CHAPTER II

REVIEW OF RELATED LITERATURE

The study of relevant literature is an essential step to get a full picture of what has been done with regard to the problem under study. Such a review brings out a deep and clear perspective of the overall field. The review of related literature is instrumental in the selection of topic, formulation of hypothesis and deductive reasons. The researcher has gone through a number of literatures from journals, published and unpublished articles available in the libraries and the website. A number of studies touching the topics have been pursued and some of the most important once are presented in this chapter for clear understanding.

The objective of the present study is to design specific package of training in physical exercise and yoga for hypertensive patients. Physical exercise and yoga have been given much importance for the past few decades and a number of studies have appeared in the research literature to measure the fruitfulness of physical exercise and yoga.

The investigator had made an attempt to bring a brief review of research related to the present study “Effect of Physical exercise and Yoga on Hypertensive patients”.

It forms the background of this study under the following headings

- Studies on physical exercise
- Studies on yoga

2.1. STUDIES ON PHYSICAL EXERCISE

Veronique et al. (2011) evaluated the effect of resistance training on blood pressure and other cardiovascular risk factors in adults. Random- and fixed-effects models were used for analyses, with data reported as weighted means and 95% confidence limits. This study includes 28 randomized, controlled trials, involving 33 study groups and 1012 participants. Overall, resistance training induced a significant blood pressure reduction in 28 normotensive or pre hypertensive study groups \([-3.9 (-6.4; -1.2)/-3.9 (-5.6; -2.2) \text{ mm Hg}]\), whereas the reduction \([-4.1 (-0.63; +1.4)\]

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When study groups were divided according to the mode of training, isometric handgrip training in 3 groups resulted in a larger decrease in blood pressure \([-13.5 (-16.5; -10.5) \text{ to } -6.1 (-8.3; -3.9) \text{ mm Hg}\] than dynamic resistance training in 30 groups \([-2.8 (-4.3; -1.3) \text{ to } -2.7 (-3.8; -1.7) \text{ mm Hg}\]. After dynamic resistance training, \(\text{VO}_2\) peak increased by 10.6\% \((P=0.01)\), whereas body fat and plasma triglycerides decreased by 0.6\% \((P<0.01)\) and 0.11 mmol/L \((P<0.05)\), respectively. No significant effect could be observed on other blood lipids and fasting blood glucose. This meta-analysis supports the blood pressure–lowering potential of dynamic resistance training and isometric handgrip training. In addition, dynamic resistance training also favorably affects some other cardiovascular risk factors. The results further suggest that isometric handgrip training may be more effective for reducing blood pressure than dynamic resistance training.

Hansen et al. (2010) inferred that prior to Exercise training, the hypertensive individuals had 36\% lower levels of vascular endothelial growth factor (VEGF) protein and 22\% lower capillary density in the muscle compared to controls. Training in the hypertensive group reduced \((P < 0.01)\) mean arterial blood pressure by 7.1 ± 0.8 mm Hg, enhanced \((P < 0.01)\) the capillary-to-fiber ratio by 17\% and elevated \((P < 0.05)\) muscle VEGF protein by 67\%. Before training, acute exercise did not induce an increase in muscle interstitial VEGF levels above resting levels, but a five-fold increase \((P < 0.05)\) was observed after the training period. Acute exercise induced an elevated \((P < 0.05)\) endothelial cell proliferative effect of muscle dialysate after, but not before, training.

Mercedes et al. (2010) revealed that fitness and physical activity are each inversely associated with the development of hypertension. Fitness and physical activity were independently associated with the 20-year incidence of hypertension in 4618 men and women. Hypertension was determined in participants who had systolic blood pressure \(\geq 140 \text{ mm Hg}\) or diastolic blood pressure \(\geq 90 \text{ mm Hg}\) or who reported antihypertensive medication use. Fitness was estimated based on the duration of a symptom-limited graded exercise treadmill test, and physical activity was self-reported. The incidence rate of hypertension was 13.8 per 1000 person-years \((n=1022)\). Both baseline fitness (hazard ratio: 0.63 [95\% CI: 0.56 to 0.70 per SD]; 2.9 minutes) and physical activity (hazard ratio: 0.86 [95\% CI: 0.79 to 0.84 per SD]; 297 exercise units)
were inversely associated with incident hypertension when included jointly in a model that also adjusted for age, sex, race, baseline smoking status, systolic blood pressure, alcohol intake, high-density lipoprotein cholesterol, dietary fiber, dietary sodium, fasting glucose, and body mass index. The magnitude of association between physical activity and hypertension was strongest among participants in the high fitness (hazard ratio: 0.80 [95% CI: 0.68 to 0.94]) category, whereas the magnitude of association between fitness and hypertension was similar across turtles of physical activity. The estimated proportion of hypertension cases that could be prevented if participants moved to a higher fitness category (ie, preventive fraction) was 34% and varied by race and sex group. Fitness and physical activity are each associated with incident hypertension, and low fitness may account for a substantial proportion of hypertension incidence.

**Palatini et al. (2010)** revealed that the Blood Pressure response to public speaking was greater in the hypertensive than the normotensive participants ($P = 0.018/0.009$). Among the former, sedentary participants showed increased BP reactivity to the speech test (45.2 ± 22.6/22.2 ± 11.5 mmHg, $P < 0.01/<0.001$ versus controls), whereas physically active participants had a response similar to that of controls (35.4 ± 18.5/18.5 ± 11.5 mm Hg, $P =$ not significant). During a median follow-up of 71 months, ambulatory Blood Pressure did not virtually change in the active participants ($−0.9 ± 7.8/−0.0 ± 4.7$ mmHg) and increased in their sedentary peers ($2.8 ± 9.8/3.2 ± 7.4$ mmHg, $P = 0.08/0.003$ versus active). Active participants were less likely to develop incident hypertension than sedentary ones. After controlling for several confounders including baseline heart rate, the hazard ratio was 0.53 [95% confidence interval (CI) 0.31–0.94] for clinic hypertension and 0.60 (95% CI 0.37–0.99) for ambulatory hypertension. Inclusion of Blood Pressure response to public speaking into the Cox model influenced the strength of the association only marginally [hazard ratio = 0.55 (95% CI 0.30–0.97) and hazard ratio = 0.59 (95% CI 0.36–0.99), respectively]. Thus, regular physical activity attenuates the BP reaction to psychosocial stressors. However, this mechanism seems to be only partially responsible for the long-term effect of exercise on Blood Pressure.

**Deepmala et al. (2009)** revealed that hypertension is a well-known risk factor for various cardiovascular diseases. Recently, exercise has been recommended as a part of lifestyle modification for all hypertensive patients. However, the precise mechanisms of
exercise training (ExT)–induced effects on the development of hypertension are poorly understood. Author hypothesized that chronic ExT would delay the progression of hypertension in young spontaneously hypertensive rats (SHRs). In addition, they explored whether the beneficial effects of chronic ExT were mediated by reduced proinflammatory cytokines and improved redox status. We also investigated the involvement of nuclear factor-κB in exercise-induced effects. To test our hypotheses, young normotensive (Wistar-Kyoto) and SHRs were given moderate-intensity ExT for 16 weeks. Blood pressure was determined by the tail-cuff method, and cardiac function was assessed by echocardiography. Myocardial total reactive oxygen species and superoxide production were measured by electron paramagnetic resonance spectroscopy; tumor necrosis factor-α, interleukin-1β, gp91phox, and inducible NO synthase by real-time PCR; and nuclear factor κB activity by electrophoretic mobility shift assay. Chronic ExT in hypertensive rats resulted in significantly reduced blood pressure, reduced concentric hypertrophy, and improved diastolic function. ExT significantly reduced proinflammatory cytokines and inducible NO synthase, attenuated total reactive oxygen species and superoxide production, and increased antioxidants in SHRs. ExT also resulted in increased NO production and decreased nuclear factor κB activity in SHRs. In summary, chronic ExT delays the progression of hypertension and improves cardiac function in young SHRs; these ExT-induced beneficial effects are mediated by reduced proinflammatory cytokines and improved redox homeostasis via downregulation of nuclear factor-κB.

