

A Review of Selected Yoga Research Findings from ACYTER, JIPMER in 2008-12

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Abstract: *The Advanced Centre for Yoga Therapy Education and Research (ACYTER), a collaborative venture between JIPMER, Puducherry and Morarji Desai National Institute of Yoga (MDNIY), New Delhi was established by an MOU between JIPMER and MDNIY in June 2008 and is focusing primarily on the role of Yoga in the prevention and management of cardiovascular disorders and diabetes mellitus. More than 24,000 patients have benefited from Yoga therapy consultation and attended therapy individual and group sessions in the past three years and a detailed survey has also been published based on feedback from patients. With the active collaboration of MDNIY, New Delhi many research projects are being conducted at JIPMER as collaborative efforts between ACYTER and the Departments of Physiology, Medicine, Biochemistry and Cardiology. This paper summarizes some of the important findings from 12 research works at ACYTER between 2008 and 2012 that provide evidence of the therapeutic potential of Yoga. These can provide a basis for further studies exploring the physiological, psychological and biochemical mechanisms such beneficial effects.*

Key words: *yoga, yoga therapy, health*

Introduction

In recent times, the therapeutic potential of Yoga has captured the imagination of researchers worldwide and numerous studies are being done on the benefits of Yoga in various medical conditions (*Khalsa, 2004; Bijlani, Vempati, Yadav, Ray, Gupta, Sharma et al, 2005; Innes, Vincent, 2007; Innes, Bourguignon, Taylor, 2005; Yang, 2007*) . Yoga is a popular means of relieving stress and improving fitness as it decreases stress and anxiety and improves health status. The application of Yoga as a therapy is simple and inexpensive and can be easily adopted in most patients without any complications (*Vijayalakshmi, Madanmohan, Bhavanani, Patil, Babu, 2004*). It must be emphasized that Yoga therapy or more correctly Yoga Chikitsa, encompasses the use of asana, pranayama and relaxation techniques along with dietary advice and Yogic counseling that address the root cause of the problem rather than merely providing symptomatic relief (*BhavananiB, 2011*).

The Advanced Centre for Yoga Therapy Education and Research (ACYTER), a collaborative venture between JIPMER, Puducherry and Morarji Desai National Institute of Yoga (MDNIY), New Delhi was established by an MOU between JIPMER and MDNIY in June 2008 and is focusing primarily on the role of Yoga in the prevention and management of cardiovascular disorders (CVD) and diabetes mellitus (DM). More than 24,000 patients have benefited from

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Yoga therapy consultation and attended therapy individual and group sessions in the past three years. A detailed survey has also been published based on feedback from patients (*Madanmohan, Bhavanani, Zeena, Dayanidy, Vithiyalakshmi, Jayasettiaseelon, 2011*). With the active collaboration of MDNIY, New Delhi many research projects are being conducted at JIPMER as collaborative efforts between ACYTER and the Departments of Physiology, Medicine, Biochemistry and Cardiology. This paper summarizes some of the important findings from research works at ACYTER between 2008 and 2012.

Review of selected studies

Study-1: Immediate effect of sukha pranayama on heart rate and blood pressure of patients with hypertension (*Bhavanani, Zeena, Madanmohan, 2011*). Hypertension (HT) is one of the most common health disorders and Yoga has been shown to be an effective adjunct therapy in its management. Earlier studies from our laboratories have demonstrated heart rate (HR) and blood pressure (BP) lowering effects of slow, deep breathing after 3 weeks and 3 months of training. Beneficial effects of deep breathing in reducing premature ventricular complexes have also been reported by us. With this background, the present study was undertaken to determine the immediate effects of sukha pranayama on cardiovascular parameters in hypertensive patients. 23 hypertensive patients attending our Yoga OPD were instructed to perform sukha pranayama for five minutes at the rate of 6 breaths / minute. Sukha pranayama is a slow and deep pattern of breathing where inhalation and exhalation are of equal duration. HR and BP were recorded before and immediately after the intervention. Rate-pressure product (RPP) and double product (Do P) were derived by formulae. Sukha pranayama produced a significant ($p < 0.05$) reduction in HR from 79.5 ± 3.09 to 78 ± 3.24 beats/min and a highly significant ($p < 0.001$) reduction in systolic pressure (SP) from 132.5 ± 5.45 to 123 ± 3.83 mmHg. Pulse pressure (PP) decreased from 61.5 ± 3.39 to 52.5 ± 2.21 mm Hg, mean pressure (MP) from 91.5 ± 3.19 to 88 ± 2.35 mm Hg, RPP from 107.28 ± 8.43 to 97.37 ± 6.97 units and Do P from 73.88 ± 53.72 to 69.52 ± 46.94 units, all these changes being statistically significant ($P < 0.001$). It is concluded that sukha pranayama breathing at the rate of 6 breaths / minute can reduce HR and BP in hypertensive patients within five minutes of the practice. This may be due to normalization of autonomic cardiovascular rhythms as a result of increased vagal modulation and /or decreased sympathetic activity. Further studies are required to understand the possible mechanisms underlying this beneficial effect in hypertensive patients.

