Chapter II

REVIEW OF RELATED LITERATURE

The search for reference material is a time consuming but fruitful phase of investigation. A familiarity with the literature on any problem helps the investigator to discover what is already known, what others have attempted to find out, what methods of investigation have been promising or disappointing, and what problems remained to be solved. In other words, the related literature is worthwhile for an effective piece of research.

The review enlisted in this chapter is based on various sources viz. journals, periodicals, encyclopedia, newspapers, unpublished thesis etc., which are available in various libraries, some literatures were also obtained from Internet. The relevant literature pertaining to the present study has been abstracted in this chapter to provide the background materials to evaluate the significance of the study. The reviews of the literature have been classified under the following headings:

1. Studies Pertaining to Body Composition and Obesity

2. Studies Pertaining to Hypertension


2.1: Studies Pertaining to Body Composition and Obesity

This section gives an insight into how yoga training has been administered for the beneficial changes in body composition and obesity. Several literature reviews have been conducted that examined the impact of yoga on specific health conditions including cardiovascular disease, health-related physical fitness, percent body fat, lean body mass
and obesity. These reviews have contributed to the large body of research evidence attesting to the positive health benefits of yoga.

**Dhananjai et al., (2013)** evaluated the effects of yogic practice on anxiety/depression associated with obesity. To achieve the purpose of these study patients were recruited from the Department of Physiology, C.S.M. Medical University (erstwhile KGMU), Lucknow, Uttar Pradesh, India. A total of 272 subjects were divided into two groups: 1) group of 205 subjects (with yogic practice) and 2) a control group of 67 subjects (with aerobic exercise). Assessment of anxiety and depression were done by Hamilton Rating Scale. In both groups, the number of male participants was higher than females. The age of participants of Aerobic and Yoga groups ranged from 20 to 45 years with mean (± SD) 32.87 ± 7.23 years and 34.24 ± 7.82 years respectively. The height, weight, HC and depression were slightly higher of Aerobic group than Yoga group while age, BMI, WC, WHR and anxiety were slightly higher of Yoga group than Aerobic group. In both groups, the participants were mostly of high economic status, graduates, sedentary workers, married and vegetarian. The demographic as well as socioeconomic status of two groups at admission were found similar i.e., not statistically significant ($P > 0.05$). They finally suggested that incorporating yogic asana in the treatment protocol of patients suffering from anxiety and depression may prove beneficial in the long run.

**Balaji, Varne and Sadat-Ali (2012)** investigated the physiological effects of yogic practices and transcendental meditation in health and disease. They stated that yoga is an ancient Indian way of life, which includes changes in mental attitude, diet, and the practice of specific techniques such as yoga asanas (postures), breathing practices (pranayamas), and meditation to attain the highest level of consciousness. Since a decade,
there has been a surge in the research on yoga, but they do find very few reviews regarding yogic practices and transcendental meditation (TM) in health and disease. Keeping this in view, a Medline search was done to review relevant articles in English literature on evaluation of physiological effects of yogic practices and TM. Data were constructed; issues were reviewed and found that there were considerable health benefits, including improved cognition, respiration, reduced cardiovascular risk, body mass index, blood pressure, and diabetes.

**Flodmark, Marcus and Britton (2006)** analyzed a systematic literature review involving selection of primary research and other systematic reviews. Articles published until 2004 were added to an earlier (2002) review by the Swedish Council on Technology Assessment in Health Care. Inclusion criteria required controlled studies with follow-up of at least 12 months and results measured as body mass index, skinfold thickness or the percentage of overweight/obesity. Children could be recruited from normal or high-risk populations. Combining the new data with the previous review resulted in an evaluation of 24 studies involving children. Of these, eight reported that prevention had a statistically significant positive effect on obesity, 16 reported neutral results and none reported a negative result (sign test; P=0.0078). Adding the studies included in five other systematic reviews yielded, in total, 15 studies with positive, 24 with neutral and none with negative results. Thus, 41% of the studies, including 40% of the children studied, showed a positive effect from prevention. These results are unlikely to be a random chance phenomenon (P=0.000061). Based on this evidence, they pointed out that it is possible to prevent obesity in children and adolescents through limited, school-based programs that combine the promotion of healthy dietary habits and physical activity.
Bulletin of the World Health Organization (2013) assessed the effect of food taxes and subsidies on diet, body weight and health through a systematic review of the literature. They searched the English-language published and grey literature for empirical and modeling studies on the effects of monetary subsidies or taxes levied on specific food products on consumption habits, body weight and chronic conditions. Empirical studies were dealing with an actual tax, while modeling studies predicted outcomes based on a hypothetical tax or subsidy. Twenty-four studies met the inclusion criteria: 13 were from the peer-reviewed literature and 11 were published online. There were 8 empirical and 16 modeling studies. Nine studies assessed the impact of taxes on food consumption only, 5 on consumption and body weight, 4 on consumption and disease and 6 on body weight only. In general, taxes and subsidies influenced consumption in the desired direction, with larger taxes being associated with more significant changes in consumption, body weight and disease incidence. However, studies that focused on a single target food or nutrient may have overestimated the impact of taxes by failing to take into account shifts in consumption to other foods. The quality of the evidence was generally low. Almost all studies were conducted in high-income countries. Food taxes and subsidies have the potential to contribute to healthy consumption patterns at the population level. However, current evidence is generally of low quality and the empirical evaluation of existing taxes is a research priority, along with research into the effectiveness and differential impact of food taxes in developing countries.

Ross and Thomas (2010) provided a scholarly review of the literature comparing the effects of yoga and exercise on a variety of health outcomes and health conditions. A comprehensive search of the research literature from core scientific and nursing journals
yielded 81 studies that met inclusion criteria. These studies subsequently were classified as uncontrolled (n=30), wait list controlled (n=16), or comparison (n=35). The most common comparison intervention (n=10) involved exercise. In the studies reviewed, yoga interventions appeared to be equal or superior to exercise in nearly every outcome measured except those involving physical fitness. The studies comparing the effects of yoga and exercise seem to indicate that, in both healthy and diseased populations, yoga may be as effective as or better than exercise at improving a variety of health-related outcome measures. They recommended that future clinical trials are needed to examine the distinctions between exercise and yoga, particularly how the two modalities may differ in their effects on the SNS=HPA axis. They also suggested that additional studies using rigorous methodologies are needed to examine the health benefits of the various types of yoga.

Madanmohan et al., (2008) designed a study to test whether yoga training of six weeks duration modulates sweating response to dynamic exercise and improves respiratory pressures, handgrip strength and handgrip endurance. Out of 46 healthy subjects (30 males & 16 females, aged 17-20 yr), 23 motivated subjects (15 male & 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, handgrip strength and handgrip endurance were determined before and after the six week study period. In the yoga group, weight loss in response to Harvard step test was 64 +/- 30 g after yoga training as compared to 161 +/- 133 g before the training and the difference was significant (n = 15 male subjects, P < 0.0001). In contrast, weight loss following step test
was not significantly different in the control group at the end of the 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). In conclusion, the study demonstrates attenuation of the sweating response to step test by yoga training. Further, yoga training for a short period of six weeks can produce significant improvements in respiratory muscle strength and endurance.

Tran et al., (2001) examined the effects of hatha yoga practice on the health-related aspects of physical fitness. To achieve the purpose of these study ten healthy, untrained volunteers (nine females & one male), ranging in age from 18-27 years, were studied to determine the effects of hatha yoga practice on the health-related aspects of physical fitness, including muscular strength and endurance, flexibility, cardio respiratory fitness, body composition, and pulmonary function. Subjects were required to attend a minimum of two yoga classes per week for a total of 8 weeks. Each yoga session consisted of 10 minutes of pranayamas (breath-control exercises), 15 minutes of dynamic warm-up exercises, 50 minutes of asanas (yoga postures), and 10 minutes of supine relaxation in savasana (corpse pose). The subjects were evaluated before and after the 8-week training program. They found that isokinetic muscular strength for elbow extension, elbow flexion, and knee extension increased by 31%, 19%, and 28% (p<0.05), respectively, whereas isometric muscular endurance for knee flexion increased 57% (p<0.01). Ankle flexibility, shoulder elevation, trunk extension, and trunk flexion increased by 13% (p<0.01), 155% (p<0.001), 188% (p<0.001), and 14% (p<0.05), respectively. Absolute and relative maximal oxygen uptake increased by 7% and 6%,
respectively (p<0.01). These findings indicate that regular hatha yoga practice can elicit improvements in the health-related aspects of physical fitness.

