CHAPTER II
REVIEW OF RELATED LITERATURE

Extensive studies have been conducted in India as well as abroad related to physical activity and health related physical fitness as well as on psychological well being among students. The researcher has gone through various databases available to locate the relevant studies. In fact, there are very few studies where health benefits and psycho-physiological well being among school girls in relation to yoga have been studied. Therefore, the present researcher has reviewed the related studies on physical activity or exercise which are presented in this chapter.

Chen et al., (2009)\(^\text{42}\) 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 County. 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. After 2 weeks of self-practice at home, yoga exercise continued to improve BMI, flexibility, muscular strength, and cardiopulmonary fitness.

Tran et al., (2001)\textsuperscript{43} studied ten healthy, untrained volunteers (nine females and one male), ranging in age from 18-27 years, to determine the effects of hatha yoga practice on the health-related aspects of physical fitness, including muscular strength and endurance, flexibility, cardiorespiratory fitness, body composition, and pulmonary function. Subjects attended 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. 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.

Harinath et al., (2004)\textsuperscript{44} evaluated effects of Hatha yoga and Omkar meditation on cardiorespiratory performance, psychologic profile, and melatonin secretion. 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. 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.

Danucalov et al., (2008)\textsuperscript{45} investigated the changes in cardiorespiratory and metabolic intensity brought about by the practice of pranayamas (breathing exercises of yoga) and meditation during the same hatha-yoga session. The technique applied was the one advocated by the hatha-yoga system. Nine yoga instructors-five females and four males, mean age of 44+/−11, 6, were subjected to analysis of the gases expired during three distinct periods of 30 min: rest, respiratory exercises and meditative practice. A metabolic open circuit computerized system was applied (VO2000, MedGraphics-USA). The oxygen uptake (VO(2)) and the carbon dioxide output (VCO(2)) were statistically different (P <or= 0.05) during meditation and pranayama practices when compared with rest. The heart rate also suffered relevant reductions when results at rest were compared with those during meditation. A smaller proportion of lipids was metabolized during meditation practice compared with rest. The results suggest that the meditation used in this study reduces the metabolic rate whereas the specific pranayama technique in this study increases it when compared with the rest state.

To determine the metabolic and heart rate (HR) responses of hatha yoga, Clay et al., (2005)\textsuperscript{46} enrolled 26 women (19-40 years old) who performed a 30-minute hatha yoga routine of supine lying, sitting, and standing asanas (i.e., postures). Subjects followed identical videotaped sequences of hatha yoga asanas. Mean physiological responses were compared to the physiological responses of resting in a chair and walking on a treadmill at 93.86 m.min(-1) [3.5 miles per hour (mph)]. During the 30-minute hatha yoga


routine, mean absolute oxygen consumption (Vo(2)), relative Vo(2), percentage maximal oxygen consumption (%Vo(2)R), metabolic equivalents (METs), energy expenditure, HR, and percentage maximal heart rate (%MHR) were 0.45 L.min(-1), 7.59 ml.kg(-1).min(-1), 14.50%, 2.17 METs, 2.23 kcal.min(-1), 105.29 b.min(-1), and 56.89%, respectively. When compared to resting in a chair, hatha yoga required 114% greater O(2) (L.min(-1)), 111% greater O(2)(ml.kg(-1).min(-1)), 4,294% greater %Vo(2)R, 111% greater METs, 108% greater kcal.min(-1), 24% greater HR, and 24% greater %MHR. When compared to walking at 93.86 m.min(-1), hatha yoga required 54% lower O(2)(L.min(-1)), 53% lower O(2)(ml.kg(-1).min(-1)), 68% lower %Vo(2)R, 53% lower METs, 53% lower kcal.min(-1), 21% lower HR, and 21% lower %MHR. The hatha yoga routine in this study required 14.50% Vo(2)R, which can be considered a very light intensity and significantly lighter than 44.8% Vo(2)R for walking at 93.86 m.min(-1) (3.5 mph). The intensity of hatha yoga may be too low to provide a training stimulus for improving cardiovascular fitness. Although previous research suggests that hatha yoga is an acceptable form of physical activity for enhancing muscular fitness and flexibility, these data demonstrate that hatha yoga may have little, if any, cardiovascular benefit.