Study-2: Effect of Yoga therapy on reaction time, biochemical parameters and wellness score of peri and post menopausal diabetic patients (*Madanmohan, Bhavanani, Dayanidy, Zeena, Basavaraddi, 2012*). Yogic practices may aid in the prevention and management of DM and reduce cardiovascular complications in the population. 15 peri and post menopausal patients receiving standard medical treatment for type 2 DM were recruited and reaction time (RT) and biochemical investigations were done before and after a comprehensive Yoga therapy programme comprising of thrice weekly sessions for 6 weeks. A post intervention, retrospective wellness questionnaire compiled by ACYTER was used to evaluate the comparative feelings of the patients after the therapy programme. Yoga training reduced auditory reaction time (ART) from right as well as left hand, the decrease being statistically significant ($p < 0.05$) for ART from the right hand. There was a significant ($p < 0.01$) decrease in fasting and postprandial blood glucose levels as well as low density lipoprotein (LDL). The decrease in total cholesterol (TC), triglycerides (TG), and very low density lipoprotein (VLDL) and increase in high density lipoprotein (HDL) was also statistically significant ($p < 0.05$). All the lipid ratios showed desirable improvement with a decrease ($p < 0.01$) of TC/HDL and LDL/HDL ratios and increase ($p < 0.05$) in the HDL/LDL ratio. Shortening of RT implies an improvement in the information processing and reflexes and is the first such report in diabetic patients. This has clinical significance and is worth

further exploration with wider, well controlled, randomized studies in the diabetic population. Changes in blood glucose levels may be due to improved insulin sensitivity, decline in insulin resistance and increased sensitivity of the pancreatic β cells to glucose signals. Yoga improved the 'heart friendly' status of lipid profile in our subjects and as our participants were peri and post menopausal, the decrease in cardiovascular risk profile is of greater significance. A comprehensive Yoga therapy programme has the potential to enhance the beneficial effects of standard medical management of DM and can be used as an effective complementary or integrative therapy programme.

Study-3: Effect of Yoga on subclinical hypothyroidism: a case report (Bhavanani, Zeena, Madanmohan, 2011). Complementary and Alternative Medical (CAM) therapies such as Yoga are being increasingly used as adjuncts to modern medicine. Though it has been suggested that Yoga may have a role in revitalizing thyroid function there are few studies on the effects of Yoga on thyroid disorders. A 36 year old female with elevated TSH level and low normal T4 levels was diagnosed as having primary subclinical hypothyroidism and advised to start replacement therapy. She came for consultation to our Yoga OPD and was given appropriate Yogic counseling and taught a series of techniques potentially beneficial to patients of thyroid conditions. She continued the practices for a year and reported back at the end of the year with her biochemical investigations. After one year of therapy, there was a fall in TSH and a normalization of free T4 values. A third biochemical analysis three months later showed that TSH and FT4 further stabilized at normal levels. As the anti TPO antibodies were positive both before and after the Yoga intervention, the patient was advised to continue the Yoga practices on a regular basis as long as possible with regular six-monthly follow up. It is suggested that Yoga can be an effective adjunct therapy in thyroid conditions and further studies in larger samples are needed to confirm these findings and to better understand the mechanisms behind such beneficial effects in patients of thyroid disorders.