**Mourya et al. (2009)** examined the effect of slow and fast – breathing exercise on autonomic functions in patients with essential hypertension. The subjects comprised 60 male and female patients aged 20 – 60 years with stage I essential hypertension, patients were randomly and equally divided into the control and other two intervention groups, who were advised to do three months of slow breathing and fast breathing exercises, respectively. Baseline and post intervention recording of response were done in all subjects. Test showed significant change only in patients practicing the slow breathing- exercise. Both types of breathing exercises benefits patients with hypertension. However, improvement in both the sympathetic and parasympathetic reactivity may be the mechanism that is associated in those practicing the slow – breathing exercise.
Rajeev and Gupta (2009) performed studies on cardiovascular risk factors in rural (JHW-R, 1992–93) and urban locations (JHW-1, 1993–94; JHW-2, 1999–2000; JHW-3, 2002–03, and JHW-4, 2004–05). The studies evaluated adults ≥20 years using standardized methodology and in the present analyses subjects aged 20–59 years from these JHW studies [4102 men (1700, 1294, 469, 179 and 413) and 2872 women (1063, 655, 486, 195 and 433)] have been included. Prevalence of various cardiovascular risk factors: smoking/tobacco use, sedentary habits, overweight/obesity (body mass index ≥25 kg/m²), central obesity (waist: hip ratio >0.95 men, >0.85 women), hypertension, dyslipidemias, metabolic syndrome and diabetes was determined. Trends were analysed using least squares linear analyses. Results show that mean systolic BP increased with age in all the study cohorts, while there was no significant difference in diastolic BP. Age-adjusted prevalence of hypertension in JHW-R, JHW-1, JHW-2, JHW-3 and JHW-4 studies in men was 21.6, 29.1, 29.6, 42.5 and 45.1% and in women it was 15.7, 21.7, 25.5, 35.2 and 38.2% (P for trend <0.05). There was a significant association of escalating hypertension with obesity and truncal obesity in both men (two-line regression analysis, unadjusted $r^2 = 0.91$ and 0.50 respectively) and women ($r^2 = 0.88$ and 0.57; P < 0.05). Increasing hypertension in India is related to increasing adiposity levels. Population and individual-based measures to prevent and control high BP should focus on measures to prevent obesity.

Sanjiv et al. (2009) revealed that ability of the Naughton-Balke exercise treadmill test, an objective indicator of exercise capacity, to predict abnormal hemodynamics and mortality in pulmonary hypertension is unknown. A cohort study was performed in 603 patients with pulmonary hypertension from 1982 to 2006, and studied the utility of exercise treadmill test as a predictor of abnormal hemodynamics and death. Multivariable linear regression was used to determine whether exercise capacity, measured in metabolic equivalents, was associated with abnormal hemodynamics, and we used a Cox proportional hazards model to determine whether decreased exercise capacity predicted death. Mean age was 50±15 years, 76% were women, 63% had World Health Organization category I pulmonary arterial hypertension, and 23% were World Health Organization functional classes I and II. Mean exercise capacity was 3.7±2.2 metabolic equivalents. Decreased exercise capacity was independently associated with elevated
right atrial and mean pulmonary artery pressure, decreased cardiac index, and increased pulmonary vascular resistance. During median follow-up of 4.6 years, 36% of the patients died. Decreased exercise capacity was associated with mortality (multivariable hazard ratio, 1.18; 95% CI, 1.01 to 1.37 for each 1-metabolic equivalent decrease in exercise capacity; P=0.031; P=0.052 after adjusting for invasive hemodynamic variables). Decreased exercise capacity also predicted mortality in functional classes I–II patients, 24% of whom died (hazard ratio, 1.53; 95% CI, 1.04 to 2.26 for each 1-metabolic equivalent decrease in exercise capacity; P=0.032), although this association did not persist after adjusting for invasive hemodynamic variables (P=0.63). It was concluded that reduced exercise capacity on exercise treadmill test is associated with worse hemodynamics and is a predictor of mortality in patients with pulmonary hypertension.

Saptarishi et al. (2009) measured the efficacy of physical exercise, reduction in salt intake and yoga, in lowering blood pressure among young (20 – 25) pre hypertensive’s and hypertensive’s, and to compare their relative efficacies. A total of 113 subjects: 30, 28, 28 and 27 in four groups respectively participated for eight weeks; control (I), physical exercise (II) – brisk walking for 50 – 60 minutes, four days/week, salt intake reduction (III) – to at least five days / week. A total of 102 participants (29, 27, 25 and 21 in groups I, II, III and IV) completed study. All three intervention groups showed a significant reduction in blood pressure. There was no significant change of blood pressure in control group (I).Physical exercise was not effective (considered individually); salt intake reduction and yoga were also effective.

Zaros et al. (2009) investigated the effects of 6 months of dynamic exercise training on blood pressure and plasma nitrate / nitrite concentration in hypertensive postmenopausal women. Eleven volunteers were submitted to the consisting in 3 days a week, each session of 60 minutes during 6 months at moderate intensity anthropometric parameters, blood pressure, and nitrous oxide concentration were measured at initial time and after exercise training. A significant reduction in both systolic and diastolic blood pressure values was seen after exercise training which was accompanied by a marked increase of nitric oxide levels. Total cholesterol was significantly reduced, whereas triglycerides levels were not modified after exercise training.
**Gordon et al. (2008)** 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 3 diabetic patients in the Hatha yoga exercise group that were matched with a similar number of type 2 diabetic patients in the conventional physical training 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 concentrations of fasting blood glucose in the Hatha yoga and conventional physical training exercise groups after six months decreased by 29.48 per cent and 27.43 per cent respectively and there was a significant reduction in serum total cholesterol in both groups.

**Elavsky et al. (2007)** examined the effects of a 4-month randomized controlled exercise trial on mental health outcomes in 164 previously low – active middle – aged women, participants completed body composition and fitness assessment and a battery of psychological measures at the beginning and end of a 4 – month randomized controlled exercise trial with 3 arms: walking, yoga and control. The results indicated that walking and yoga were effective in enhancing positive effect and menopause – related quality of life and reducing negative effect. Women who experienced decreases in menopausal symptoms access the trial also experienced improvements in all positive mental health and quality of outcomes and reductions in negative mental health outcomes physical activity appears to enhance mood and menopause – related quality of life during menopause, however, other aspects of mental health may be affected only as a result of reduction in menopausal symptoms. Increasing cardio respiratory fitness could be one way to reduce menopausal symptoms.

**James et al. (2007)** reported that clinical relevance of exercise-induced pulmonary arterial hypertension (PAH) is uncertain, and its existence has never been well studied by direct measurements of central hemodynamics. Using invasive cardiopulmonary exercise testing, exercise-induced PAH was hypothesized which represents a symptomatic stage of PAH, physiologically intermediate between resting pulmonary arterial hypertension.
and normal. A total of 406 consecutive clinically indicated cardiopulmonary exercise tests with radial and pulmonary arterial catheters and radionuclide ventriculographic scanning were analyzed. The invasive hemodynamic phenotype of exercise-induced PAH (n=78) was compared with resting PAH (n=15) and normals (n=16). Log-log plots of mean pulmonary artery pressure versus oxygen uptake (Vo2) were obtained, and a “join-point” for a least residual sum of squares for 2 straight-line segments (slopes m1, m2) was determined; m2<m1=“plateau,” and m2>m1=“takeoff” pattern. At maximum exercise, Vo2 (55.8±20.3% versus 66.5±16.3% versus 91.7±13.7% predicted) was lowest in resting PAH, intermediate in exercise-induced PAH, and highest in normals, whereas mean pulmonary artery pressure (48.4±11.1 versus 36.6±5.7 versus 27.4±3.7 mm Hg) and pulmonary vascular resistance (294±158 versus 161±60 versus 62±20 dyne · s · cm⁻⁵, respectively; P<0.05) followed an opposite pattern. An exercise-induced PAH plateau (n=32) was associated with lower Vo2max (60.6±15.1% versus 72.0±16.1% predicted) and maximum cardiac output (78.2±17.1% versus 87.8±18.3% predicted) and a higher resting pulmonary vascular resistance (247±101 versus 199±56 dyne · s · cm⁻⁵; P<0.05) than takeoff (n=40). The plateau pattern was most common in resting PAH, and the takeoff pattern was present in nearly all normals. It was concluded that exercise-induced PAH is an early, mild, and clinically relevant phase of the PAH spectrum.

