NO production, UA, TAA and OS.

\textsuperscript{82} K.E. Innes and H.K. Vincent, “The Influence of Yoga-based Programs on Risk Profiles in Adults with Type 2 Diabetes Mellitus: A Systematic Review”, \textit{Evid Based Complement Alternat Med}, 4:4, (December 2007), 469-86.
after the yoga session. Alpha was set a-priori at $p<0.05$ and corrected by Bonferroni technique for multiple comparisons. There was a reduction in lipid hydroperoxide concentration (µM) at both 1 h and IAHY in comparison to 24 h (24 h: 52.7±11.4; 1 h: 20.3±6.8; IAHY: 26.3±7.0; $p<0.05$). There was also a decrease in TAA (mM) at IAHY in comparison to 1 h before HY session (1 h: 1.21±0.41; IAHY: 1.00±0.37; $p<0.05$). However, neither UA nor NO concentrations showed any change. Contrary to other physical exercises, one session of Hatha yoga inhibits salivary oxidative stress in healthy young adults.\(^{83}\)

---