Surya Namaskar (SN), a group of Yogic exercise consists of a set of twelve postures. The present study conducted by Sinha et al., (2004)47 observed critically the energy cost and different cardiorespiratory changes during the practice of SN. Twenty-one male volunteers from the Indian Army practiced selected Yogic exercises for six days in a week for three months duration. The Yogic practice schedule consisted of Hatha Yogic Asanas (28 min), Pranayama (10.5 min) and Meditation (5 min). In the Yogic practice schedule 1st they practiced Kapal Bhathi (breathing maneuvers) for 2 min then Yogamudra (yogic postural exercise) for 2 min, after that they took rest until oxygen consumption and heart rate (HR) came to resting value.

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Subsequently subjects performed SN for 3 min 40 seconds on an average. After three months of training at the beginning of the fourth month subjects performed entire Yogic practice schedule in the laboratory as they practiced during their training session and experiments were carried out. Their pulmonary ventilation, carbon dioxide output, Oxygen consumption, HR and other cardiorespiratory parameters were measured during the actual practice of SN. Oxygen consumption was highest in the eighth posture (1.22 +/- 0.073 1 min(-1)) and lowest in the first posture (0.35 +/- 0.02 1 min(-1)). Total energy cost throughout the practice of SN was 13.91 kcal and at an average of 3.79 kcal/min. During its practice highest HR was 101 +/- 13.5 b.p.m. As an aerobic exercise SN seemed to be ideal as it involves both static stretching and slow dynamic component of exercise with optimal stress on the cardiorespiratory system.

Madanmohan et al., (2008) conducted 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 and 16 females, aged 17-20 yr), 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, 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 present 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.

Hagins, Moore and Rundle (2007) conducted a study with a view to determine whether a typical yoga practice using various postures meets the current recommendations for levels of physical activity required to improve and maintain health and cardiovascular fitness; 2) to determine the reliability of metabolic costs of yoga across sessions; 3) to compare the metabolic costs of yoga practice to those of treadmill walking. In this observational study, 20 intermediate-to-advanced level yoga practitioners, age 31.4 +/- 8.3 years, performed an exercise routine inside a human respiratory chamber (indirect calorimeter) while wearing heart rate monitors. The exercise routine consisted of 30 minutes of sitting, 56 minutes of beginner-level hatha yoga administered by video, and 10 minutes of treadmill walking at 3.2 and 4.8 kph each. Measures were mean oxygen consumption (VO2), heart rate (HR), percentage predicted maximal heart rate (%MHR), metabolic equivalents (METs), and energy expenditure (kcal). Seven subjects repeated the protocol so that measurement reliability could be established. Mean values across the entire yoga session for VO2, HR, %MHR, METs, and energy/min were 0.6 L/kg/min; 93.2 beats/min; 49.4%; 2.5; and 3.2 kcal/min; respectively. Results of the ICCs (2,1) for mean values across the entire yoga session for kcal, METs, and %MHR were 0.979 and 0.973, and 0.865, respectively. Metabolic costs of yoga averaged across the entire session represent low levels of physical activity, are similar to walking on a treadmill at 3.2 kph, and do not meet recommendations for levels of physical activity for improving or maintaining health or cardiovascular fitness. Yoga practice incorporating sun

salutation postures exceeding the minimum bout of 10 minutes may contribute some portion of sufficiently intense physical activity to improve cardio-respiratory fitness in unfit or sedentary individuals. The measurement of energy expenditure across yoga sessions is highly reliable.