Study-4: Immediate effect of suryanadi and chandranadi on short term heart rate variability in healthy volunteers (Rajajeyakumar, Madanmohan, Amudharaj, Bandi Harikrishna, Jeyasetteloune, Bhavanani, 2011). Heart rate variability (HRV) has come to be widely used as a non-invasive tool to assess autonomic function in a variety of physiological as well as disease states. Different types of pranayams are known to improve autonomic function by changing sympathetic or parasympathetic activity. In view of this, the present study was aimed to study the effect of suryanadi (SNP) and chandranadi (CNP) pranayams on HRV in healthy young volunteers. The present study was conducted on 11 male volunteers 20-30yrs who were taught both SNP and CNP and made to practice under direct supervision. The procedures and recordings were carried out in lying down posture for all volunteers between 4-6.30 pm in the ACYTER research lab. HRV was recorded by using BIOHARNESS AcqKnowledge 4.1 version and analyzed by Kubios HRV 2.00 software. Basal resting parameters and HRV were recorded for 5 minutes after that. SNP was performed in six cycles per minute (each cycle consists of 5 seconds for each inspiration and expiration) for 5 minutes followed by 5 min rest. Three such sessions (before, during and after) HRV were recorded. The same procedure and recording were followed for CNP. Appropriate statistical analysis was done using SPSS version 16 (Repeated measures of ANOVA followed by post hoc analysis with Benferroni adjustment) and the level of statistical significance is considered at a p value < 0.05. The results of our study were much in accordance with the previous studies. The time domain analysis of SNP revealed an increased HR with decreased RMSSD, the index of short term HRV. However SDNN which is considered the index of long term HRV increased. In frequency domain analysis there was an increased LF power and decreased HF power. The index of sympathovagal balance as reflected by LF/HF ratio increased (from 1.8 to 2.2) after the intervention. All the observation showed that SNP is sympathomimetic. In CNP, the time domain

analysis of HRV revealed a decreased HR and an increased pNN50. The frequency domain analysis revealed an increased HF power with decreased LF/HF ratio i.e. from 2.1 to 1.5. We conclude that SNP increases sympathetic activity while CNP increases parasympathetic activity and hence they can be appropriately advocated in many chronic CVD where autonomic imbalance is one of the primary derangements.

Study-5: Immediate effect of Shavasana on short term heart rate variability in heart failure patients (Hari Krishna, Madanmohan, Balachander, Jayasettiaseelon, Bhavanani, 2012). In this cross sectional study, we recruited 20 heart failure patients (EF: 30% - 40%) stabilized on standard medical therapy. HRV was recorded by using BIOHARNESS AcqKnowledge 4.1 version and analyzed by Kubios HRV 2.00 software. Five minutes of baseline HRV was recorded before and after the practice of 15 minutes of Shavasana. In time domain analysis there were increases in mean of RR intervals (from 1100.83 to 1184.41, $p=0.017$), SDNN (from 29 to 30.45), RMSSD (from 23.92 to 28.74) while mean HR/1min decreased from 55.44 to 51.14 ($p=0.018$). In frequency domain analysis there was a decrease in LF/HF (from 4.04 to 2.34) and LF (from 71.43 to 67.12) with increase in HF (from 28.67 to 32.69) and Total power (from 794.90 to 842.95). the increase in SDNN, RMSSD, HF, Total power with decrease in Mean HR, LF and LF/HF in short term HRV suggests an increase in cardiac parasympathetic activity with decrease in cardiac sympathetic activity. We conclude that Shavasana can be used as an add-on therapy for maintenance of sympathovagal balance in heart failure patients.

Study-6: Effects of eight week Yoga therapy programme on cardiovascular health in hypertensives (Madanmohan, Bhavanani, Zeena, Vithiyalakshmi, Dayanidy, In press). The present study was undertaken to validate the usage of Yoga as an adjunct therapy in HT by evaluating the effects of a comprehensive eight week Yoga therapy programme in such patients. Fifteen hypertensives receiving standard medical treatment were recruited and anthropometric, cardiovascular and biochemical investigations were done before and after a comprehensive Yoga therapy programme comprising of three times a week sessions for 8 weeks. A post intervention, retrospective wellness questionnaire was used to evaluate the comparative feelings of the patients after the therapy programme. There was a statistically significant decrease in weight, BMI and all resting HR and BP indices. TC, TG, LDL and VLDL reduced significantly while HDL increased significantly. All cholesterol based ratios showed improvements. Post intervention overall wellness scores of the participants indicated that the majority were satisfied with their wellbeing after the programme. It is concluded that a comprehensive Yoga therapy programme has potential to enhance the beneficial effects of standard medical management of essential HT and can be used as an effective complementary or integrative therapy programme.