Peter et al. (2007) revealed that prehypertensive individuals are at increased risk for developing hypertension and cardiovascular disease compared with those with normal blood pressure. Early compromises in left ventricular structure may explain part of the increased risk. Echocardiographic and exercise parameters are utilised in prehypertensive individuals (n=790) to determine associations between exercise blood pressure and left ventricular structure. The exercise systolic blood pressure at 5 metabolic equivalents (METs) and the change in blood pressure from rest to 5 METs were the strongest predictors of left ventricular hypertrophy. The systolic blood pressure of 150 mm Hg at the exercise levels of 5 METs is threshold for left ventricular hypertrophy. There was a 4-fold increase in the likelihood for left ventricular hypertrophy for every 10-mm Hg increment in systolic blood pressure beyond this threshold (OR: 1.15; 95% CI: 1.12 to 1.18). There was also a 42% reduction in the risk for left ventricular hypertrophy for every 1 MET increase in the workload (OR: 0.58; P<0.001). When compared with low-fit,
moderate, and high-fit individuals exhibited significantly lower systolic blood pressure at an exercise workload of 5 METs (155±14 versus 146±10 versus 144±10; P<0.05), lower left ventricular mass index (48±12 versus 41±10 versus 41±9; P<0.05), and prevalence of left ventricular hypertrophy (48.3% versus 18.7% versus 21.6%; P<0.001). This suggests that moderate improvements in cardio respiratory fitness achieved by moderate intensity physical activity can improve hemodynamics and cardiac performance in prehypertensive individuals and reduce the work of the left ventricle, ultimately resulting in lower left ventricular mass.

Kanji et al. (2006) determined the effectiveness of autogenic training in reducing anxiety in nursing students. A randomized controlled trial with 3 parallel arms was completed in 1998 with 93 nursing students aged 19 – 49 years. The treatment group received eight weekly sessions of autogenic training, the attention control group received 8 weekly sessions of laughter therapy, and the time control group received no intervention. The outcome measures were the state trait anxiety Inventory, the Maslach Burnout Inventory, blood pressure and pulse rate completed at baseline, 2 months (end of treatment), 5,8 and 11 months from randomization. There was a statistically significantly greater reduction of state and trait anxiety in the autogenic training group than in both other groups immediately after treatment. The autogenic training group also showed statistically significantly greater reduction immediately after treatment is systolic (P < 0.01) and diastolic (p < 0.05) blood pressure, and pulse rate (p < 0.002), than the other two groups.

Kim and Park (2006) have analyzed the effects of an exercise program on body composition and physical fitness of obese female college students. Data was collected from September 29, 2003 to December 29, 2003. The research design was a randomized control group pretest – posttest experimental design. The subjects were college nursing students, 20 in the experimental group and 24 in a control group, with more than 30 per cent body fat were randomly assigned. The subjects in the experimental group participated in an exercise program for 12 weeks, sixty minutes per session, five times per week. Body composition and physical fitness were measured by a body composition analyzer – cardiovascular endurance, muscle endurance, muscle strength (grip strength, back strength), flexibility, balance, agility(whole body reaction time) and power (standing long
Body weight (F = 4.76, P = 0.035), body fat (kg) (F = 5.68, P = 0.022) and body mass index (F = 5.73, P = 0.021) of the experimental group were significantly different from the control group, but there were no significant differences in body fat (per cent) lean body mass, muscle mass and WHR. Back strength (F = 6.50, P = 0.015), flexibility (F = 14.62, P = 0.007), power (F = 5.76, P = 0.0021) and balance (F = 2.46, P = 0.018) of the experimental group were significantly different from the control group, but there were no significant differences in cardiovascular endurance, grip strength or agility. The exercise program has become effective in improving body weight, body fat (kg), body mass index, body strength, muscle endurance, flexibility balance and power of obese female college students.

**Choudhury and Lip (2005)** conducted a study on Exercise and Hypertension. They reported that moderate-intensity (40–70% VO₂ max) aerobic exercise is associated with a significant reduction of blood pressure in hypertensive and normotensive participants and in overweight, as well as normal-weight participants. Interestingly, increasing exercise intensity to above 70% VO₂ max did not have any additional impact on blood pressure reduction. The effects of moderate- and high-intensity exercise on haemostasis and platelet function also appear to be different. For example, moderate exercise yields an enhancement of fibrinolysis without a concomitant increase in markers of blood coagulation, whereas heavy exercise activates both systems simultaneously. Moreover, moderate exercise seems to suppress platelet adhesiveness and aggregation, whereas heavy exercise induces a transient increase in agonist-induced platelet aggregation, as well as increase platelet count, adhesiveness and secretary activity. These effects seem to be more pronounced in sedentary than active healthy subjects, thus potentially explaining the risk of sudden death in susceptible sedentary individuals or in patients with pre-existing atherosclerotic vascular disease.

**Chacko et al. (2005)** reported that sympathetic hyperactivity and parasympathetic withdrawal may cause and sustain hypertension. This autonomic imbalance is in turn related to a reduced or reset arterial baroreflex sensitivity and chemoreflex-induced hyperventilation. Slow breathing at 6 breaths/min increases baroreflex sensitivity and reduces sympathetic activity and chemoreflex activation, suggesting a potentially beneficial effect in hypertension. We tested whether slow breathing was capable of modifying blood pressure in hypertensive and control subjects and improving baroreflex
sensitivity. Continuous noninvasive blood pressure, RR interval, respiration, and end-tidal CO₂ (CO₂-et) were monitored in 20 subjects with essential hypertension (56.4±1.9 years) and in 26 controls (52.3±1.4 years) in sitting position during spontaneous breathing and controlled breathing at slower (6/min) and faster (15/min) breathing rate. Baroreflex sensitivity was measured by autoregressive spectral analysis and “alpha angle” method. Slow breathing decreased systolic and diastolic pressures in hypertensive subjects (from 149.7±3.7 to 141.1±4 mm Hg, \( P<0.05 \); and from 82.7±3 to 77.8±3.7 mm Hg, \( P<0.01 \), respectively). Controlled breathing (15/min) decreased systolic (to 142.8 ± 3.9 mm Hg; \( P<0.05 \)) but not diastolic blood pressure and decreased RR interval (\( P<0.05 \)) without altering the baroreflex. Similar findings were seen in controls for RR interval. Slow breathing increased baroreflex sensitivity in hypertensives (from 5.8 ± 0.7 to 10.3±2.0 ms/mm Hg; \( P<0.01 \)) and controls (from 10.9±1.0 to 16.0±1.5 ms/mm Hg; \( P<0.001 \)) without inducing hyperventilation. During spontaneous breathing, hypertensive subjects showed lower CO₂ and faster breathing rate, suggesting hyperventilation and reduced baroreflex sensitivity (\( P<0.001 \) versus controls). Slow breathing reduces blood pressure and enhances baroreflex sensitivity in hypertensive patients. These effects appear potentially beneficial in the management of hypertension.

**Cornelissen and Fagard (2005)** examined the previous meta-analysis of randomized controlled trials on the effect of chronic dynamic aerobic endurance training on blood pressure reporting on resting blood pressure only. Our aim was to perform a comprehensive meta-analysis including resting and ambulatory blood pressure, blood pressure-regulating mechanisms, and concomitant cardiovascular risk factors. Inclusion criteria of studies were: random allocation to intervention and control; endurance training as the sole intervention; inclusion of healthy sedentary normotensive or hypertensive adults; intervention duration of approximate four weeks; availability of systolic or diastolic blood pressure; and publication in a peer-reviewed journal up to December 2003. The meta-analysis involved 72 trials, 105 study groups, and 3936 participants. After weighting for the number of trained participants and using a random-effects model, training induced significant net reductions of resting and daytime ambulatory blood pressure of, respectively, 3.0 / 2.4 mm Hg (\( P < 0.001 \)) and 3.3 / 3.5 mm Hg (\( P < 0.01 \)). The reduction of resting blood pressure were more pronounced in the 30 hypertensive
study decreased by 7.1% (P < 0.05), neither plasma nor epinephrine by 29% (P < 0.01), and plasma rennin activity by 20% (P < 0.05). Body weight decreased by 1.2 kg (P < 0.001), waist circumference by 2.8 cm (P < 0.001), percent body fat by 1.4% (P < 0.001), and the homeostasis model assessment index of insulin resistance by 0.31 U (P < 0.01); HDC cholesterol increased by 0.032 mmol/L-1 (P < 0.05). In conclusion, aerobic endurance training decreases blood pressure through a reduction of vascular resistance, in which the sympathetic nervous system and the renin-angiotensin system appear to be involved, and favourably affects concomitant cardiovascular risk factors.