Chen et al., (2009) investigated the effect of yoga exercise on the health-related physical fitness of school-age children with asthma. The study employed a quasi-experimental research design in which 31 voluntary children (exercise group 16; control group 15) aged 7 to 12 years were purposively sampled from one public elementary school in Taipei Country. The yoga exercise program was practiced by the exercise group three times per week for a consecutive 7 week period. Each 60-minute yoga session included 10 minutes of warm-up and breathing exercises, 40 minutes of yoga postures, and 10 minutes of cool down exercises. Fitness scores were assessed at pre-exercise (baseline) and at the seventh and ninth week after intervention completion. A total of 30 subjects (exercise group 16; control group 14) completed follow-up. Results included: 1. Compared with children in the general population, the study subjects (n = 30) all fell below the 50th percentile in all five physical fitness items of interest. There was no significant difference in scores between the two groups at baseline (i.e., pre-exercise) for all five fitness items. 2. Research found a positive association between exercise habit after school and muscular strength and endurance among asthmatic children. 3. Compared to the control group, the exercise group showed favorable outcomes in terms of flexibility and muscular endurance. Such favorable outcomes remained evident even after adjusting for age, duration of disease and steroid use, values for which were unequally distributed between the two groups at baseline. 4. There was a tendency for all item-specific fitness scores to increase over time in the exercise group. The GEE analysis showed that yoga exercise indeed improved BMI, flexibility, and muscular endurance.
They observed that after 2 weeks of self-practice at home, yoga exercise continued to improve BMI, flexibility, muscular strength, and cardiopulmonary fitness.

Kristal et al., (2005) examined whether yoga practice is associated with attenuated weight gain in healthy, middle-aged men and women. Participants included 15,550 adults, aged 53 to 57 years, recruited to the Vitamin and Lifestyle (VITAL) cohort study between 2000 and 2002. Physical activity (including yoga) during the past 10 years, diet, height, and weight at recruitment and at ages 30 and 45. All measures were based on self-reporting, and past weight was retrospectively ascertained. Multiple regression analyses were used to examined covariate-adjusted associations between yoga practice and weight change from age 45 to recruitment, and polychotomous logistic regression was used to examine associations of yoga practice with the relative odds of weight maintenance (within 5%) and weight loss (> 5%) compared to weight gain. Yoga practice for four or more years was associated with a 3.1-lb lower weight gain among normal weight (BMI < 25) participants [9.5 lbs versus 12.6 lbs] and an 18.5-lb lower weight gain among overweight participants [-5.0 lbs versus 13.5 lbs] (both P for trend <.001). Among overweight individuals, 4+ years of yoga practice was associated with a relative odds of 1.85 (95% confidence interval [CI] 0.63-5.42) for weight maintenance (within 5%) and 3.88 (95% CI 1.30-9.88) for weight loss (> 5%) compared to weight gain (P for trend .026 and .003, respectively). Regular yoga practice was associated with attenuated weight gain, most strongly among individuals who were overweight. They suggested that regular yoga practice can benefit individuals who wish to maintain or lose weight.
Sievenpiper et al., (2001) assessed whether skinfold-thickness measurements may be a useful adjunct to conventional anthropometric assessments in predicting glucose and insulin regulation. They studied responses to replicate 75-g oral-glucose-tolerance tests (OGTTs) and performed simple anthropometry in a cross section of subjects. Thirty-five subjects completed the study: 11 lean [mean (+/-SEM) age: 33 +/- 3.2 y; body mass index (BMI; in kg/m(2)): 24.1 +/- 0.8; and percentage body fat (%BF): 11.5 +/- 1.5%], 12 normal-weight (age: 33 +/- 2.9 y; BMI: 23.9 +/- 0.7; and %BF: 24.3.5 +/- 1.3%), and 12 obese (age: 41 +/- 4.5 y; BMI: 34.5 +/- 1.7; and %BF: 34.2 +/- 1.5%) individuals. The lean and normal-weight groups were selected to have similar BMIs but different %BFs. They measured the participants' heights, weights, %BFs, waist circumferences, hip circumferences, and truncal and peripheral skinfold thicknesses. Subjects received nine 75-g OGTTs and blood samples were collected at 0, 15, 30, 45, 60, 90, and 120 min. Mean plasma glucose and insulin values were used to calculate the insulin sensitivity index. The obese group had higher plasma glucose concentrations and areas under the curve (AUCs) than did the normal-weight or lean group and higher plasma insulin concentrations and AUCs than did the lean group (P < 0.05). Stepwise multiple regression, with adjustment for demographic and anthropometric measurements, identified the following predictors: waist circumference, peripheral skinfold thickness, and BMI for fasting plasma glucose (partial R(2) = 0.20, 0.13, and 0.13, P < 0.05); waist circumference and truncal skinfold thickness for plasma glucose AUC (partial R(2) = 0.20 and 0.13, P < 0.05); age, waist-to-hip ratio, and peripheral skinfold thickness for fasting plasma insulin (partial R(2) = 0.26, 0.22, and 0.15, P < 0.05); truncal skinfold thickness for plasma insulin AUC (partial R(2) = 0.41, P < 0.001); and peripheral
skinfold thickness for both 2-h plasma glucose (partial R(2) = 0.59, P < 0.001) and the insulin sensitivity index (partial R(2) = 0.49, P < 0.001). They documented that Skinfold-thickness measurements may complement to other established measurements for predicting abnormal glucose and insulin regulation.

**Huang, Chien and Chung (2013)** investigated the comparative effectiveness of a single 90-minute Hatha yoga class and an 8-week, 90-minute-class-per-week course. They used a quasi experimental design and recruited 63 female community residents in New Taipei City aged 40-60 years. The selected participants were randomly divided into an experimental group (n = 30) and a control group (n = 33). The experimental group received the 8-week Hatha yoga course. The control group received no intervention. The Perceived Stress Scale (PSS) and heart rate variability (HRV) assessed stress reduction effectiveness. Chi-square, independent t test, paired t test, and generalized estimating equations were used for data analysis. After a single 90-minute class of Hatha yoga, experimental group PSS scores were significantly less than those of the control group (p = .001). Although experimental group HRV (low-frequency norm and high-frequency norm) had improved, these changes were not statistically significant (p = .059). PSS scores for the single 90-minute class and 8-week course did not significantly differ (p = .157) and HRV of statistics is significant (p = .005). Generalized estimating equations analyzed changes in the effectiveness over time of stress reduction (HRV and PSS) after the Hatha yoga intervention. Results showed the post intervention HRV and PSS of the experimental group decreased significantly (p < .001) more than the control group. Their findings support the position that regular, long-term practice of Hatha yoga provides clear and significant health benefits. They suggested that
participation in a single 90-minute Hatha yoga class regularly can reduce perceived stress even more significantly.

Pal, Srivastava and Tiwari (2011) observed the effect of regular yogic practices and self-discipline in reducing body fat and elevated lipids in CAD patients. To achieve the purpose of these study one hundred seventy (170) subjects, of both sexes having coronary artery disease were randomly selected from Department of Cardiology. Subjects were divided into two groups randomly in yoga group and in non-yoga group, eighty five (85) in each group. Out of these (170 subjects), one hundred fifty four (154) completed the study protocol. The yogic intervention consisted of 35-40 min/day, five days in a week till six months in the Department of Physiology CSMMU UP Lucknow. Body fat testing and estimation of lipid profile were done of both groups at zero time and after six months of yogic intervention in yoga group and without yogic intervention in non yoga group. The result of the study shows that BMI (p<0.04), fat % (p<0.0002), fat free mass (p<0.04), SBP (p<0.002), DBP (p<0.009), heart rate (p<0.0001), total cholesterol (p<0.0001), triglycerides (p<0.0001), HDL (p<0.0001) and low density lipoprotein (p<0.04) were changed significantly. Reduction of SBP, DBP, heart rate, body fat%, total cholesterol, triglycerides and LDL after regular yogic practices is beneficial for cardiac and hypertensive patients. They pointed out that yogic practices included in this study are helpful for the patients of coronary artery disease.