Study-7: Immediate cardiovascular effects of pranava pranayama in hypertensive patients (Bhavanani, Madanmohan, Zeena, Basavaraddi, In press). Slow, deep, pranayama - based breathing training has been shown to be effective in reducing BP. The present study was undertaken to determine immediate effects of performing pranava pranayama on cardiovascular parameters in hypertensive patients. Twenty nine hypertensive patients who were on medical treatment and also attending Yoga sessions were recruited for the present study. Supine HR and BP were recorded before and after performance of pranava pranayama for five minutes. Post intervention statistical analysis revealed a significant ($p < 0.05$) reduction in SP and a more significant ($p < 0.01$) reduction in HR, PP and Do P. The reduction in RPP was highly significant ($p < 0.001$). Pranava pranayama is effective in reducing HR and SP in hypertensive patients within five minutes of the practice. This may be due to a normalization of autonomic cardiovascular rhythms as a result of increased vagal modulation and / or decreased sympathetic activity and improved baroreflex sensitivity along with an augmentation of endogenous nitric oxide production. Our findings have potential therapeutic applications in day-to-day as well as

clinical situations where BP needs to be brought down at the earliest. The significant fall in RPP and Do P signifies a reduction in oxygen consumption and work done by the heart. It is concluded that pranava pranayama, a simple and cost effective technique can be used in the management of hypertensive patients in addition to the regular medical management. Further studies are required to enable a deeper understanding of the mechanisms involved and its usefulness in the long term management of HT.

Study-8: Immediate effect of chandra nadi pranayama (left unilateral forced nostril breathing) on cardiovascular parameters in hypertensive patients (Bhavanani, Madanmohan, Zeena, In Press). Yoga therapists routinely use CNP to help reduce BP in hypertensive patients. This is attributed to its stress lowering effects that have been documented by previous studies. Though there are some studies on the long term effect of CNP, there are no studies on its immediate effect on cardiovascular parameters in hypertensive patients. Twenty six hypertensive patients attending our Yoga OPD were recruited and taught CNP. They were then instructed to perform the same for five minutes in sitting position. HR and BP were recorded with non-invasive automatic BP apparatus before and immediately after the practice. RPP and Do P were derived by formulae. There was a significant ($p < 0.001$) reduction in HR from 75.5 ± 2.78 to 70 ± 2.72 beats/min, RPP from 106.15 ± 4.53 to 96.06 ± 4.24 units and Do P from 76.36 ± 33.90 to 72.66 ± 33.36 units. A significant reduction ($p < 0.01$) occurred in SP from 140 ± 3.26 to 137 ± 3.12 mmHg and PP from 58.5 ± 2.78 to 50 ± 2.39 mmHg. There was a statistically insignificant rise in MP from 101 ± 1.97 to 103.67 ± 2.01 mmHg and DP from 81.5 ± 1.76 to 87 ± 1.76 mm Hg. CNP produced a significant decrease in HR and SP signifying a normalization of cardiovascular reflex mechanisms within 5 minutes. It also produced a significant fall in RPP and Do P signifying a reduction in oxygen consumption and work done by the heart. However the rise in DP and MAP is difficult to explain. Further studies with more subjects and control groups are required to understand the possible mechanisms underlying this immediate effect of CNP in hypertensive patients.