**Fagard (2005)** conducted study on “effects of exercise, diet and their combination on blood pressure”. Epidemiological studies suggest an inverse relationship between physical activity or fitness and blood pressure. In a meta-analysis of 44 randomized controlled intervention trials, the weighted net change in conventional systolic/diastolic blood pressure in response to dynamic aerobic training averaged -3.4/-2.4 mmHg (P < 0.001). The effect on blood pressure was more pronounced in hypertensives than in normotensives. This type of training also lowered the blood pressure measured during ambulatory monitoring and during exercise. However, exercise appears to be less effective than diet in lowering blood pressure (P < 0.02), and adding exercise to diet does not seem to further reduce blood pressure.

**Jojic et al. (2005)** checked the influence of autogenic training on the biophysical and biochemical indicator of adjustment disorder and their changes in 3 phases: before the beginning, immediately after the beginning and six months after the completion, of a practical course in autogenic training. Systolic and diastolic arterial blood pressure, brachial pulse rate as well as the levels of cortisol in plasma, of cholesterol in blood, and of glucose was measured. During that period, autogenic training functioned as the sole therapy. They found that arterial blood pressure, pulse rate, concentration of cholesterol and cortisol, after the application of autogenic training among the subjects suffering from adjustment disorder, were lower in comparison to the initial values. These values remained lower even 6 months after the completion of the practical course in autogenic training.

**Kaijun Niu et al. (2005)** conducted an experiment to determine whether leisure-time physical activity (LTPA) modifies the relation between C-reactive protein (CRP) and
hypertension among Japanese elderly. Our study population comprised 643 subjects aged 70 years and over in whom CRP, home BP, and self-reported LTPA were measured. LTPA was categorized into three levels of intensity—walking, brisk walking, and sports—and a questionnaire were used to estimate the level in each patient. Hypertension was defined as a home systolic BP of 135 mmHg or over and/or home diastolic Blood Pressure of 85 mmHg or over or current use of antihypertensive agents. LTPA levels were associated with both CRP and hypertension. After adjustment for factors affecting CRP and hypertension, and additional adjustment for LTPA levels, the odds ratio (95 per cent confidence interval) of hypertension by CRP was 2.21 (range: 1.33–3.72), 1.99 (1.17–3.42), and 2.38 (1.36–4.21) times higher in subjects in the second, third, and fourth quartiles of CRP, as compared to subjects in the first quartile, respectively. A multiple regression model showed a positive and significant relation between log-transformed CRP and systolic BP after adjustment for potential confounding factors when participants taking antihypertensive medication were excluded.

Veronique et al. (2005) conducted a study on “effects of Endurance Training on Blood Pressure, Blood Pressure–Regulating Mechanisms, and Cardiovascular Risk Factors”. This study aims to perform a comprehensive meta-analysis including resting and ambulatory blood pressure, blood pressure–regulating mechanisms, and concomitant cardiovascular risk factor. After weighting for the number of trained participants and using a random-effects model, training induced significant net reductions of resting and daytime ambulatory blood pressure of, respectively, 3.0/2.4 mm Hg (P<0.001) and 3.3/3.5 mm Hg (P<0.01). The reduction of resting blood pressure was more pronounced in the 30 hypertensive study groups (−6.9/−4.9) than in the others (−1.9/−1.6; P<0.001 for all). Systemic vascular resistance decreased by 7.1% (P<0.05), plasma nor epinephrine by 29% (P<0.001), and plasma renin activity by 20% (P<0.05). Body weight decreased by 1.2 kg (P<0.001), waist circumference by 2.8 cm (P<0.001), percent body fat by 1.4% (P<0.001), and the homeostasis model assessment index of insulin resistance by 0.31 U (P<0.01); HDL cholesterol increased by 0.032 mmol/L−1 (P<0.05). IN CONCLUSION, aerobic endurance training decreases blood pressure through a reduction of vascular resistance, in which the sympathetic nervous system and the renin-angiotensin system appear to be involved, and favorably affects concomitant cardiovascular risk factors.
Jen-Chen Tsai et al. (2004) conducted a study on “The Beneficial Effect of Regular Endurance Exercise Training on Blood Pressure and Quality of Life in Patients with Hypertension”. Regular aerobic exercise can reduce blood pressure and is recommended as part of the lifestyle modification to reduce high blood pressure and cardiovascular risk. Hypertension itself, or/and pharmacological treatment for hypertension is associated with adverse effects on some aspects of quality of life. This study was performed to evaluate the effects of regular endurance exercise training on quality of life and blood pressure. Patients with mild to moderate hypertension (systolic blood pressure 140–180 or diastolic blood pressure 90–110 mm Hg) were randomized to a moderate intensity aerobic exercise group training for 3 sessions/week over 10 weeks or to a non-exercising control group. Health-related quality of life was assessed with the Short Form 36-item Health Survey (SF-36) at baseline and after 6 and 10 weeks. In the 102 subjects (47 male, mean age 47 years) who completed the study, reductions in blood pressure in the exercise group at 10 weeks (-13.1/-6.3 mm Hg) were significant (P < 0.001) compared to baseline and to the control group (-1.5/+6.0 mm Hg). Unlike the control group, the exercise group showed an increase in exercise capacity from 8.2 ± 1.6 to 10.8 ± 2.2 METS (P < 0.01) and showed higher scores on 7 out of 8 subscales (P < 0.05) of the SF-36. Improvement in bodily pain and general health sub-scores correlated with reduction in systolic blood pressure. Regular endurance training improves both blood pressure and quality of life in hypertensive patients and should be encouraged more widely.

Caroline Rheaume et al. (2002) reported that physical exercise increases insulin sensitivity in conditions associated with insulin resistance, such as obesity and diabetes, but little is known in this regard in hypertension. Whether post exercise changes in hemodynamics and/or changes in insulin-induced vasodilatation could contribute to a post exercise increase in insulin sensitivity in hypertensive subjects is unknown. Author investigated the effects of acute physical exercise on insulin sensitivity in 10 hypertensive and 10 normotensive subjects during a control evaluation (CTRL), during lower body negative pressure (LBNP), after 30 minutes of mild bicycle exercise (POSTEX), and during LBNP after exercise (POSTEX+LBNP). Insulin-induced vasodilatation was assessed from peak forearm blood flow during the intravenous glucose tolerance test.
Cardiac output (4.9±0.3 versus 5.3±0.4 L/min, mean±SEM) and insulin sensitivity (the glucose disappearance rate over insulin area under the curve: 0.91±0.07 versus 1.38 ±
0.25 min⁻¹/ [pmol·L⁻¹]· minute) were lower (both P<0.05) in hypertensive than in normotensive subjects, respectively. Cardiac output decreased during LBNP, increased during POSTEX, and was similar to control during POSTEX+LBNP in both groups. Insulin sensitivity was unchanged during LBNP, increased during POSTEX, and remained elevated during POSTEX+LBNP in hypertensive subjects, whereas it remained unchanged in normotensives. Peak forearm blood flow was significantly lower in hypertensive than in normotensive subjects, despite higher insulin levels in hypertensive’s, and was not modified by LBNP or exercise. In conclusion, insulin sensitivity increases after exercise in hypertensive subjects, and the increase in cardiac output does not contribute to this effect. Endogenous insulin-induced vasodilatation is reduced in hypertensive subjects, and this insulin action is not affected by physical exercise.