Moliver et al. (2011) examined the extent to which body mass index (BMI) and medication use in a sample of female yoga practitioners over 45 years varied according to the length and frequency of yoga practice. They administered online surveys to 211 female yoga practitioners aged 45 to 80 years. They used regression analyses to evaluate
the relationship of extent of yoga experience to both BMI and medication use after accounting for age and lifestyle factors. They also conducted comparisons with 182 matched controls. Participants had practiced yoga for as long as 50 years and for up to 28 hours per week. There were significant inverse relationships between yoga experience and both BMI and medication load. These significant relationships remained after accounting for age and lifestyle factors. When computed yoga experience in terms of total calendar years, without accounting for hours of practice, significant relationships did not remain. However, there was no obesity in the 49 participants with more than 25 years of yoga practice. Yoga practitioners were less likely than non-practitioners to use medication for metabolic syndrome, mood disorders, inflammation, and pain. A long-term yoga practice was associated with little or no obesity in a non-probability sample of women over 45 years. Relationships showed a dose-response effect, with increased yoga experience predicting lower BMI and reduced medication use.

_Telles et al., (2010)_ investigated the effects of yoga and diet change program, emphasizing breathing techniques practiced while seated, was assessed in obese persons. A single group of 47 persons were assessed on the first and last day of a yoga and diet change program, with 6 days of the intervention between assessments. The assessments were: body mass index (BMI), waist and hip circumferences, mid-arm circumference, body composition, hand grip strength, postural stability, serum lipid profile and fasting serum leptin levels. Participants practiced yoga for 5 hours every day and had a low fat, high fiber, vegetarian diet. Last and first day data were compared using a t-test for paired data. Following the 6-day residential program, participants showed a decrease in BMI (1.6 percent), waist and hip circumferences, fat-free mass, total
cholesterol (7.7 percent decrease), high density lipoprotein (HDL) cholesterol (8.7 percent decrease), fasting serum leptin levels (44.2 percent decrease) and an increase in postural stability and hand grip strength (p<0.05, all comparisons). A 6-day yoga and diet change program decreased the BMI and the fat-free mass. Total cholesterol also decreased due to reduced HDL levels. This suggests that a brief, intensive yoga program with a change in diet can pose certain risks. Benefits seen were better postural stability, grip strength (though a 'practice effect' was not ruled out), reduced waist and hip circumferences and a decrease in serum leptin levels.

**Bhutkar et al., (2011)** evaluated effects of regular practice of sun salutation on muscle strength, general body endurance and body composition. Subjects (49 male & 30 female) performed 24 cycles of sun salutation, 6 days a week for 24 weeks. Upper body muscle strength was determined by 1 repetition maximum (1RM) for bench press and shoulder press technique. Back and leg dynamometry was used to assess strength of back and leg muscles. General body endurance was evaluated by push-up and sit-up tests. Body composition was assessed by noting % body fat by using bioelectric impedance analysis. Perceived intensity of exercise by subjects was noted by Borg scale. Muscle strength by bench press showed significant increase in male (29.49±9.70 to 36.12±9.09 Kg, P<0.001) and female (10.5±4.42 to 13.16±4.44 Kg, P<0.001) subjects. Strength by shoulder press also increased (males; 22.96±9.57 Kg to 26.53±11.05 Kg, P<0.001, females; 6.83±2.78 to 8.83±3.87, P<0.001). Endurance by push-ups & sit-ups showed similar findings in male (19.0±9.58 to 21.98±8.98, P<0.001 and 24.92±10.41 to 29.84±12.64, P<0.001 respectively) and female (14.66±6.80 to 18.56±6.97 and 13.16±7.75 to 19.23±8.25, P<0.001 respectively) subjects. A significant
decrease in body fat percent was observed only in female (27.68±5.46 to 25.76±4.72, P<0.001) but not in male subjects. BMI significantly decreased in both the groups (z=4.37, P<001 and t=5.41, P<0.001 respectively). They concluded that the sun salutation can be an ideal exercise to keep oneself in optimum level of fitness.

**Kristal et al., (2005)** examined whether yoga practice is associated with lower mean 10-year weight gain after age 45. Participants included 15,550 adults, aged 53 to 57 years, recruited to the Vitamin and Lifestyle (VITAL) cohort study between 2000 and 2002. Physical activity (including yoga) during the past 10 years, diet, height, and weight at recruitment and at ages 30 and 45. All measures were based on self-reporting, and past weight was retrospectively ascertained. Multiple regression analyses were used to examined covariate-adjusted associations between yoga practice and weight change from age 45 to recruitment, and polychotomous logistic regression was used to examine associations of yogapractice with the relative odds of weight maintenance (within 5%) and weight loss (> 5%) compared to weight gain. Yoga practice for four or more years was associated with a 3.1-lb lower weight gain among normal weight (BMI < 25) participants [9.5 lbs versus 12.6 lbs] and an 18.5-lb lower weight gain among overweight participants [-5.0 lbs versus 13.5 lbs] (both P for trend <.001). Among overweight individuals, 4+ years of yoga practice was associated with a relative odds of 1.85 (95% confidence interval [CI] 0.63-5.42) for weight maintenance (within 5%) and 3.88 (95% CI 1.30-9.88) for weight loss (> 5%) compared to weight gain (P for trend .026 and .003, respectively). Regular yoga practice was associated with attenuated weight gain, most strongly among individuals who were overweight. Although causal inference from
this observational study is not possible, results are consistent with the hypothesis that regular yoga practice can benefit individuals who wish to maintain or lose weight.

Manchanda and Madan (2014) stated that yoga is a holistic mind-body intervention aimed at physical, mental, emotional and spiritual well being. Several studies have shown that yoga and/or meditation can control risk factors for cardiovascular disease like hypertension, type II diabetes and insulin resistance, obesity, lipid profile, psychosocial stress and smoking. Some randomized studies suggest that yoga/meditation could retard or even regress early and advanced coronary atherosclerosis. A recent study suggests that transcendental meditation may be extremely useful in secondary prevention of coronary heart disease and may reduce cardiovascular events by 48% over a 5-year period. Another small study suggests that yoga may be helpful in prevention of atrial fibrillation. However, most studies have several limitations like lack of adequate controls, small sample size, inconsistencies in baseline and different methodologies, etc. and therefore large trials with improved methodologies are required to confirm these findings. However, in view of the existing knowledge and yoga being a cost-effective technique without side effects, it appears appropriate to incorporate yoga/meditation for primary and secondary prevention of cardiovascular disease.

Rioux and Ritenbaugh (2013) assessed the quantity and quality of clinical trials of yoga as an intervention for weight loss or as a means of risk reduction or treatment for obesity and diseases in which obesity is a causal factor. This review summarized the studies' research designs and evaluated the efficacy of yoga for weight loss via the current evidence base. The research team evaluated published studies to determine the appropriateness of research designs, comparability of programs' intervention elements,
and standardization of outcome measures. The research team's literature search used the key terms yoga and obesity or yoga and weight loss in three primary medical-literature databases (PubMed, PsychInfo, and Web of Science). The study excluded clinical trials with no quantitative obesity related measure. Extracted data included each study's (1) design; (2) setting and population; (3) nature, duration, and frequency of interventions; (4) comparison groups; (5) recruitment strategies; (6) outcome measures; (7) data analysis and presentation; and (8) results and conclusions. The research team developed an overall evaluation parameter to compare disparate trials. The research team reviewed each study to determine its key features, each worth a specified number of points, with a maximum total of 20 points. The features included a study's (1) duration, (2) frequency of yoga practice, (3) intensity of (length of) each practice, (4) number of yogic elements, (5) inclusion of dietary modification, (6) inclusion of a residential component, (7) the number of weight-related outcome measures, and (8) a discussion of the details of the yogic elements. Overall, therapeutic yoga programs are frequently effective in promoting weight loss and/or improvements in body composition. The effectiveness of yoga for weight loss is related to the following key features: (1) an increased frequency of practice; (2) a longer intervention duration (3) a yogic dietary component; (4) a residential component; (5) the comprehensive inclusion of yogic components; (5) and a home-practice component. Yoga appears to be an appropriate and potentially successful intervention for weight maintenance, prevention of obesity, and risk reduction for diseases in which obesity plays a significant causal role.