Ray et al., (2001)\textsuperscript{50} observed the effect of training in Hatha yogic exercises on aerobic capacity and PE after maximal exercise. Forty men from the Indian army (aged 19-23 yr) were administered maximal exercise on a bicycle ergometer in a graded work load protocol. The oxygen consumption, carbon dioxide output, pulmonary ventilation, respiratory rate, heart rate (HR) etc., at maximal exercise and PE score immediately thereafter were recorded. The subjects were divided into two equal groups. Twelve subjects dropped out during the course of study. One group (yoga, \(n = 17\)) practiced Hatha yogic exercises for 1 h every morning (6 days in a week) for six months. The other group (PT, \(n = 11\)) underwent conventional physical exercise training during the same period. Both groups participated daily in different games for 1 h in the afternoon. In the 7th month, tests for maximal oxygen consumption (VO2Max) and PE were repeated on both groups of subjects. Absolute value of VO2Max increased significantly (\(P < 0.05\)) in the yoga group after 6 months of training. The PE score after maximal exercise decreased significantly (\(P < 0.001\)) in the yoga group after 6 months but the PT group showed no change. The practice of Hatha yogic exercises along with games helps to improve aerobic capacity like the practice of conventional exercises (PT) along with games. The yoga group performed better than the PT group in terms of lower PE after exhaustive exercise.

Mohan (1996)\textsuperscript{51} examined the Svara yoga concept of Ida, Pingala and Susumna svara representing rest, active and turbulent states by recording


nostril dominance (svara) and bilateral volar GSR (galvanic skin resistance) as an indicator of sympathetic activity under field and laboratory conditions. The author of this study demonstrated that the sympathetic activity was low in Ida svara, followed by Pingala svara and was maximum in Susumna svara group of subjects under both field and laboratory conditions which agreed with the traditional Svara yoga description. The volar GSR on the right side more readily varied with svara, particularly so in the physically relaxed subjects of laboratory condition than the left volar GSR. The latter observation was worth noting because the subjects were right handed. The right side could be recommended as the standard site for recording volar GSR to closely reflect the sympathetic activity, particularly so when physical rest was given to subjects.

There is increasing interest in the fact that breathing exclusively through one nostril may alter the autonomic functions. Hence Telles, Nagarathna and Nagendra (1994)\textsuperscript{52} studied whether breathing through a particular nostril can alter metabolism and autonomic activities and whether breathing is consciously regulated. For this purpose 48 male subjects, with ages ranging from 25 to 48 years were randomly assigned to different groups. Each group was asked to practice one out of three pranayamas (viz. right nostril breathing, left nostril breathing or alternate nostril breathing). These practices were carried out as 27 respiratory cycles, repeated 4 times a day for one month. Parameters were assessed at the beginning and end of the month, but not during the practice. The 'right nostril pranayama' group showed a significant increase, of 37% in baseline oxygen consumption. The 'alternate nostril' pranayama group showed an 18% increase, and the left nostril pranayama group also showed an increase, of 24%. This increase in metabolism could be due to increased sympathetic discharge to the adrenal medulla. The 'left nostril Pranayama' group showed an increase in volar

\textsuperscript{52} S. Telles, R. Nagarathna and H.R. Nagendra, “Breathing through a particular nostril can alter metabolism and autonomic activities.” Indian Journal of Physiology and Pharmacology, 38, 2, 1994, pp. 133-137.
galvanic skin resistance, interpreted as a reduction in sympathetic nervous system activity supplying the sweat glands. These results suggest that breathing selectively through either nostril could have a marked activating effect or a relaxing effect on the sympathetic nervous system.

Vempati and Telles (2002)\textsuperscript{53} studied that yoga-based guided relaxation reduces sympathetic activity judged from baseline levels. In this study 35 male volunteers whose ages ranged from 20 to 46 years were studied in two sessions of yoga-based guided relaxation and supine rest. Assessments of autonomic variables were made for 15 subjects, before, during, and after the practices, whereas oxygen consumption and breath volume were recorded for 25 subjects before and after both types of relaxation. A significant decrease in oxygen consumption and increase in breath volume were recorded after guided relaxation (paired t test). There were comparable reductions in heart rate and skin conductance during both types of relaxation. During guided relaxation the power of the low frequency component of the heart-rate variability spectrum reduced, whereas the power of the high frequency component increased, suggesting reduced sympathetic activity. Also, subjects with a baseline ratio of LF/HF > 0.5 showed a significant decrease in the ratio after guided relaxation, while subjects with a ratio < or = 0.5 at baseline showed no such change. The results suggest that sympathetic activity decreased after guided relaxation based on yoga, depending on the baseline levels.