Stewart (2002) conducted a study on the effects of exercise on the cardiovascular consequences of diabetes and hypertension. The coexistence of type 2 diabetes and hypertension is especially damaging to cardiovascular health most trials of exercise training for these conditions have focused on glycemic control and blood pressure reduction. This article reviews the available evidence and plausible mechanisms by which exercise training may improve the cardiovascular health of persons with type 2 diabetes and hypertension and provides practical guidelines and for exercise prescription. Type 2 diabetes and hypertension result in abnormalities in central and peripheral parameters of cardiovascular function and left ventricular diastolic function. Evidence for exercise training benefit is strongest for improvements in endothelial vasodilator function. The data for exercise training’s improvement of arterial stiffness and system inflammation and reductions of left ventricular mass are less robust. However, this assertion is based more on a lack of randomized controlled trials rather than data to the contrary exercise training also reduces total and abdominal fat. These changes in body composition mediate improvements in insulin sensitivity and blood pressure and may improve endothelial vasodilator function. The current evidence, suggests that the benefits of exercise training go beyond the recognized benefits of glycemic control and blood pressure reduction.
Whelton et al. (2002) investigated to physical activity has been associated with reduced blood pressure in observational epidemiologic studies and individual clinical trials. This meta-analysis of randomized, controlled trials was conducted to determine the effect of aerobic exercise on blood pressure. DATA SOURCES: English-language articles published before September 2001, STUDY SELECTION: 54 randomized, controlled trials / 2419 participants) whose intervention and control groups differed only in aerobic exercise. DATA EXTRACTION: Using a standardized protocol and data extraction form, three of the investigators independently abstracted data on study design, sample size, participant characteristics, type of intervention, follow-up duration and treatment outcomes. DATA SYNTHESIS: In a random effect model, data from each trial were pooled and weighted by the universe of the total variance. Aerobic exercise was associated with the significant reduction in mean systolic and diastolic blood pressure (-3.84 mm Hg (95% CI, -4.97 to -2.72 mm Hg) and 2.58 mm Hg (CI, -3.35 to -1.81 mm Hg), respectively). A reduction in blood pressure was associated with hypertensive participants and normotensive participants and in overweight participants and normal-weight participants. CONCLUSIONS: aerobic exercise reduces blood pressure in both hypertensive and normotensive persons. An increase in aerobic physical activity should be considered as important component of lifestyle modification for prevention and treatment of high blood pressure.

Cox and others (2001) evaluated the long term effects of regular to moderate intensity exercise on effects on blood pressure and blood lipids in previously sedentary older women. Subjects were randomly assigned to either a supervised center based (CB) or a minimally supervised home based (HB) exercise programme, initially for 6 months. Within each programme, subjects were further randomized to exercise either at a moderate (40 - 55 % heart rate reserve, Hrres) or vigorous intensity (65 - 80 per cent Hrres). After 6 months, all groups continued a HB moderate or vigorous exercise programme for another twelve months. METHODS: Healthy, sedentary women (aged 40 - 65 years) (n = 126) were recruited from the community. The subjects exercised thrall of 2.81 mm Hg in systolic blood pressure (P = 0.0049) and 2.70 mm Hg in diastolic blood pressure (P = 0.004) after correction for age and baseline values with moderate exercise, but not with vigorous intensity exercise. When this analysis was repeated with the change
in the body mass included, the results were unchanged. After correction for potential confounding factors, there was a significant fall in total cholesterol and low density lipoprotein cholesterol with vigorous but not moderate exercise at 6 months (P < 0.05) but 18 months. In this largely normotensive population of older women, a moderate, but not vigorous exercise programme, achieved sustained falls in resting systolic and diastolic blood pressure over 18 months. The study demonstrates that in older women, moderate intensity exercise is well accepted, in a sustainable long term and has the health benefit of reduced blood pressure.

Kelley and Sharpe Kelley (2001) investigated the effects of aerobic exercise for reducing resting systolic blood pressure (SBP) and diastolic blood pressure in older adults. It is well established that resting systolic and diastolic blood pressure (SBP and DBP, respectively) increases as one ages. METHODS: Study data were compiled through use of the following: (i) Computer searches (MEDLINE, Current Contents, and Sport Discus), (ii) Cross-referencing from bibliographies of retrieved studies and review articles and (iii) an expert who reviewed our reference list. Inclusion criteria and sources for this study were (i) randomized trials, (ii) aerobic activity as the only exercise intervention, (iii) a non exercise control group, (iv) an assessment of changes in resting Systolic blood pressure and/or Diastolic blood pressure, (v) within-study ages of subjects > or = 50 years, (vi) English-language studies published between January 1996 and January 1998. Net changes in resting blood pressure were calculated as the exercise minus control group difference. RESULTS: Fourteen primary outcomes were derived from seven studies. Decreases approximately 2% and 1% were found for resting Systolic Blood Pressure (SBP) and Diastolic Blood Pressure (DBP), with only changes in SBP, as statistically significant (SBP, mean +/- SD = -2 +/-3 mm Hg, 95% Confidence Interval (CI) = -4 to -1 mm Hg; DBP, mean +/- SD = -1 +/- 2 mm Hg, 95% CI = -2 to 0 mm Hg). CONCLUSIONS: This study supports the efficacy of aerobic exercise for reducing resting SBP in older adults. However, a need exists for studies that address the effectiveness of this intervention for reducing resting blood pressure in older adults.

Rigila (2000) evaluated the effect of physical exercise on blood pressure, the lipid profile, lipoprotein (a) (LP(a)) and low density lipoprotein (LDL) modifications in untrained diabetics, 27 diabetic patients (14 type 1 and 13 type 2) under acceptable and
stable glycemic control were studied before and after a surprised 3 month physical exercise programme. Anthropometric parameters, insulin requirements, blood pressure, the lipid profile, lp(a), LDL composition size and susceptibility to oxidation and the proportion of electronegative (LDL (LDL (-))) were measured. After 3 months of physical exercise, physical fitness improved. The Body Mass Index (BMI) did not change, but the waist circumference decreased significantly. An increase in the sub scapular to triceps skin fold ratio and mid arm muscle circumference (MMC) 23.1 +/- 3.4 V 2.44 +/- 3.7 cm, p < 0.01) were observed after exercise. Insulin requirements and diastolic cholesterol (HDL - C) increased in type 1 patient while LDL cholesterol (LDL - C) decreased in type 2 patients. Although lp (a) levels did not vary in the whole group, a significant decrease was noted in patients with baseline (lp (a) above 300 mg / L (mean decrease, -13 %). A relationship between baseline lp (a) and the change in lp (a) was also observed. After exercise programme 3, of 4 patients with LDL phenotype B changed to LDL phenotype A, and the proportion of LDL (-) tended to decrease. No changes were observed for LDL composition or susceptibility to oxidation. In addition to its known beneficial effects on the classic cardiovascular risk factors, regular physical exercise may reduce the risk of cardiovascular disease in diabetic patients by reducing lp (a) levels in those with elevated lp (a) and producing favourable qualitative LDL modifications.

Kelley et al. (1999) undertook a study was to use the meta – analytic approach to examine the effects of aerobic exercise on resting systolic and diastolic blood pressure in women. Twenty – one studies representing 1029 subjects (663 exercises, 366 controls) and 54 primary outcomes (28 systolic, 26 diastolic) met the criteria for inclusion. Across all in resting systolic (mean +/- SD, -2.03 +/- 2.87, 95 per cent confidence interval (CI) - 3.14 to -0.92 mm Hg) but not diastolic (mean +/- SD, 0.64 +/- 2.02, 95 per cent CI - 1.45 to 0.18 mm Hg) blood pressure were found. Changes systolic blood pressure, initial body mass index, initial resting heart rate, and rest period before assessment of blood pressure meta – analysis of included studies suggests that aerobic exercise causes small reductions in resting systolic blood pressure in women. However, a need exists for additional, well – designed studies on this topic, especially among hypertensive adult women.