Seo et al., (2012) tested the effect of an 8-week of yoga-asana training on body composition, lipid profile, and insulin resistance (IR) in obese adolescent boys. Twenty
volunteers with body mass index (BMI) greater than the 95th percentile were randomly assigned to yoga (age 14.7±0.5 years, n=10) and control groups (age 14.6±1.0 years, n=10). The yoga group performed exercises three times per week at 40~60% of heart-rate reserve (HRR) for 8 weeks. IR was determined with the homeostasis model assessment of insulin resistance (HOMA-IR). After yoga training, body weight, BMI, fat mass (FM), and body fat % (BF %) were significantly decreased, and fat-free mass and basal metabolic rate were significantly increased than baseline values. FM and BF % were significantly improved in the yoga group compared with the control group (p<0.05). Total cholesterol (TC) was significantly decreased in the yoga group (p<0.01). HDL-cholesterol was decreased in both groups (p<0.05). No significant changes were observed between or within groups for triglycerides, LDL-cholesterol, glucose, insulin, and HOMA-IR. Our findings show that an 8-week of yoga training improves body composition and TC levels in obese adolescent boys, suggesting that yoga training may be effective in controlling some metabolic syndrome factors in obese adolescent boys.

2.2: Studies Pertaining to Hypertension

The studies reviewed in this section mostly to find out the effect of the yoga training to control hypertension. The investigator has traced out different types of research works that have been undertaken by the physical educationists and sports scientists to reduce blood pressure through yoga training. The researcher came across several books, periodicals, journals and published thesis, while searching for relevant facts and finding that were related to this present study. From these reviews, the investigator found that there was scope for further research to assess the effects of yoga training on hypertension among middle aged people.
Hagins, States, Selfe and Innes (2013) systematically reviewed and meta-analyze the effectiveness of yoga for reducing blood pressure in adults with hypertension and to assess the modifying influences of type and length of yoga intervention and type of comparison group. Academic Search Premier, Alt Health Watch, Biosis/Biological Abstracts, Cinahl, Cochrane Library, Embase, Medline, Psyc Info, Psyc Articles, Natural Standard, and Web of Science databases were screened for controlled studies from 1966 to March 2013. Two authors independently assessed risk of bias using the Cochrane Risk of Bias Tool. All 17 studies included in the review had unclear or high risk of bias. Yoga had a modest but significant effect on systolic blood pressure (SBP) (-4.17 [-6.35, -1.99], P = 0.0002) and diastolic blood pressure (DBP) (-3.62 [-4.92, -1.60], P = 0.0001). Subgroup analyses demonstrated significant reductions in blood pressure for (1) interventions incorporating 3 basic elements of yoga practice (postures, meditation & breathing) (SBP: -8.17mmHg [-12.45, -3.89]; DBP: -6.14mmHg [-9.39, -2.89]) but not for more limited yoga interventions; (2) yoga compared to no treatment (SBP: -7.96mmHg [-10.65, -5.27]) but not for exercise. They stated that yoga can be preliminarily recommended as an effective intervention for reducing blood pressure.

Okonta (2012) presented an evidence-based integrative research review that validates yoga therapy as an effective complementary treatment in the management of high blood pressure (BP). The article also uses the theoretical framework of Dr Hans Selye's general adaptation syndrome. Yoga researchers demonstrate that yoga works because it modulates the physiological system of the body, specifically its effect on the heart rate. This review is significant because yoga presents an effective method of treating hypertension that is nonpharmacologic and therefore there are no adverse effects
and there are other valuable health benefits. Research suggests that stress is a contributing factor to high BP; hence, the use of the general adaptation syndrome and the most important attribute of yoga, that is, it is a physical and mental exercise program that is in sync with the philosophy of holistic nursing care where one treats the whole individual and not just the disease. The review was conducted with a search of computerized databases such as Ovid, Academic Search Premier, Cinahl, Medline, and Health Source: Nursing/Academic edition, Psych Info, as well as reliable Web sites such as the cdc.gov, among others. An integrative review search was conducted, and 10 studies met the inclusion criteria. They include a combination of randomized controlled trials, quasi-experimental studies, and pilot studies. Yoga therapy is a multifunctional exercise modality with numerous benefits. Not only does yoga reduce high BP but it has also been demonstrated to effectively reduce blood glucose level, cholesterol level, and body weight, major problems affecting the American society. The completed integrative review provides guidelines for nursing implementation as a complementary treatment of high BP.

Dhameja et al., (2011) investigated the association of glutathione S-transferase (GST) gene polymorphism with oxidative stress in hypertensive patients and the possible beneficial effect of yoga on them. To achieve the purpose of the study sixty (60) hypertensive individuals, between 30 and 60 years of age were recruited and divided into two groups of 30 each. The yoga group was subjected to 50-60 minutes of yogic practices daily for 42 days, while the control group included the remaining 30 age- and sex-matched hypertensive individuals. GST gene polymorphism was analyzed using multiple allele specific polymerase chain reaction and oxidative stress parameters were assessed
biochemically. Assessment of blood pressure showed a statistically significant though modest reduction (p<0.05) in the yoga group as compared to the control group. Malondialdehyde was observed to be significantly low (p<0.05), while antioxidant capacity in the form of GST showed an increasing trend and ferric-reducing ability of plasma was significantly increased (p<0.05) in the subjects who practiced yoga. The result of the study revealed that yoga has been found to decrease blood pressure as well as the levels of oxidative stress in patients with hypertension.

Dickinson et al., (2008) evaluated the effects of relaxation therapies on cardiovascular outcomes and blood pressure in people with elevated blood pressure. Twenty nine RCTs, with eight weeks to five years follow-up, met their inclusion criteria; four were excluded from the primary meta-analysis because of inadequate outcome data. The remaining 25 trials assessed 1,198 participants, but adequate randomization was confirmed in only seven trials and concealment of allocation in only one. Only one trial reported deaths, heart attacks and strokes (one of each). Meta-analysis indicated that relaxation resulted in small, statistically significant reductions in SBP (mean difference: -5.5 mmHg, 95% CI: -8.2 to -2.8, I² =72%) and DBP (mean difference: -3.5 mmHg, 95% CI: -5.3 to -1.6, I² =75%) compared to control. The substantial heterogeneity between trials was not explained by duration of follow-up, type of control, type of relaxation therapy or baseline blood pressure. The nine trials that reported blinding of outcome assessors found a non-significant net reduction in blood pressure (SBP mean difference: -3.2 mmHg, 95% CI: -7.7 to 1.4, I²(2) =69%) associated with relaxation. The 15 trials comparing relaxation with sham therapy likewise found a non-significant reduction in blood pressure (SBP mean difference: -3.5 mmHg, 95% CI: -7.1 to 0.2, I²(2) =63%). In
view of the poor quality of included trials and unexplained variation between trials, the evidence in favour of causal association between relaxation and blood pressure reduction is weak. They suggested that the some of the apparent benefit of relaxation was probably due to the aspects of treatment unrelated to relaxation.