Telles, Nagarathna and Nagendra (1996)\textsuperscript{54} conducted a study to assess the physiological effects of a yoga breathing practice that involves breathing exclusively through the right nostril. This practice is called surya anuloma viloma pranayama (SAV). Twelve volunteers (average age 27.2


years +/- 3.3 years, four males) were assessed before and after test sessions conducted on two consecutive days. On one day the test session involved practicing SAV pranayama for 45 minutes (SAV session). During the test period of the other day, subjects were asked to breathe normally for 45 minutes (NB session). For half the patients (randomly chosen) the SAV session was on the first day and the NB session on the next day. For the remaining six patients, the order of the two sessions was reversed. After the SAV session (but not after the NB) there was a significant (p < .05, paired t test) increase in oxygen consumption (17%) and in systolic blood pressure (mean increase 9.4 mm Hg) and a significant decrease in digit pulse volume (45.7%). The latter two changes are interpreted to be the result of increased cutaneous vasoconstriction. After both SAV and NB sessions, there was a significant decrease in skin resistance (two factor ANOVA, Tukey test). These findings show that SAV has a sympathetic stimulating effect. This technique and other variations of unilateral forced nostril breathing deserve further study regarding therapeutic merits in a wide range of disorders.

Telles et al., (1997)\textsuperscript{55} carried a study ‘comparison of changes in autonomic and respiratory parameters of girls after yoga and games at a community home’. In this study the heart rate, breathing rate, and skin resistance were recorded for 20 community home girls (Home group) and for 20 age-matched girls from a regular school (School group). The former group had a significantly higher rate of breathing and a more irregular breath pattern known to correlate with high fear and anxiety, than the School group. Skin resistance was significantly lower in the School group, which may suggest greater arousal, 28 girls of the Home group formed 14 pairs, matched for age and duration of stay in the home. Subjects of a pair were randomly assigned to either yoga or games groups. For the former emphasis was on relaxation and awareness, whereas for the latter increasing physical activity was

emphasized. At the end of an hour daily for six months both groups showed a significant decrease in the resting heart rate relative to initial values (Wilcoxon paired-sample rest), and the yoga group showed a significant decrease in breath rate, which appeared more regular but no significant increase in the skin resistance. These results suggest that a yoga program which includes relaxation, awareness, and graded physical activity is a useful addition to the routine of community home children.

Mohan, Reddy and Wei (2001)\textsuperscript{56} conducted a study modulation of intraocular pressure by unilateral and forced unilateral nostril breathing in young healthy human subjects, the purpose of this study was to determine the effects of unilateral right/left nostril breathing (URNB/ULNB) and forced unilateral right/left nostril breathing (FURNB/FULNB) on intraocular pressure (IOP) and to examine the differences in the IOP during the various phases of nasal cycle. Young healthy volunteers of either sex aged between 19-24 years, participated in the sessions using URNB/ULNB (n = 52) and FURNB/FULNB (n = 28). The nostril dominance was calculated from signals recorded on the Power Lab equipment, representing pressure changes at the end of the nostrils during respiration. The IOP was measured with Tono-Pen. The subjects were divided into 4 groups viz. right nostril dominant (RND), left nostril dominant (LND), transitional right nostril dominant (TRND) and transitional left nostril dominant (TLND) groups. The IOP data 'before and after' URNB/ULNB or FURNB/FULNB were compared by using paired t-test. The baseline data of IOP between the groups were analyzed by using independent samples t-test. Results of this study revealed that the URNB decreased the IOP in the LND and TLND (p < 0.01) and also in the RND (p < 0.05) groups but not significantly in the TRND group. The ULNB decreased the IOP in the RND group (p < 0.01) only. The FURNB significantly reduced the IOP (p < 0.05) only in the LND and RND groups. The FULNB decreased the IOP but not significantly. The baseline IOP did not differ significantly

between the LND, RND, TLND and TRND groups. From this the authors concluded that the URNB/FURNB reduced the IOP, while ULNB/FULNB failed to increase the IOP significantly. It is suggested that the lowering of IOP by URNB indicated sympathetic stimulation.