Halbert et al. (1998) worked on Effectiveness of exercise training in lowering blood pressure: a meta-analysis of randomized controlled trials of 4 weeks or longer.
To identify the features of an optimal exercise programme in terms of type of exercise, intensity and frequency that would maximize the training induced decrease in blood pressure (BP). *Data identification:* Trials were identified by a systematic search of Medline, Embase and Science Citation Index (SCI), previous review articles and the references of relevant trials, from 1980 until 1996, including only English language studies. *Study selection:* The inclusion criteria were limited to randomized controlled trials of aerobic or resistance exercise training conducted over a minimum of 4 weeks where systolic and diastolic BP was measured. *Results:* A total of 29 studies (1533 hypertensive and normotensive participants) were included, 26 used aerobic exercise training, two trials used resistance training and one study had both resistance and aerobic training groups. Aerobic exercise training reduced systolic BP by 4.7 mm Hg (95% CI: 4.4, 5.0) and diastolic BP by 3.1 mm Hg (95% CI: 3.0, 3.3) as compared to a non-exercising control group, however, significant heterogeneity was observed between trials in the analysis. The BP reduction seen with aerobic exercise training was independent of the intensity of exercise and the number of exercise sessions per week. The evidence for the effect of resistance exercise training was inconclusive. *CONCLUSIONS:* Aerobic exercise training had a small but clinically significant effect in reducing systolic and diastolic BP. Increasing exercise intensity above 70% VO\textsubscript{2} max or increasing exercise frequency to more than three sessions per week did not have any additional impact on reducing BP.

Selvamurthy *et al.* (1998) conducted research on new physiological approach to control essential hypertension. This study was conducted on 20 male patients of Essential Hypertension (EH) in order to explore the possible role of baroreflex mechanism in the etiology of EH and also to find out whether by restoration of baroreflex sensitivity to normal level either by postural tilt stimulus on a tilt table or by the equivalent yogic postural exercise (Yogic asanas), the EH could be cured or controlled. Patients on therapeutic regime were gradually withdrawn from drug therapy, and later divided into two groups of 10 each. Group-I (age 34 +/- 1.7 years) was subjected to a 3 week course of 70 degrees head-up tilt for 30 min daily, while in group-II (age 50 +/- 3.3 years), specific yogic exercises equivalent to head-up or head-down tilt were administered for the same duration. The progressive autonomic readjustments were assessed by a battery
of tests including cardiovascular responses to head up tilt, cold presser response at 4 degrees C water (CPR), alpha index of EEG (AI), level of blood catecholamine’s (CA) and plasma renin activity (PRA). At the end of 3 weeks, there was a significant reduction (P < 0.001) in blood pressure in both the groups. Progressive changes in BP and HR response to tilt during 3 weeks course of tilt and yogic exercise clearly indicated gradual improvement in baroreflex sensitivity. Likewise, changes in other indices like CPR, AI, CA and PRA indicated progressive attenuation of sympatho-adrenal and renin-angiotensin activity. All these changes together with the reduction in BP strongly suggest a close link between the etiology of EH and baroreflexes on the one hand and controlling influence of the latter on sympahto-adrenal and renin-angiotensin systems on the other. It also throws light on the physiological mechanism underlying the effects of selected yogic exercises in the treatment of EH.

Tanaka (1997) found the fact that swimming was often recommended for the prevention and treatment of hypertension, no study has examined the potential efficacy of regular swimming exercise for lowering the blood pressure in hypertensive humans. To test the hypothesis that regular swimming exercise lowers the resting blood pressure, a 10 week closely supervised swimming training program is compared with a non-exercising control group. Eighteen previously sedentary men and women [aged 48 +/- 2 years (mean +/- SEM)] with stage 1 or 2 essential hypertension were selected. The resting heart rated, an index of cardiovascular adaptation decreased in the swimming training group from 81 +/- 4 to 71 +/- 3 beats / minute (P < 0.01). The body mass and body fat percentage did not show statistically significant changes. The systolic blood pressure of patients in the seated position fell significantly (P < 0.05) from 150 +/- 5 to 144 +/- mm Hg. The seated diastolic blood pressure did not change significantly. A similar magnitude of reductions in systolic blood pressure (P < 0.05) was also found in patients in the supine position. No significant changes in plasma catecholamine concentrations, casual forearm vascular resistance, plasma volume and blood volume were observed. There were no significant changes in any of these variables in the control group. Swimming training elicits significant reductions in arterial blood pressure at rest in individuals with hypertension. This is a clinically important finding since swimming can be a highly useful alternative to land based exercises for hypertensive patients with obesity, exercise – induced asthma, or orthopedic injuries.
Wallak (1997) studied the women swimmers and runners, who were matched in terms of endurance training volume and age – adjusted competitive performance and all women including the control group in terms of age and hormonal replacement therapy. It is concluded that higher total and abdominal body fatness are associated with less favourable coronary heart disease risk factors. Total body fat was higher in swimmers than runners, but lower than those of sedentary women, HDL–C, HDL2–C, Triglycerides and HDL/total cholesterol were less favourable in swimmers than runners. Ambulatory systolic blood pressure level was 6 – 10 mm Hg higher in swimmers and sedentary compared to runners. Fasting plasma insulin concentration was higher in swimmers than in runners. All haemostatic risk factors (Fibrogen, fibrin D – dimer, Pal – antigen, t – PA activity, t – Pa antigen) but PA1 – 1 activity were less favourable in swimmers than in runners.

Bertrand et al. (1995) conducted a study to compare the effects of exercise training on Blood Pressure is reviewed. Blood pressure rises during exercise and lowers in the post – exercise period. Regular physical training results in a significant lowering of blood pressure at rest as long as the training is continued. Moreover exercise training results in a blood pressure lowering during exercise which is greater in hypertensive patients than in normotensive patients. A favourable effect is observed also on ambulatory blood pressure, but the night – time blood pressure is not lowered. The mechanisms of training induced changes of blood pressure are not sufficiently known. The exercise training seems act on systemic vascular resistance, plasma catecholamine, PGE 2 and taurine levels, rennin – angiotensin – aldosterone system. As adequate physical training can reduce blood pressure, we can consider it as a non pharmacological treatment of hypertension: mainly for border lines, labile and mild hypertensive patients. For certain hypertensive patients, some sports can be permitted when no target organ is involved.

2.2. STUDIES ON YOGA

Cade et al. (2010) conducted a prospective, randomized, controlled study to evaluate whether a yoga lifestyle intervention improves cardiovascular diseases risk factors, virological or immunological status, or Quality Of Life (QOL) in HIV – infected
adults relative to standard of care treatment in a matched control group. 60 HIV – infected adults with mild – moderate Cardio Vascular Diseases (CVD) risk were assigned to 20 weeks of supervised yoga practice or standard of care. Resting systolic and diastolic blood pressure improved more in the yoga group than in the standard of care group. However, there was no greater reduction in body weight, fat mass or proatherogenic lipids, or improvements in glucose tolerance or overall quality of life after yoga.

Cohen et al. (2009) conducted a randomized controlled trial to assess the effects of 12 weeks of IY (Iyengar Yoga) versus enhanced usual care (EUC) (based on individual dietary adjustment) on 24-h ambulatory BP in yoga-naive adults with untreated prehypertension or Stage 1 hypertension. In total, 26 and 31 subjects in the IY and EUC arms, respectively, completed the study. There were no differences in BP between the groups at 6 and 12 weeks. In the EUC group, 24-h systolic BP (SBP), diastolic BP (DBP) and mean arterial pressure (MAP) significantly decreased by 5, 3 and 3 mmHg, respectively, from baseline at 6 weeks (P < 0.05), but were no longer significant at 12 weeks. In the IY group, 24 h SBP was reduced by 6 mmHg at 12 weeks compared to baseline (P = 0.05). 24 h DBP (P < 0.01) and MAP (P < 0.05) decreased significantly each by 5 mmHg. No differences were observed in catecholamine or cortisol metabolism to explain the decrease in BP in the IY group at 12 weeks. Twelve weeks of IY produces clinically meaningful improvements in 24 h SBP and DBP. Larger studies are needed to establish the long term efficacy, acceptability, utility and potential mechanisms of IY to control BP.