Harinath et al., (2004) evaluated the effects of Hatha yoga and Omkar meditation on cardiorespiratory performance, psychologic profile, and melatonin secretion. To achieve the purpose of the study thirty healthy men in the age group of 25-35 years volunteered for the study. They were randomly divided in two groups of 15 each. Group 1 subjects served as controls and performed body flexibility exercises for 40 minutes and slow running for 20 minutes during morning hours and played games for 60 minutes during evening hours daily for 3 months. Group 2 subjects practiced selected yogic asanas (postures) for 45 minutes and pranayama for 15 minutes during the morning, whereas during the evening hours these subjects performed preparatory yogic postures for 15 minutes, pranayama for 15 minutes, and meditation for 30 minutes daily, for 3 months. Orthostatic tolerance, heart rate, blood pressure, respiratory rate, dynamic lung function (such as forced vital capacity, forced expiratory volume in 1 second, forced expiratory volume percentage, peak expiratory flow rate, and maximum voluntary ventilation), and psychologic profile were measured before and after 3 months of yogic practices. Serial blood samples were drawn at various time intervals to study effects of these yogic practices and Omkar meditation on melatonin levels. The result of the study showed that yogic practices for 3 months resulted in an improvement in cardiorespiratory performance and psychologic profile. The plasma melatonin also showed an increase after three months of yogic practices. The systolic blood pressure, diastolic blood
pressure, mean arterial pressure, and orthostatic tolerance did not show any significant correlation with plasma melatonin. However, the maximum night time melatonin levels in yoga group showed a significant correlation ($r = 0.71$, $p < 0.05$) with well-being score. These observations suggest that yogic practices can be used as psychophysiologic stimuli to increase endogenous secretion of melatonin, which, in turn, might be responsible for improved sense of well-being.

Kuntsevich, Bushell and Theise (2010) investigated the mechanisms underlying the modulating effects of yogic cognitive-behavioral practices (eg, meditation, yoga asanas, pranayama breathing, caloric restriction) on human physiology. Here they give examples of these transduction pathways and how, yogic practices might optimize health, delay aging, and ameliorate chronic illness and stress from disability. They also recognize that most studies of these mechanisms remain embedded in a reductionist paradigm, investigating small numbers of elements of only 1 or 2 pathways. Moreover, often, subjects are not long-term practitioners, but recently trained. The models generated from such data are, in turn, often limited, top-down, without the explanatory power to describe beneficial effects of long-term practice or to provide foundations for comparing one practice to another. More flexible and useful models require a systems-biology approach to gathering and analysis of data. Such a paradigm is needed to fully appreciate the deeper mechanisms underlying the ability of yogic practice to optimize health, delay aging, and speed efficient recovery from injury or disease. In this regard, 3 different, not necessarily competing, hypotheses are presented to guide design of future investigations, namely, that yogic practices may: (1) promote restoration of physiologic set points to normal after derangements secondary to disease or injury, (2) promote homeostatic
negative feedback loops over nonhomeostatic positive feedback loops in molecular and cellular interactions, and (3) quench abnormal "noise" in cellular and molecular signaling networks arising from environmental or internal stresses.

Mandanmohan et al., (2003) studied the effect of yoga training on hand grip strength (HGS), hand grip endurance (HGE), maximum expiratory pressure (MEP), maximum inspiratory pressure (MIP), forced expiratory volume (FEV), forced expiratory volume in first second (FEV1) and peak expiratory flow rate (PEFR). 20 school children in the age group of 12 to 15 years were given yoga training (asans & pranayams) for 6 months. Twenty age and gender-matched students formed the control group. Yoga training produced statistically significant (P < 0.05) increase in HGS and HGE. MEP, MIP, FEV, FEV1 and PEFR also increased significantly (P < 0.001) after the yoga training. In contrast, the increase in these parameters in the control group was statistically insignificant. The result of the study shows that yoga training for 6 months improves lung function, strength of inspiratory and expiratory muscles as well as skeletal muscle strength and endurance. They suggested that yoga be introduced at school level in order to improve physiological functions, overall health and performance of students.

Sodhi, Singh and Dandona (2009) examined the effect of yoga training on pulmonary functions in patients with bronchial asthma. To achieve the purpose of the study one hundred twenty patients of asthma were randomized into two groups i.e Group A (yoga training group) and Group B (control group). Each group included sixty patients. Pulmonary function tests were performed on all the patients at baseline, after 4 weeks and then after 8 weeks. Majority of the subjects in the two groups had mild disease (34 patients in Group A and 32 in Group B). From the result of the study it was observed that
the subjects of experimental groups showed a statistically significant increasing trend (P < 0.01) in % predicted peak expiratory flow rate (PEFR), forced expiratory volume in the first second (FEV1), forced vital capacity (FVC), forced mid expiratory flow in 0.25-0.75 seconds (FEF25-75) and FEV1/FVC% ratio at 4 weeks and 8 weeks as compared to control group. They observed that, the yoga breathing exercises used adjunctively with standard pharmacological treatment significantly improves pulmonary functions in patients with bronchial asthma.

Bhavanani et al., (2011) conducted a comparative study of slow and fast suryanamaskar on physiological function. To achieve the purpose of the study forty two school children in the age group of 12-16 years were randomly selected as subjects and equally divided into two groups of 21 each. Group I and II received 6 months training in performance of slow suryanamaskar (SSN) and fast suryanamaskar (FSN), respectively. The result of the study revealed that training in SSN produced a significant decrease in diastolic pressure. In contrast, training in FSN produced a significant increase in systolic pressure. Although there was a highly significant increase in isometric hand grip (IHG) strength and hand grip endurance (HGE) in both the groups, the increase in HGE in FSN group was significantly more than in SSN group. Pulmonary function tests showed improvements in both the groups though intergroup comparison showed no significance difference. Maximum inspiratory pressure (MIP) and maximum expiratory pressure increased significantly in both the groups with increase of MIP in FSN group being more significant than in SSN. The study reports that SN has positive physiological benefits as evidenced by improvement of pulmonary function, respiratory pressures, hand grip strength and endurance, and resting cardiovascular parameters. The result of the study
also demonstrates the differences between SN training when performed in a slow and fast manner, concluding that the effects of FSN are similar to physical aerobic exercises, whereas the effects of SSN are similar to those of yoga training.

**Hagberg, Park and Brown (2000)** analyzed the most recent review of the effects of exercise training on patients with hypertension. Fifteen studies have been published in the English literature. These results continue to indicate that exercise training decreases blood pressure (BP) in approximately 75% of individuals with hypertension, with systolic and diastolic BP reductions averaging approximately 11 and 8mm Hg, respectively. Women may reduce BP more with exercise training than men, and middle-aged people with hypertension may obtain greater benefits than young or older people. Low to moderate intensity training appears to be as, if not more, beneficial as higher intensity training for reducing BP in individuals with hypertension. BP reductions are rapidly evident although, at least for systolic BP, there is a tendency for greater reductions with more prolonged training. However, sustained BP reductions are evident during the 24 hours following a single bout of exercise in patients with hypertension. Asian and Pacific Island patients with hypertension reduce BP, especially systolic BP, more and more consistently than Caucasian patients. The minimal data also indicate that African-American patients reduce BP with exercise training. Some evidence indicates that common genetic variations may identify individuals with hypertension likely to reduce BP with exercise training. Patients with hypertension also improve plasma lipoprotein-lipid profiles and improve insulin sensitivity to the same degree as normotensive individuals with exercise training. Some evidence also indicates that exercise training in hypertensive patients may result in regression of pathological left ventricular
hypertrophy. These results continue to support the recommendation that exercise training is an important initial or adjunctive step that is highly efficacious in the treatment of individuals with mild to moderate elevations in BP.

Hagberg et al., (1999) documented that exercise training improves cardiovascular disease risk, but individual responses are highly variable. They hypothesized that common polymorphic gene variations would affect these responses. Sedentary obese hypertensive older men who had undergone exercise training were typed at the apolipoprotein (apo) E, angiotensin-converting enzyme (ACE), and lipoprotein lipase (LPL) loci. Individuals of all genotype subgroups were generally similar before training; they also changed body weight, body composition, and \( f_{1}\text{O}_2\)max similarly with training. ACE insertion/insertion (II) and insertion/deletion (ID) genotype individuals (n=10) tended to reduce systolic blood pressure more with training than deletion/deletion (DD) individuals (n=8) (-10 versus -5 mm Hg, P=0.16). ACE II and ID individuals decreased diastolic blood pressure more with training than DD individuals (-10 versus -1 mm Hg, P<0.005). Systolic blood pressure reductions with training were also larger in apoE3 and E4 (n=15) than apoE2 men (n=3) (-10 versus 0 mm Hg, P<0.05). The same trend was evident for diastolic blood pressure (-7 versus -3 mm Hg), but the difference was not significant. Systolic (14 versus -6 mm Hg, P=0.08) and diastolic (-9 versus -5 mm Hg, P=0.10) blood pressure reductions tended to be greater in LPL PvuII +/+ (n=4) than +/- and -/- individuals (n=14). Systolic (-10 versus 3 mm Hg, P<0.05) and diastolic (-9 versus 2 mm Hg, P<0.05) blood pressure reductions were larger in LPL HindIII +/- and +/- (n=15) than -/- persons (n=3), respectively. LPL PvuII -/- individuals (n=3) had larger increases in HDL cholesterol (11 versus 2 mg/dL, P<0.05) and HDL(2) cholesterol.
(8 versus 0 mg/dL, P<0.05) than LPL PvuII +/- and +/+ individuals (n=15). The results of
the study were consistent with the possibility that apoE, ACE, and LPL genotypes may
identify hypertensives who will improve blood pressure, lipoprotein lipids, and
cardiovascular disease risk the most with exercise training.