Miller, Fletcher, Kabat-Zinn (1995) conducted a three-year follow-up and clinical implications of a mindfulness meditation-based stress reduction intervention in the treatment of anxiety disorders. A previous study of 22 medical patients with DSM-III-R-defined anxiety disorders showed clinically and statistically significant improvements in subjective and objective symptoms of anxiety and panic following an 8-week outpatient physician-referred group stress reduction intervention based on mindfulness meditation. Twenty subjects demonstrated significant reductions in Hamilton and Beck Anxiety and Depression scores postintervention and at 3-month follow-up. In this study, 3-year follow-up data were obtained and analyzed on 18 of the original 22 subjects to probe long-term effects. Repeated measures analysis showed maintenance of the gains obtained in the original study on the Hamilton [F(2,32) = 13.22; p < 0.001] and Beck [F(2,32) = 9.83; p < 0.001] anxiety scales as well as on their respective depression scales, on the Hamilton panic score, the number and severity of panic attacks, and on the Mobility Index-Accompanied and the Fear Survey. A 3-year follow-up comparison of this cohort with a larger group of subjects from the intervention who had met criteria for screening for the original study suggests generalizability of the results obtained with the smaller, more intensively studied cohort. Ongoing compliance with the meditation practice was also demonstrated in the majority of subjects at 3 years. Concluding that an intensive but time-limited group stress reduction intervention based on mindfulness meditation can have long-term beneficial effects in the treatment of people diagnosed with anxiety disorders.

Bera, Gore, and Oak (1998) conducted a study on Recovery from stress in two different postures and in Shavasana - a yogic relaxation posture. The recovery from induced physiological stress in Shavasana (a yogic relaxation posture) and two other postures (resting in chair and resting supine posture) was compared. Twenty one males and 6 females (age 21-30 yrs) 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 (BP). HR and BP 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 was reversed in significantly (P < 0.01) shorter time in Shavasana, compared to the resting posture in chair and a supine posture.

Tekur et al., (2008) compared the effect of a short-term intensive residential yoga program with physical exercise (control) on pain and spinal flexibility in subjects with chronic low-back pain (CLBP). This study was conducted at a residential integrative health center in Bangalore, South India. Eighty (80) subjects (females, n = 37) with CLBP, who consented were randomly assigned to receive yoga or physical exercise if they satisfied the selection criteria. The intervention consisted of a 1-week intensive residential yoga program comprised of asanas (physical postures) designed for back pain, pranayamas (breathing practices), meditation, and didactic and interactive sessions on philosophical concepts of yoga. The control group practiced physical exercises under a trained physiatrist and also had didactic and interactive sessions on lifestyle change. Both of the groups were matched for time on intervention and attention. Pain-related outcomes were assessed by the Oswestry Disability Index (ODI) and by spinal flexibility, which was


assessed using goniometer at pre and post intervention. Data were analyzed using repeated measures analysis of variance (RMANOVA). Data conformed to a Gaussian distribution. There was a significant reduction in ODI scores in the yoga group compared to the control group ($p = 0.01$; effect size 1.264). Spinal flexibility measures improved significantly in both groups but the yoga group had greater improvement as compared to controls on spinal flexion ($p = 0.008$; effect size 0.146), spinal extension ($p = 0.002$; effect size 0.251), right lateral flexion ($p = 0.059$; effect size 0.006); and left lateral flexion ($p = 0.006$; effect size 0.171). Seven (7) days of a residential intensive yoga-based lifestyle program reduced pain-related disability and improved spinal flexibility in patients with CLBP better than a physical exercise regimen.