Monika et al. (2009) conducted a study on “Effect of Slow- and Fast-Breathing Exercises on Autonomic Functions in Patients with Essential Hypertension”. Breathing exercises practiced in various forms of meditations such as yoga may influence autonomic functions. This may be the basis of therapeutic benefit to hypertensive patients. Slow breathing had a stronger effect than fast breathing. Blood Pressure decreased longitudinally over a 3-month period with both interventions. standing-to-lying ratio (S/L) ratio, 30:15 ratio, heart rate variation with respiration( E/I ) ratio, and Blood Pressure response in the hand grip and cold presser test showed significant change only in patients practicing the slow-breathing exercise. CONCLUSIONS: Both types of
breathing exercises benefit patients with hypertension. However, improvement in both the sympathetic and parasympathetic reactivity may be the mechanism that is associated in those practicing the slow-breathing exercise.

Niranjan et al. (2009) conducted a study on “Effects of yoga and supervised integrated exercise on heart rate variability and blood pressure in hypertensive patient”. A significant improvement of HRV (heart rate variability) was found during the entire duration of exercise (12.29±1.75 vs 15.64±1.72 at 9 months P<0.001). No significant change in HRV was found in yoga group at the end of 9 months. Supervised integrated exercise + yoga for 9 months showed a significant HRV improvement in this group (15.41±2.06 at 6 months vs. 17±2.06 at 9 months P<0.001). The systolic blood pressure (SBP) and diastolic blood pressure (DBP) in these hypertensive patients corrected towards normalcy in different groups, except in yoga group. There was no significant effect on HRV and BP in control group in the intervening period. CONCLUSIONS: Supervised integrated exercise improves HRV and BP significantly in hypertensive subjects. Yoga does not cause any significant change in HRV and SBP. Yoga combined with regulated exercise was found be very effective in improving HRV and reducing blood pressure.

Pramanik et al. (2009) evaluated the immediate effect of slow pace bhastrika 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 min) following oral intake of hyoscine – N – butyl bromide (Buscopan), a parasympathetic blocker drug. Heart rate and blood pressure of volunteers (n = 39, age = 25 – 40 years) was recorded. After 5 minutes of this breathing exercise, the blood pressure and heart rate again was recorded in the afore said 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. It was noted that after slow bhastrika 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.
Madanmohan et al. (2008) studied whether yoga training of 6 weeks duration nodulated sweating response to dynamic exercise and improves respiratory pressures, hand grip strength and hand grip endurance. Out of 46 healthy subjects (30 males and 16 females. Aged 17 – 20 years), 23 motivated subjects (15 male and 8 female) were given yoga training and the remaining 23 subjects served as controls. Weight loss following Harvard step test (an index of sweat loss), maximum inspiratory pressure, maximum expiratory pressure, 40 mm endurance, hand grip strength and hand grip endurance were determined before and after six week study period. Yoga training produced a marked increase in respiratory pressures and endurance in 40 mm Hg test in both male and female subjects (P < 0.05 for all comparisons). The present study demonstrates attenuation of the sweating response to step test by yoga training. Further, yoga training for a short period of 6 weeks can produce significant improvements in respiratory muscle strength and endurance.

Madanmohan et al. (2008b) studied the effects of yoga training on cardiovascular response to exercise and the time course of recovery after the exercise was determined by the varad step test using a platform at a rate of 30 per minutes for a total duration of 5 minutes or until fatigue, which ever was earlier. Heart rate (HR) and blood pressure response to exercise were measured in supine position before exercise and at 1, 2, 3,4,5,7 and 10 minutes after the exercise. Rate – pressure product and double product which are indices of work done by the heart were also calculated. After 2 months of yoga training, exercise – induced changes in these parameters were significantly reduced.

Dhungel et al. (2008) investigated the responses of alternate nostril breathing the nadisudhi pranayama on some cardio- respiratory functions in healthy young adults. The subjects performed the alternate nostril breathing exercise (15 minutes every day in the morning) for four weeks. Cardio – respiratory parameters were recorded before and after 4 weeks training period. A significant increment in peak expiratory flow rate and pulse pressure was noted. Although systolic blood pressure was decreased insignificantly, the decrease in pulse rate, respiratory rate, and diastolic blood pressure was significant.

Dvivedi et al. (2008) conducted a study on fifty clinically healthy women volunteers who were in their reproductive age group and in their premenstrual period.
Thirty women having premenstrual syndrome were compared with 20 control women to evaluate one week training of 61 points relaxation (61 – PR) yogic exercise. In both the groups cold pressor test was performed; and systolic blood pressure (mm Hg), diastolic blood pressure (mm Hg) and heart rate (1 min) were measured. Basal systolic blood pressure, diastolic pressure and heart rate of women with premenstrual syndrome were significantly higher than the control subjects with P value.

Innes et al. (2008) suggested that tradition mind – body practices such as yoga, tai chi and gigong may offer safe and cost – effective strategies for reducing insulin resistance syndrome – related risk factors for cardiovascular disease in older populations, including postmenopausal women. Current evidence suggested that these practices may reduce insulin resistance and related physiological risk factors for cardiovascular disease; improve mood, well – being and sleep; decrease sympathetic activation; and enhance cardiovascular function.

Raghuraj et al. (2008) found the effect of right, left and alternate nostril yoga breathing (i.e., RNYB, LNYB and ANYB, respectively) were compared with breath awareness (BAW) and normal breathing (CTL). Automatic and respiratory variables were studied in 21 male volunteers with ages between 18 and 45 years and experience in the yoga breathing practices between 3 and 48 months. Subjects were assessed in five experimental sessions on five separate days. The sessions were in fixed possible sequences and subjects were assigned to a sequence randomly. Each session was for 40 minutes; 30 minutes for the breathing practice, preceded and followed by five minutes of quite sitting. Assessments included heart rate variability, skin conductance, finger plethysmogram amplitude, breath rate and blood pressure. Following right nostril yoga breathing there was a significant decrease in systolic, diastolic pressure decreased after alternate nostril yoga breathing there was a significant decrease in systolic, diastolic pressure decreased after alternate nostril yoga breathing and the systolic and mean pressure were lower after left nostril yoga breathing. Hence, unilateral nostril yoga breathing practices appear to influence the blood pressure in different ways.

Vyas et al. (2008) assessed the effect of raja yoga meditation of Bramakumaris on serum lipids in normal Indian women. 49 normal female volunteers were the subjects.
They were divided into premenopausal (n = 23) and post-menopausal (n=26) groups. They were further divided into non-meditators, short term meditators and long term meditators. Lipid profile was assessed using their respective reagent sets. The results showed thus, raja yoga meditation lowered serum cholesterol and low-density lipoprotein-cholesterol in post-menopausal women thus reducing the risk of coronary artery disease in them.

Kyeongra Yang et al. (2007a) conducted a study on review of yoga programs for four leading risk factors of chronic disease. Yoga was effective in reducing Blood Pressure in a group of low-income elderly people; effects on systolic BP did not differ between a yoga class and an aerobic exercise class, both held three times a week for 10 weeks. However, eight other studies found that yoga practice was effective in lowering BP in healthy samples, regardless of the type of yoga. Yoga practice also significantly improved BP among people with hypertension cardiovascular disease or type 2 diabetes. For example, in 13 patients, aged 41–60 years, with essential hypertension, BP dropped significantly during the third week of a 4-week yoga program (1 hr per day, 6 days per week), and it fell further after the program. For example, systolic BP dropped from 141.7 to 127.9 mmHg by the third week and to 120.7 mmHg by the fourth week.