Bacon et al., (2004) examined the effects of exercise, diet and weight loss on high
blood pressure. Although high BP is among the most common reasons for outpatient
visits, BP control is often inadequate. It is well established that BP can be lowered
pharmacologically in hypertensive individuals; however, anti-hypertensive medications
are not effective for everyone, and may be costly and result in adverse effects that impair
quality of life and reduce adherence. Moreover, abnormalities associated with high BP,
such as insulin resistance and hyperlipidaemia, may persist or may even be exacerbated
by some anti-hypertensive medications. Consequently, there has been a great deal of
interest in the development and application of behavioural interventions in the
management of high BP. The main behavioural interventions that are recommended to
reduce BP are exercise and the Dietary Approaches to Stop Hypertension (DASH) diet.
Weight loss is also recommended for BP reduction in overweight individuals. Exercise
alone is associated with reductions of approximately 3.5 and 2.0mm Hg in systolic (SBP)
and diastolic blood pressure (DBP), respectively. Patients fed a DASH diet (a diet high in
low-fat dairy products and fibre, including fruits and vegetables) had reductions in SBP
and DBP of 5.5 and 3.0mm Hg, respectively, compared with those consuming a standard
US diet. Reductions of approximately 8.5mm Hg SBP and 6.5mm Hg DBP accompany
weight loss of 8 kg. In overweight hypertensive patients, a combined exercise and
weight-loss intervention has been shown to decrease SBP and DBP by 12.5 and 7.9 mm
Hg, respectively. There is evidence to suggest that these decreases in BP are associated with improvements in left ventricular structure and function, and peripheral vascular health. They observed that both exercise training and weight loss have been shown to decrease left ventricular mass and wall thickness, reduce arterial stiffness and improve endothelial function. These data support the role of behavioural interventions in the treatment of patients with elevations in BP.

Tsai et al., (2002) analyzed the beneficial effects on blood pressure and lipid profile of programmed exercise training in subjects with white coat hypertension. To achieve the purpose of the study a total of 42 patients (23 men & 19 women) with white coat hypertension (mean 24-h ambulatory BP 119.2 +/- 6.6/78.3 +/- 5.8 mm Hg) were divided randomly into two groups: control (n = 20) (no exercise), and moderate-intensity exercise (n = 22). The training group exercised three times per week at the prescribed exercise intensity using a treadmill exercise program. Blood pressure, heart rate, and biochemical parameters were monitored every 4 weeks for 12 weeks. Significant reductions in clinic and ambulatory BPs were seen in the exercise group after only 4 weeks regular exercise training and these persisted over the 12-week study. The result of the study shows that the mean maximal reductions in clinic BP were 11 mm Hg for systolic and 5 mm Hg for diastolic pressure. Significant reductions were found in plasma total cholesterol (-6.1%), low-density lipoprotein cholesterol (LDL-C) (-14.1%), and triglyceride (-11.4%). Elevation of high-density lipoprotein cholesterol (HDL-C) (+11.2%) was also noted. These data, which are clinically significant, suggest that 12 weeks of exercise training can result in successful reduction of BP and favorable changes in the lipid profile that would be beneficial to patients with white coat hypertension.
Tsai et al., (2002) examined the beneficial effect on blood pressure and lipid profile by programmed exercise training in Taiwanese patients with mild hypertension. Mild essential hypertensive patients comprise a large portion of the hypertensive population. Previous reports have shown that moderate-intensity regular exercise training in these patients usually reduces blood pressure. By designing programmed exercise to evaluate whether it is effective in reducing blood pressure in mild hypertensive patients and also has beneficial effects on other biochemical parameters. To achieve the purpose of the study twenty-three mild hypertensive Taiwanese patients (resting blood pressure 139.1 +/- 11.4/99.5 +/- 8.0 mmHg) were divided randomly into two groups: control (no exercise) and moderate-intensity exercise (average 6.4 +/- 0.7 METs). The training group exercised three times per week at the prescribed exercise intensity by using the Treadmill exercise test. Blood pressure, heart rate and other biochemical parameters were monitored regularly every 4 weeks for 12 weeks. The result of the study revealed that after 12 weeks regular exercise training, the exercise group showed for significant resting blood pressure reduction. Mean maximal reduction of systolic pressure was 18 mmHg. Significant reduction of total cholesterol, low-density lipoprotein cholesterol (LDL-C) and triglyceride were found; elevation of high-density lipoprotein cholesterol (HDL-C) was also noted. These data suggest that after 12 weeks of exercise training in mild hypertensive patients, successful reduction of blood pressure and favorable changes of lipid profile will be noted.

Ehsani (2001) analyzed the exercise in patients with hypertension. A progressive increase in arterial stiffness with aging contributes to systolic hypertension those results in left ventricular hypertrophy and concentric remodeling in the elderly. Lowering of
blood pressure in older adults reduces cardiovascular risks. Endurance exercise training can lower blood pressure in older adults with mild (grade I) hypertension. However, the blood pressure-lowering effect of exercise training, compared with antihypertensive medications, is generally modest for both systolic and diastolic blood pressure. Exercise training alone is likely to be ineffective in lowering blood pressure sufficiently in older adults with moderate to severe (grade II & higher) hypertension. However, exercise and weight loss may potentiate the effects of antihypertensive medications in these subjects. Low-intensity endurance exercise training appears to be most effective in reducing blood pressure in older hypertensive adults. Metabolic adaptations to exercise training can significantly reduce other risk factors for coronary artery disease and atherosclerosis, in addition to reducing blood pressure. Endurance exercise training improves exercise capacity and quality of life, and can induce a modest but significant regression of left ventricular hypertrophy and remodeling in older adults with hypertension.

**Blom et al., (2012)** analyzed the stress reduction using Mindfulness meditation and Yoga. To achieve the purpose of the study men and women unmedicated for hypertension with mean daytime ambulatory blood pressure (ABP) ≥135/85 mm Hg or 24 h ABP ≥130/80 mm Hg are included in the study. Subjects are randomized to receive MBSR immediately or after a wait-list control period. The primary outcome measure is mean awake and 24h ABP. The primary objective of the harmony study is to compare ABP between the treatment and wait-list control at the 12-week primary assessment period. The results from this study determined that MBSR is an effective intervention for lowering BP in early unmedicated hypertensives.
Bhavanani, Sanjay and Madanmohan (2011) undertaken this study to determine the immediate cardiovascular effects of sukha pranayama in hypertensive patients. To achieve the purpose of the study twenty-three hypertensive patients attending the Yoga OPD at JIPMER were recruited for the study and instructed to perform sukha pranayama for 5 minutes at the rate of 6 breaths/min. This pranayama involves conscious, slow and deep breathing with equal duration for inhalation and exhalation. Heart rate (HR) and BP were recorded before and immediately after the intervention. Post-intervention statistical analysis revealed a significant (p < .05) reduction in HR and a highly significant (p < .001) reduction in systolic pressure, pulse pressure, mean arterial pressure, rate-pressure product, and double product with an insignificant fall in diastolic pressure. It is concluded that sukha pranayama at the rate of 6 breaths/minute can reduce HR and BP in hypertensive patients within 5 minutes of practice. This may be due to a normalization of autonomic cardiovascular rhythms as a result of increased vagal modulation and/all decreased sympathetic activity and improved baroreflex sensitivity.