Study-9: Immediate cardiovascular effects of pranava relaxation in patients of hypertension and diabetes (Bhavanani, Madanmohan, Zeena, Vithiyalakshmi, In press). Relaxation therapy has been reported to be useful in management of HT and DM. Pranava pranayama is part of our comprehensive Yoga therapy schedules and hence this study planned to determine its immediate cardiovascular effects in supine position in patients with concomitant HT and DM. Twenty nine patients of HT and DM attending regular therapy sessions were recruited and randomly allotted to pranava or control groups. HR and BP were recorded before and after 10 minutes of “sham relaxation” in control group and 10 minutes of pranava pranayama in study group. Intra group comparison showed significant changes ($p < 0.05$) in all parameters following pranava pranayama whereas this was only significant with respect to fall in HR ($p = 0.010$) and rise in PP ($p = 0.016$) in control group. Inter group comparison showed no significant differences between groups at baseline ($p > 0.05$). However post comparisons showed significant differences between groups with regard to SP ($p = 0.015$), PP ($p = 0.018$), MP ($p = 0.035$) and RPP ($p = 0.047$). Cardiovascular changes following pranava may be as a result of the prolonged exhalation phase producing a mild Valsalva like effect with decreased pre-load. Prolonged, audible chanting may improve baroreflex sensitivity and normalize autonomic cardiovascular rhythms. Reduction in RPP is representative of enhanced HRV power implying better autonomic regulation of the heart in our subjects. We conclude that pranava pranayam in the supine posture produces an integrated relaxation response, clinically valuable in patients with HT and DM.

Study-10: Suryanadi pranayama (right unilateral nostril breathing) may be safe for hypertensives (Bhavanani, Madanmohan, Zeena, In press). Previous studies have suggested that exclusive right uni-nostril breathing known as SNP has sympathomimetic effects and hence,

the present study was designed to determine immediate effects of 27 rounds of SNP on cardiovascular parameters in patients of essential HT. This has clinical significance in determining whether such a potentially sympathomimetic practice is safe in such a population. Twenty hypertensive patients on standard medical management were taught to perform SNP by qualified Yoga instructors. HR and BP were recorded after 5 minutes of rest in sitting posture and after 27 rounds of SNP. All data passed normality testing and hence was analyzed using Students t test for paired data. Statistical analysis revealed no statistically significant changes in any of the parameters following SNP. Gender based sub analysis of $\Delta\%$ following SNP revealed no significant differences between male and female subjects. The absence of any significant increase in HR or BP following SNP goes against earlier theories that it may be dangerous for hypertensive patients due to its sympathomimetic nature. SNP may not be increasing HR and BP in our subjects because they already had reached a certain threshold of reactivity. The goal of Yoga is to restore homeostasis. Hence, if sympathetic reactivity of a subject is already higher than normal, Yogic techniques will not further increase such a hyper reactivity but rather bring it back to normal. The small 1-2% decrease in most parameters in our study gives a hint of this possibility. In conclusion, our study offers evidence that exclusive right nostril breathing as performed in SNP may be safe in patients of HT. We also conclude that the cardiovascular effects of SNP in hypertensives are different than those reported by previous studies done in normal subjects.

Study-11: Effect of 12 week Yoga therapy as a lifestyle intervention in patients of type 2 diabetes mellitus with distal symmetric polyneuropathy – a randomized controlled study.

Distal symmetric polyneuropathy, the commonest form of diabetic neuropathy (DN) is associated with significant morbidity and mortality. The only proven disease modifying treatment is a strict glycaemic control though there are emerging evidences that lifestyle modifications in the form of exercise and diet can modify the natural history of DN. We have attempted to evaluate the effect of 12 week Yoga therapy as a lifestyle intervention on the clinical outcome, neurophysiologic derangements and indices of glycaemic control in type 2 diabetic patients with distal symmetric polyneuropathy. The Yoga therapy included Yogic counseling, breath-body coordination practices, static postures (asana), breathing practices (pranayama) and relaxation techniques. Patients were randomized to either Yoga or control group by block randomization and both the groups received standard medical care in the form of individualized drug therapy, diet and exercise counseling. Patients in the Yoga group underwent 3 supervised Yoga therapy sessions per week for 12 weeks. Compliance of patients to daily brisk walking was also good in both the groups. Patients were followed up rigorously by weekly telephonic conversations. Despite these efforts, drop-out rates reached 40%. Family obligations, change in work schedule and lack of motivation were the usual reasons for dropping out. A total of 25 patients in the Yoga group and 22 in the control group were successfully followed up. Among the anthropometric parameters, the only significant finding was an improvement in waist circumference in the Yoga group. Among biochemical parameters, there was no significant improvement in the Yoga group but there was a significant worsening of FG and HbA1c% in the control group. No significant results were obtained with respect to HOMA-IR and lipid profile. Among the clinical parameters, there were significant improvements with respect to DNS score, DNE score and visual analogue score for pain in Yoga group. Vibration perception at great toe and ankle reflex also improved significantly. Among the cardiovascular parameters, although SP decreased significantly in both groups, reductions with respect to DP and MP were exclusive to the Yoga group. Although short-term HRV and cardiovascular reflex tests did not yield significant results, there were trends of improvement in Yoga group and there was a significant deterioration of 30/15 ratio in the control group. The results of electrodiagnostic tests are interesting because there were improvements in both groups with respect to certain parameters. Since exercise can improve NCSs, this could be due to a very good adherence of control patients to daily brisk walking. However improvements