Kyeongra Yang et al. (2007b) conducted a study on review of yoga programs for four leading risk factors of chronic disease. The practice of yoga was associated with significant decreases in cholesterol among subjects with cardiovascular disease, hypertension or type 2 diabetes. One study examined a regimen involving 4 days of a yoga program at a residential course, followed by 1 year of yoga practice at home. In both men with angina and asymptomatic participants with CAD risk factors, all lipid variables except HDL decreased beginning the fourth week of yoga practice (e.g. total cholesterol fell from 206.6 to 193.6 mg dl\(^{-1}\)), and the level of total cholesterol continued falling to 176.06 mg dl\(^{-1}\) at 14 weeks. A study of subjects at risk for cardiovascular disease and diabetes found significant improvements (\(P < 0.01\)) in total cholesterol, triglycerides, LDL, HDL and very-LDL (VLDL, defined as total cholesterol minus LDL minus HDL) after short-term intensive yoga practice (3–4 h per day for 8 days). Notably, for subjects whose baseline total cholesterol was 200 mg dl\(^{-1}\) or higher, the reduction in triglycerides (from 151.5 ± 48.9 to 132.7 ± 50.5 mg dl\(^{-1}\), \(P < 0.001\)) and VLDL (from 36.7 ± 13.8 to
30.2 ± 14.6 mg dl−1, P < 0.001) was significantly greater than in subjects with lower baseline total cholesterol (triglycerides falling from 113.6 ± 46.5 to 110.5 ± 38.1 mg dl−1, P > 0.05; VLDL from 23.7 ± 12.8 to 23.2 ± 12.5 mg dl−1, P > 0.05). Finally, a study of healthy adults over 40 years old found that 5 years of yoga practice reduced age-related deterioration in cardiovascular functions. Although the article describing this observational study did not detail the type of yoga performed nor the frequency or intensity of the yoga sessions, the data showed a long-term change indicating the effectiveness of yoga on cardiovascular functioning.

Sahay et al. (2007) assessed the role of yogic practices on glycaemic control, insulin kinetics, body composition exercise tolerance and various co–morbidities like hypertension and dyslipidemia of the individual with diabetics. These studies were both short and long term and confirmed the useful role of yoga in the control of diabetes mellitus. Fasting and postprandial blood glucose levels came down significantly. Good glycaemic status can be maintained for long periods of time. There was a lowering of drug requirement and the incidence of acute complications like infection and ketosis was significantly reduced. There were significant change in the insulin kinetics and those of counter-regulatory hormones like cortisols. There was a decrease in body fat percentage. There was an improvement in insulin sensitivity and decline in insulin resistance.

Yang et al. (2007) determined 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 students 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.

Rajeev et al. (2006) reported that both mental relaxation and slow breathing resulted in a fall in systolic blood pressure, diastolic blood pressure, heart rate, respiratory rate and electromyographic activity with increase in peripheral skin temperature and skin conductance. Slow breathing caused a significantly higher fall in heart rate (p<0.05), respiratory rate (p < 0.001), systolic blood pressure (p < 0.05) and diastolic blood pressure (p < 0.01). Increase in peripheral skin temperature (p < 0.05) and reduction in
electromyographic activity ($p < 0.05$) occurred more with mental relaxation. No significant differences were seen between increases in skin conductance ($p > 0.2$) observed with both the modalities. Thus, even a single session of mental relaxation or slow breathing can result in a temporary fall in blood pressure. Both the modalities increase the parasympathetic tone but have effects of different intensity on different autonomic parameters.

**Khalsa et al. (2004)** investigated the hemodynamics of a yogic breathing technique claimed to help eliminate and prevent heart attacks due to abnormal electrical events to the heart, and to generally “enhance performance of the central nervous system and to help eliminate the effects of traumatic shock and stress to the Central Nervous System”. Parameters for (4) subjects were recorded during a pre exercise resting period, a 31 minute exercise period, and a post exercise resting period, cardiac index, end diastolic index, peak flow, ejection fraction, thoracic fluid index, index of contractibility ejection ratio, systolic time ratio, acceleration index and systolic, diastolic and mean arterial pressure (MAPs). Left stroke cork index (LSWI) and Stroke Systemic Vascular Resistance Index (SSVRI) were calculated. This technique induces dramatic shifts in all homodynamic variables during the 1 BPM exercise and can produce unique changes in the post exercise resting period after long – term practice that appears to have a unique effect on the brain stem cardio respiratory center regulating the mayer wave (0.1 – 0.01 Hz) patterns of the cardiovascular system.

**Sinha et al. (2004)** observed critically the energy cost and different cardio respiratory changes during the practice of Surya Namaskar. Twenty –one male volunteer from the Indian army practice selected yogic exercises for 6 days in a week for three months duration. The yogic practice schedule consisted of Hatha yogic asana (28 min), pranayama (10.5 min) and meditation (5 min). Oxygen consumption was highest and lowest in the 8th posture [1.22 +/- 0.073 1 min (-1)] and lowest in the 1st posture [0.35 +/- 0.02 1 min (-1)]. In Total energy cost throughout the practice of Surya Namaskar was 13.91 k cal and at an average of 3.79 k cal/ min. During its practice highest heart rate was 100 +/- 13.5 b.p.m. As an aerobic exercise Surya Namaskar seemed to be ideal as it involves both static strengthening and slow dynamic component of exercise with optional stress on the cardio respiratory system.
Telles et al. (2004) aimed at determining whether novices to yoga would be able to reduce their heart rate voluntarily and whether the magnitude of reduction would be more after 30 days of yoga training. 2 groups (yoga and control, n = 12 each) were assessed on day 1 and on day 30. During the intervener 30 days, the yoga group received training in yoga techniques while the control group carried on with their routine. At each assessment the baseline heart rate was recorded for 1 minute, this was followed by a six-minute period during which participants were asked to attempt to voluntarily reduce their heart rate. In contrast, there was no significant change in either the baseline heart rate or the lowest heart rate achieved voluntarily in the control group on day 30 compared to day 1. The results suggested that yoga training can enable practitioners to use their own strategies to reduce the heart rate.

Damodharan (2002) studied the effect of yoga on the physiological, psychological well being, psychomotor parameter and modifying cardiovascular risk factors in mild to moderate hypertensive patients. Twenty patients (16 males, 4 females) in the age group of 35 to 55 years with mild to moderate essential hypertension underwent yogic practices daily for one hour for three months, biochemical, physiological and psychological parameters were studied prior and following a period of three months of yoga practices, biochemical parameters included, blood glucose, lipid profile, catecholamine, MDA, vitamin C, cholinesterase and urinary VMA. Psychological evaluation was done by using personal orientation inventory and subjective well being. Results showed decrease in blood pressure and drug score modifying risk factors i.e., blood glucose, cholesterol and triglycerides decreased the overall improvement in subjective well being and quality of life. There were decrease in VMA catecholamine and decrease at the MDA level suggestive of oxidant stress. Yoga can play an important role in risk modification for cardiovascular diseases in mild to moderate hypertension.

Vyas and Dikhit (2002) explained in his study the respiratory functions; cardiovascular parameters and lipid profile of those practicing Raja yoga meditation (short and long term meditators) and it were compared with those of non meditators. Vital capacity, tidal volume and breath holding were significantly high in short and long term meditators than non –meditators. Long term meditators had significantly higher vital
capacity and expiratory pressure than short term meditators. Diastolic blood pressure was significantly lower in both short and long term meditators as compared to non meditators. Heart rate was significantly lower in both short and long term meditators than in short term meditators and non meditators. Lipid profile showed a significant lowering of serum cholesterol in short and long term meditators as compared to non meditators. Lipid profile of short and long term meditators was better than the profile of non meditators in spite of similar physical activity. This shows that Raja yoga meditation provides significant improvements in respiratory functions, cardiovascular parameters and lipid profile.

Manchanda and others (2000) evaluated the possible role of life style modification incorporating Yoga on retardation of coronary atherosclerotic disease. In this prospective randomized, controlled trial, 42 men with angiographically proven coronary artery disease (CAD) were randomized to control (n = 21) and yoga intervention group (n = 21) and were followed for one year. The active group was treated with a user friendly programme consisting of yoga, control of risk factors, diet control and moderate aerobic exercise. The control group was managed by conventional methods ie., risk factor control and American Heart Association Step I diet. After one year, the yoga groups showed significant reduction in number of anginal episodes per week, improved exercise capacity and decrease in body weight. Serum total cholesterol, LDC cholesterol and triglyceride levels also showed greater reductions as compared with control group.

Bera et al. (1998) compared the recovery from induced physiological stress in Shavasana (a yogic relaxation posture) and two other postures (resting in chair and resting supine posture). Twenty one males and six females (age 21-30 years) were allowed to take rest in one of the above postures immediately after completing the scheduled treadmill running. The recovery was assessed in terms of Heart Rate (HR) and blood pressure. Heart rate and blood pressure were measured before and every two minutes after the treadmill running till they returned to the initial level. The results revealed that the effects of stress were reversed in significantly (P < 0.01) shorter time in Shavasana, compared to the resting posture in chair and a supine posture.