Declines in physical performance are associated with aging and chronic health conditions. Appropriate physical activity interventions can reverse functional limitations and help maintain independent living. Tai chi is a popular form of exercise in China among older adults. Taylor-Piliae et al., (2006) conducted a study to determine whether tai chi improves balance, muscular strength and endurance, and flexibility over time. 39 Chinese adults with at least one cardiovascular disease risk factor were assessed with a battery of physical fitness measures at baseline, 6 weeks and 12 weeks. Subjects were 65.7 (+/- 8.3) years old, Cantonese-speaking (97%) immigrants, with 12 years or less of formal education (87%) and very low income (67%). Reported CVD risk factors were hypertension (92%), hypercholesteremia (49%), diabetes (21%), and 1 current smoker. Subjects were below the 50th percentile of fitness at baseline compared to age- and gender-specific normative US data. Statistically significant improvements were observed in all balance, muscular strength and endurance, and flexibility measures after 6 weeks, and they increased further after 12 weeks. The results indicate that Tai chi is a potent intervention that improved balance,

upper- and lower-body muscular strength and endurance, and upper- and lower-body flexibility in these older Chinese adults. These findings provide important information for future community-based tai chi exercise programs and support current public health initiatives to reduce disability from chronic health conditions and enhance physical function in older adults.

Stress has been cited as a causal factor in heart disease. Therefore, Robert McComb et al., (2004)\textsuperscript{61} examined the effects of an 8-week mindfulness-based stress-reduction program on the resting levels of stress hormones, physical functioning, and submaximal exercise responses in women with heart disease. Random selection with the numbers 1 and 2 were used to assign 18 women (60 +/-6.3 years old) with documented histories of heart disease to a treatment group (n = 9) or a control group (n = 9). Speilberger’s state anxiety scores for the treatment (M = 37.88; standard deviation (SD) = 10.91) and control group (M = 43.22; SD = 12.26) were not significantly different prior to the start of the study. However, their scores fell in the upper percentile rank for normal adults in their age category. The intervention was provided one night each week for 2 hours over a period of 8 weeks. The intervention included didactic, inductive, and experiential modes of learning regarding stress responses and mindfulness skill-development training. Pre-post test hormonal measurements and physical function were analyzed using a 2 (group) by 2 (time) analysis of variance (ANOVA) with repeated measures following the 8-week program. Submaximal exercise responses were also compared between the treatment group and the control group following the 8-week program. A 2 (group) by 3 (time) ANOVA with repeated measures was used to analyze the data. Weekly meetings were held on a university medical school campus. Submaximal exercise responses were recorded while participants cycled on a stationary bike in an applied physiology laboratory following the 8-week program. There were no significant

main effects or interaction for the resting levels of stress hormones or physical functioning. There were no significant interactions for the submaximal exercise responses, however, there were significant main effects between groups for ventilation [F(2,32) = 7.65, p < .01, f = 0.8], and between group [F(1,16) = 8.84, p < .01, f = 0.8] and time [F(2,32) = 10.42, p < .01, f = 0.9], for breathing frequency. While the 8-week stress reduction program for women with heart disease did not show significant interactions between groups for resting levels of stress hormones, physical functioning, or submaximal exercise responses, there was a significant difference in breathing patterns between the 2 groups during exercise following the mindfulness-based stress-reduction program. There was also a trend for change in the intervention group in the resting levels of cortisol and physical function scores that was not seen in the control group. Future studies could use the effect size generated from this pilot study to calculate the number of subjects needed for adequate power to detect significant differences between groups.

Vedanthan et al., (1998)\textsuperscript{62} enrolled adult asthmatics, ranging from 19 to 52 years from an asthma and allergy clinic in a university setting. The 17 students were randomly divided into yoga (9 subjects) and nonyoga control (8 subjects) groups. The yoga group was taught a set of breathing and relaxation techniques including breath slowing exercises (pranayama), physical postures (yogasanas), and meditation. Yoga techniques were taught at the university health center, three times a week for 16 weeks. All the subjects in both groups maintained daily symptom and medication diaries, collected A.M. and P.M. peak flow readings, and completed weekly questionnaires. Spirometry was performed on each subject every week. Analysis of the data showed that the subjects in the yoga group reported a significant degree of relaxation, positive attitude, and better yoga exercise tolerance. There was also a tendency toward lesser usage of beta adrenergic inhalers. The pulmonary functions did

not vary significantly between yoga and control groups. Yoga techniques seem beneficial as an adjunct to the medical management of asthma.