Murthy et al., (2010) studied the effect of naturopathy and yoga interventions in treatment of mild to moderate hypertension. The variables of interest were measured at the beginning and end of the intervention using a pre-post design. To achieve the purpose of the study a total of 104 subjects, already diagnosed with mild to moderate hypertension and on treatment with antihypertensive medicines were included in study. The intervention consisted of various inpatient administrations of different naturopathy treatments, yoga therapies, low calorie and low sodium diet for 21 days. Antihypertensive medicines were withdrawn for some patients in one week based upon response to the treatment. The outcome measures were values of diastolic and systolic blood pressure
and body weight. Subjects were followed for a period of one year after every 3 months. It was concluded from the result of the study that after starting nonpharmacological approach of naturopathy and yoga, systolic blood pressure came down from mean of 139.6 to 129.6 where as it came down from 91.2 to 86.1 for diastolic blood pressure. At the same time favorable effect was also seen in other variables like lipid profile and body weight. At the end of one year out of 57 patients who came for follow-up, 14 cases were found to have blood pressure within normal ranges without any medication over the previous 12 months. They suggested that naturopathy and yoga therapy can be considered as a valuable nonpharmacological approach in treatment of hypertension.

Cohen (2009) examined the cerebral blood flow effects of yoga training: preliminary evaluation of 4 cases. Experienced practitioners of yoga have been shown to alter brain function, but this case series measured cerebral blood flow before and after a 12-week training program in Iyengar yoga (IY). On the first day, each of the 4 subjects listened to the teacher speaking on the history and background of the yoga program while they were injected with 250 MBq of (99m) Tc-bicisate and received a single photon emission computed tomography scan (pre-program baseline). Subjects then had their first IY training and were injected and scanned with 925 MBq bicisate while they did their first meditation (pre-program meditation). Subjects then underwent a 12-week training program in IY and then underwent the same imaging protocol with a post program baseline and post program meditation scan. Baseline and meditation scans, before and after training, were compared using paired t tests. The result of the study showed that there were significant decreases (p < 0.05) between the pre- and post program baseline scans in the right amygdala, dorsal medial cortex, and sensorimotor area. It was also
found that there was a significant difference (p < 0.05) in the pre- and post program percentage change (i.e., activation) in the right dorsal medial frontal lobe, prefrontal cortex, and right sensorimotor cortex. These initial findings suggest the brain experiences a "training effect" after 12 weeks of Iyengar yoga (IY) training.

Agte, Jahagirdar and Tarwadi (2011) investigated the effects of Sudarshan Kriya Yoga on some physiological and biochemical parameters in mild hypertensive patients. To achieve the purpose of the study an open label intervention study was undertaken on 26 mild hypertensive and 26 apparently healthy adults (30-60 y), for the effect of Sudarshan Kriya Yoga practice for two months as complementary therapy. The result of the study showed that in the hypertensives, there was a significant decrease in diastolic blood pressure (P < 0.01), serum urea (P < 0.01) and plasma MDA (malondialdehyde adducts) as oxidative stress marker (P < 0.05). Other parameters; viz.; plasma levels of cholesterol, triglycerides, glucose, did not change significantly (P > 0.1). The pattern of change in most of the study parameters was such that values above normal range were lowered but values within normal range were unaltered. They suggested that the action of yoga on diastolic blood pressure, malondialdehyde adducts and kidney function in hypertensives was of counteractive nature and felt to be distinctly different than the effect of drugs.

Mourya et al., (2009) observed the effect of slow and fast breathing exercises on autonomic functions in patients with essential hypertension. The study design was a randomized, prospective, controlled clinical study using three groups. The subjects comprised 60 male and female patients aged 20-60 years with stage 1 essential hypertension. Patients were randomly and equally divided into the control and other two
intervention groups, who were advised to do 3 months of slow breathing and fast breathing exercises, respectively. Baseline and post intervention recording of blood pressure (BP), autonomic function tests such as standing-to-lying ratio (S/L ratio), immediate heart rate response to standing (30:15 ratio), Valsalva ratio, heart rate variation with respiration (E/I ratio), hand-grip test, and cold pressor response were done in all subjects. They concluded that slow breathing had a stronger effect than fast breathing. BP decreased longitudinally over a 3-month period with both interventions. S/L ratio, 30:15 ratio, E/I ratio, and BP response in the hand grip and cold pressure test showed significant change only in patients practicing the slow-breathing exercise. 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.

Sharma, Gupta and Bijlani (2008) explore the short-term impact of a comprehensive but brief lifestyle intervention, based on yoga, on subjective well being levels in normal and diseased subjects. To achieve the purpose of the study normal healthy individuals and subjects having hypertension, coronary artery disease, diabetes mellitus or a variety of other illnesses were included in the study. The outcome measures were 'subjective well being inventory' (SUBI) scores, taken on the first and last day of the course. The inventory consists of questions related to one's feelings and attitude about various areas of life, such as happiness, achievement and interpersonal relationship. The result of the study revealed that there was significant improvement in the subjective well being scores of the 77 subjects within a period of 10 days as compared to controls. These observations suggest that a short lifestyle modification and stress management
educational program leads to remarkable improvement in the subjective well being scores of the subjects and can therefore make an appreciable contribution to primary prevention as well as management of lifestyle diseases.

Schwickert et al., (2006) studied the stress management in the treatment of essential arterial hypertension. Between 60 and 90% of patients consult their family doctor for stress-associated complaints. Not infrequently, a considerable number of these patients already have elevated blood pressure. The positive effect on high blood pressure of relaxation techniques has been confirmed in various studies. Accordingly, stress management should now have a permanent place in effective antihypertensive treatment. Appropriate relaxation techniques include, for example, autogenic training, progressive muscle relaxation, visualization and breathing exercises, chi gong and yoga. These practices are incorporated in various lifestyle programs. They act in different ways, and can be offered to the patient in accordance with his/her individual wishes.

Murugesan, Govindarajulu and Bera (2000) analyzed the effect of selected yogic practices on the management of hypertension. On the basis of medical officers diagnosis, thirty three (N = 33) hypertensives, aged 35-65 years, from Govt. General Hospital, Pondicherry, were examined with four variables viz, systolic and diastolic blood pressure, pulse rate and body weight. The subjects were randomly assigned into three groups. The experimental group-I underwent selected yoga practices, experimental group-II received medical treatment by the physician of the said hospital and the control group did not participate in any of the treatment stimuli. Yoga imparted in the morning and in the evening with 1 hr/session on day-1 for a total period of 11-weeks. Medical treatment comprised drug intake every day for the whole experimental period. The result
of pre-post test with ANCOVA revealed that both the treatment stimuli (yoga & drug) were effective in controlling the hypertension.

**Chhabra, Lal and Sharma (2001)** documented the status of lifestyle modifications in hypertension. Hypertension is essentially the elevation of arterial blood pressure beyond an arbitrary cut off point, though the dividing line between normal and elevated BP is lacking. Hypertension can be classified into primary, essential or idiopathic hypertension on one hand, and secondary one due to some disease itself. In treating hypertension, antihypertensives have their role, but attention may be directed towards some lifestyle modifications. As regarding dietary interventions, calorie restriction may influence the minimization of BP. Body weight reduction, less alcohol consumption, salt restriction, potassium and calcium supplementation can enhance the process of lowering BP. The role of magnesium in hypertension is debatable. Serum cholesterol level is commonly elevated in hypertensive patients and its reduction reduces the risk of non-fatal coronary events. Diet rich in plant fibres either alone or with low fat, low sodium could lower the BP by about 5 mm Hg in hypertensives. The omega-3-polyunsaturated fatty acids found in highest concentrations in cold water fishes have a modest antihypertensive effect. Caffeine contained in two cups of coffee may raise the BP by 5 mm Hg in infrequent users but in habitual users, caffeine has no role. Deficiency of vitamin C might lead to hypertension. As regarding behavioural changes, stopping smoking, regular physical exercise, relaxation therapies like yoga, etc, have definite beneficial effect on hypertensives. The antihypertensive effect of lifestyle modifications may obviate drug therapy. For this, one or more of the lifestyle modifications should be tried initially in all hypertensive patients.
Sahay (2007) examined the role of yoga in diabetes. The science of yoga is an ancient one. It is a rich heritage of our culture. Several older books make a mention of the usefulness of yoga in the treatment of certain diseases and preservation of health in normal individuals. The effect of yogic practices on the management of diabetes has not been investigated well. He carried out well designed studies in normal individuals and those with diabetes to assess the role of yogic practices on glycaemic control, insulin kinetics, body composition exercise tolerance and various co-morbidities like hypertension and dyslipidemia. These studies were both short term and long-term. These studies have 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 changes in the insulin kinetics and those of counter-regulatory hormones like cortisol. There was a decrease in free fatty acids. There was an increase in lean body mass and decrease in body fat percentage. The number of insulin receptors was also increased. There was an improvement in insulin sensitivity and decline in insulin resistance. The results of these studies suggest that yogic practices have a role even in the prevention of diabetes. There is a beneficial effect on the co-morbid conditions like hypertension and dyslipidemia.