with respect to tibial DML, and ulnar and median SNAP amplitudes were exclusive to Yoga. There were 2 instances in Yoga group where H-reflex appeared after follow-up period despite absent recordings at baseline. Thus Yoga therapy showed an additive effect to standard medical care by providing more benefits with respect to electrodiagnostic studies. The results of our study provide preliminary evidence that Yoga when combined with standard medical care provides additional benefits in terms of improving clinical outcome, glycaemic control, resting cardiovascular parameters, cardiovagal modulation of heart and peripheral neurophysiologic derangements. These results may provide directions for further in-depth research evaluating efficacy of Yoga as a complementary therapy for DN.

Study-12: Effect of Yoga therapy on cardiac autonomic function in patients of essential hypertension – a randomized controlled study. HT is an asymptomatic chronic disorder prevalent throughout the world. The magnitude of the burden of HT not only needs an increase in awareness and treatment, but also lifestyle modification. Prior studies have shown that autonomic imbalance occurs in patients with HT and Yoga training restores the sympathovagal balance. In spite of growing popularity regarding the role of Yoga in the management of HT, relatively few rigorous, controlled studies have been conducted to study the therapeutic potential of Yoga. Patients with essential HT from JIPMER outpatient department satisfying study criteria, after obtaining a written informed consent, were randomly divided into two groups: Yoga group, n=34 (who underwent Yoga training along with antihypertensive drugs as prescribed in OPD) and control group, n=36 (on antihypertensive drugs only). Yoga therapy consisting of static postures, breathing and relaxation techniques was given for a period of 12 weeks, thrice weekly at ACYTER. Lifestyle modifications like dietary pattern, physical activity, cessation of smoking and alcohol were advised to both groups. Anthropometric parameters, resting BP and autonomic functions (short-term spectral analysis of HRV, HR and BP response to standing, deep breathing and handgrip) were recorded in all subjects before and after study period. There was a significant improvement in resting cardiovascular parameters like HR, BP, MP and RPP showing decrease in sympathetic activity at rest and better vagal modulation. Reduced HRV is a feature of essential HT and in our Yoga group, there was an improvement in resting HRV evidenced by increase in standard deviation of R-R interval, mean RR, total spectral power and RRi. There was an improvement in vagal modulation as evident from increase in high frequency power (HF), HF in normalized units and the ratio between highest HR during inspiration and lowest during expiration (I-E ratio) during deep breathing test. Reduction in sympathetic activity was evident from decrease in low frequency spectral power in normalized unit and Δ HRmax in response to standing suggesting improvement of sympathovagal balance. In reactivity tests, there was an insignificant improvement in vagal modulation and decrease in sympathetic reactivity. It is concluded that 12 weeks of Yoga therapy can improve cardiac autonomic functions in patients of essential HT if practiced regularly along with other lifestyle modifications and drugs. Therefore, Yoga therapy can be prescribed along with antihypertensive drugs to restore sympathovagal homeostasis.

Conclusion

The selected research studies discussed above provide evidence of the therapeutic potential of Yoga in HT, DM, CVD and other disorders like hypothyroidism. These may provide the basis for further studies that can explore the physiological, psychological and biochemical mechanisms behind such beneficial effects. The strength of our work is the excellent compliance of our patients as well as the fact that these studies were been done in actual patient populations as opposed to most Yoga research studies that are done primarily in normal subjects.

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