Poor cardiovascular fitness (CVF) is a risk factor for obesity, as well as insulin resistance (IR), inflammation, and cardiovascular disease. Previously it was seen that a school-based fitness curriculum can improve CVF, as well as IR and body composition in obese children. Whether such a program improves CVF, IR, and other health indicators in non-obese children is unresolved. Therefore, Carrel (2009) conducted a study to determine whether a school-based fitness program improves body composition, CVF, markers of inflammation (e.g. CRP, TNF-alpha, adiponectin), and insulin sensitivity in nonobese children. 35 non-obese middle school children with body mass index below the 95th percentile for age were enrolled in a 'fitness-oriented' gym class. Children underwent fasting evaluation of insulin, glucose, adiponectin, CRP, TNF-alpha, body composition by dual X-ray absorptiometry (DXA), and maximal VO2 treadmill testing at baseline (prior to the school year) and again at end of the school year. Testing for CVF (maximal VO2 treadmill testing), DXA, and fasting evaluation of insulin, glucose, adiponectin, CRP and TNF-alpha. Children demonstrated a decrease in BMI z-score (-0.14 +/- 0.33, p = 0.02), HOMA-IR (-0.15 +/- 0.35, p = 0.016), and TNF-alpha (-2.55 +/- 1.79 pg/ml, p < 0.001), and an increase in VO2(max) (+1.58 +/- 2.34 ml/kg/min, p < 0.001), adiponectin (+7,553 +/- 11,100 ng/ml, p < 0.001), and muscle mass (+2,282 +/- 1,882.73 g, p < 0.001) after nine months of study. The school-based fitness oriented curriculum resulted in improved body composition and insulin sensitivity, increased CVF, and decreased inflammation in non-obese children. Combined with prior studies, these data demonstrate that school-based fitness curricula can benefit both obese and non-obese children. Partnerships with schools to promote fitness should be part of a public health approach to improving children's health.

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Berger, Silver and Stein (2009) compared fourth- and fifth-grade students at 2 after-school programs in Bronx, New York. One program offered yoga 1 hour per week for 12 weeks (yoga) and the other program (non-yoga) did not. Pre intervention and post intervention emotional well-being was assessed by Harter’s Global Self-Worth and Physical Appearance subscales, which were the study’s primary outcome measures. Secondary outcomes included other measures of emotional well-being assessed by 2 new scales: Perceptions of Physical Health and Yoga Teachings (including Negative Behaviors, Positive Behaviors, and Focusing/relaxation subscales). Pre intervention and post intervention, physical wellbeing was assessed by measures of flexibility and balance. Subjective ratings of yoga’s effects on well-being were evaluated by an additional questionnaire completed by the yoga group only. Data were collected from 78% (n=39) and 86.5% (n=32) of potential yoga and non-yoga study enrollees. No differences in baseline demographics were found. Controlling for pre intervention well-being differences using analysis of covariance, we found that children in the yoga group had better post intervention Negative Behaviors scores and balance than the non-yoga group (P < .05). The majority of children participating in yoga reported enhanced wellbeing, as reflected by perceived improvements in behaviors directly targeted by yoga (e.g., strength, flexibility, balance). Although no significant differences were found in the study’s primary outcomes (global self-worth and perceptions of physical well-being), children participating in yoga reported using fewer negative behaviors in response to stress and had better balance than a comparison group. Improvements in wellbeing, specifically in behaviors directly targeted by yoga, were reported. These results suggest a possible role of yoga as a preventive intervention as well as a means of improving children’s perceived well-being.

Tracy and Hart (2012) examined the effect of short-term Bikram yoga training on general physical fitness. Young healthy adults were randomized to yoga training (N=10, 29 ± 6 yrs, 24 sessions in eight weeks) or a control group (N=11, 26 ± 7 yrs). Each yoga training session consisted of 90 min of standardized, supervised postures performed in a heated and humidified studio. Isometric dead lift strength, handgrip strength, lower back/hamstring and shoulder flexibility, resting heart rate and blood pressure, maximal oxygen consumption (treadmill), and lean and fat mass (DEXA) were measured before and after training. Yoga subjects exhibited increased dead lift strength, substantially increased lower back/hamstring flexibility, increased shoulder flexibility, and modestly decreased body fat compared with Control. There were no changes in handgrip strength, cardiovascular measures, or maximal aerobic fitness. In summary, this short-term yoga training protocol produced beneficial changes in musculoskeletal fitness that were specific to the training stimulus.