Herrmann (2002) reported that psychosocial factors play an important role in the development and course of essential hypertension, although "stress" can account for only 10% of blood pressure variance. A variety of psychotherapeutic interventions, such as relaxation techniques (autogenic training or progressive muscular relaxation), behavioral
therapy or biofeedback techniques, can lower elevated blood pressure by an average of 10 mmHg (systolic) and 5 mmHg (diastolic). As a "secondary effect", such measures may also prompt the hypertensive to adopt a more health-conscious lifestyle.

**Damodaran et al., (2002)** examined the therapeutic potential of yoga practices in modifying cardiovascular risk profile in middle aged men and women. The effect of yoga on the physiological, psychological well being, psychomotor parameter and modifying cardiovascular risk factors in mild to moderate hypertensive patients were investigated. To achieve the purpose of the study 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 were selected as subjects. Biochemical, physiological and psychological parameters were studied prior and following period of three months of yoga practices, biochemical parameters included, blood glucose, lipid profile, catecholmines, 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 overall improvement in subjective well being and quality of life. There was decrease in VMA catecholamine, and decrease MDA level suggestive decrease sympathetic activity and oxidant stress. They suggested that yoga can play an important role in risk modification for cardiovascular diseases in mild to moderate hypertension.

**Ernst (2005)** suggested complementary/alternative medicine for hypertension. Many hypertensive patients try complementary/alternative medicine for blood pressure control. Based on extensive electronic literature searches, the evidence from clinical trials
is summarized. Numerous herbal remedies, non-herbal remedies and other approaches have been tested and some seem to have antihypertensive effects. The effect size is usually modest, and independent replications are frequently missing. The most encouraging data pertain to garlic, autogenic training, biofeedback and yoga. He pointed out that more research is required before firm recommendations can be offered.

McCaffrey et al., (2005) determined the effectiveness of a yoga program on blood pressure and stress, a group of hypertensive patients in Thailand were studied, with the experimental group showing significantly decreased mean stress scores and blood pressure, heart rate, and body mass index levels compared with the control group.

Cade (2010) conducted a prospective, randomized, controlled study to evaluate whether a yoga lifestyle intervention improves CVD 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. Sixty To achieve the purpose of the study HIV-infected adults with mild-moderate CVD risk were assigned to 20 weeks of supervised yoga practice or standard of care treatment. Baseline and week 20 measures were: 2-h oral glucose tolerance test with insulin monitoring, body composition, fasting serum lipid/lipoprotein profile, resting blood pressures, CD4 T-cell count and plasma HIV RNA, and the Medical Outcomes Study Short Form (SF)-36 health-related QOL inventory. The findings of the study showed that resting systolic and diastolic blood pressures improved more (P=0.04) in the yoga group (-5 +/- 2 and -3 +/- 1 mmHg, respectively) than in the standard of care group (+1 +/- 2 and+2 +/- 2 mmHg, respectively). However, there was no greater reduction in body weight, fat mass or proatherogenic lipids, or improvements in glucose tolerance or overall QOL after yoga.
Immune and virological status was not adversely affected. He pointed out that, among traditional lifestyle modifications, yoga is a low-cost, simple to administer, nonpharmacological, popular behavioural intervention that can lower blood pressure in pre-hypertensive HIV-infected adults with mild-moderate CVD risk factors.

Miles et al., (2013) intended to determine the acute effects of one session of hatha yoga practice on blood pressure and other cardiovascular responses. To gain insight into the long-term effects of yoga practice, both novice (n = 19) and advanced (n = 18) yoga practitioners were studied. The two groups were matched for age, gender, BMI, and blood pressure. Thirty-six apparently healthy, nonobese, sedentary, or recreationally active individuals from the community participated in the study. The intervention comprised one session of yoga practice, in which participants followed a custom made instructional video providing a yoga routine that consisted of a series of 23 hatha-based yoga postures. Prior to arriving at the laboratory, each participant completed a research health questionnaire, a training-status questionnaire, and a yoga-experience questionnaire. Prior to the yoga practice, each participant's height, body fat percentage, trunk or lumbar flexibility, and arterial stiffness as assessed by carotid femoral pulse wave velocity (cfPWV) were measured. For each posture during the yoga practice, the study continuously measured systolic, mean, and diastolic blood pressures, heart rate, stroke volume, and cardiac output. Systolic, mean, and diastolic blood pressures increased significantly during the yoga practice. The magnitude of these increases in blood pressure was greatest with standing postures. Heart rate and cardiac output increased significantly during yoga practice, especially with standing postures. Overall, no differences existed in cardiovascular responses between the novice and advanced
practitioners throughout the yoga testing session; (cfPWV) velocity was significantly and inversely associated with lumbar flexion but not with sit-and-reach test scores. The research team concluded that a variety of hatha yoga postures, especially standing postures, evoked significant increases in blood pressure. The elevation in blood pressure due to yoga practice was associated with increases in cardiac output and heart rate, which are responses similar to those observed in isometric exercise. The lack of obvious differences in blood pressure and other cardiovascular responses between novice and advanced yoga practitioners suggests that long-term yoga practice does not attenuate acute yoga responses.

2.3: Summary of the Literature

Yoga is an ancient Indian way of life, which includes changes in mental attitude, diet, and the practice of specific techniques such as yoga asanas (postures), breathing practices (pranayamas), and meditation to attain the highest level of consciousness. Since a decade, there has been a surge in the research on yoga, but the investigator found very few reviews regarding yogic practices in health and disease. Keeping this in view, an investigation was done to examine the effects of yogic practices on body composition, obesity and hypertension among middle aged people.

It has been hypothesized that a steady decline in physical activity among all age groups has heavily contributed to rising rates of obesity all around the world. Physical activity strongly influenced weight gain in a study of monozygotic twins (Heitmann, 1997). Numerous studies have shown that sedentary behaviours like watching television and playing computer games are associated with increased prevalence of obesity (Swinburn & Egger, 2002; Tremblay & Willms, 2003). Furthermore, parents report
that they prefer having their children watch television at home rather than play outside unattended because parents are then able to complete their chores while keeping an eye on their children (Gordon-Larsen, 2004). In addition, increased proportions of children who are being driven to school and low participation rates in sports and physical education, particularly among adolescent girls (Swinburn & Egger, 2002), are also associated with increased obesity prevalence. Since both parental and children's choices fashion these behaviors, it is not surprising that overweight children tend to have overweight parents and are themselves more likely to grow into overweight adults than normal weight children (Carriere, 2003). In response to the significant impact that the cultural environment has on his/her daily choices, promoting a more active lifestyle has wide ranging health benefits and minimal risk, making it a promising public health recommendation.

Although there are a number of reports on the effect of yoga training on pulmonary functions, very few studies have been undertaken on the effect of yoga training on obesity, hypertension, a chronic medical condition of increased blood pressure, is a serious public health problem. Environmental and genetic risk factors are known to predispose to hypertension. Patients with hypertension comprise a substantial portion of the hypertensive population. Previous reports have shown that moderate-intensity regular exercise training in patients with mild hypertension usually reduces blood pressure (BP), but there is a lack of data regarding the impact of yoga on hypertension. Hence, this study was performed to evaluate whether programmed yoga exercises are effective in reducing BP in patients with hypertension and whether it also had beneficial effects on other body composition variables.