To address the mechanisms underlying hatha yoga's potential stress-reduction benefits, Kiecolt-Glaser (2012) compared adiponectin and leptin data from well-matched novice and expert yoga practitioners. These adipocytokines have counter-regulatory functions in inflammation; leptin plays a proinflammatory role, while adiponectin has anti-inflammatory properties. Fifty healthy women (mean age=41.32, range=30-65), 25 novices and 25 experts, provided fasting blood samples during three separate visits. Leptin was 36% higher among novices compared to experts, P=.008. Analysis of adiponectin revealed a borderline effect of yoga expertise, P=.08; experts' average adiponectin levels were 28% higher than novices across the three visits. In contrast, experts' average adiponectin to leptin ratio was nearly twice that of novices, P=.009. Frequency of self-reported yoga practice showed

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significant negative relationships with leptin; more weeks of yoga practice over the last year, more lifetime yoga sessions, and more years of yoga practice were all significantly associated with lower leptin, with similar findings for the adiponectin to leptin ratio. Novices and experts did not show even marginal differences on behavioral and physiological dimensions that might represent potential confounds, including BMI, central adiposity, cardiorespiratory fitness, and diet. Prospective studies addressing increased risk for type II diabetes, hypertension, and cardiovascular disease have highlighted the importance of these adipocytokines in modulating inflammation. Although these health risks are clearly related to more extreme values then the healthy sample, this data raise the possibility that longer-term and/or more intensive yoga practice could have beneficial health consequences by altering leptin and adiponectin production.

 Woodyard (2011)\textsuperscript{67} conducted a study with the objective to assess the findings of selected articles regarding the therapeutic effects of yoga and to provide a comprehensive review of the benefits of regular yoga practice. As participation rates in mind-body fitness programs such as yoga continue to increase, it is important for health care professionals to be informed about the nature of yoga and the evidence of its many therapeutic effects. Thus, this manuscript provides information regarding the therapeutic effects of yoga as it has been studied in various populations concerning a multitude of different ailments and conditions. Therapeutic yoga is defined as the application of yoga postures and practice to the treatment of health conditions and involves instruction in yogic practices and teachings to prevent reduce or alleviate structural, physiological, emotional and spiritual pain, suffering or limitations. Results from this study show that yogic practices enhance muscular strength and body flexibility, promote and improve respiratory and cardiovascular function, promote recovery from and treatment of addiction, reduce stress, 

\textsuperscript{67}C. Woodyard, “Exploring the therapeutic effects of yoga and its ability to increase quality of life.” Int J Yoga, 4, 2, 2011, pp.49-54.
anxiety, depression, and chronic pain, improve sleep patterns, and enhance overall well-being and quality of life.

With the recent rise in obesity awareness and the increased understanding of the importance of physical activity in promoting overall health, greater emphasis has been placed on improving physical fitness to enhance quality of life. Surya Namaskar, a component of Hatha Yoga, has been practiced by Asian Indians for hundreds of years and is often used in place of a typical fitness program. It consists of a series of postures (asanas) that are repeated 12 times per round. Only one published study has looked specifically at Surya Namaskar, measuring the energy cost of individual asanas (Sinha et al., 2004). However, practitioners typically perform several rounds of the asanas during a session. Therefore, Mody (2011) assessed the cardiorespiratory and metabolic responses of four rounds of Surya Namaskar, a typical amount performed by practitioners, to determine its potential as a training and weight loss tool. Six healthy Asian Indian men and women (18-22 years) who had trained in Surya Namaskar for over two years participated in the study. Testing was completed in a single session lasting about 30 min. To measure heart rate and oxygen consumption while performing the four rounds, participants were connected to a heart rate monitor and the Oxycon Mobile Metabolic System. Participants exercised at 80% of age-predicted maximal heart rate (HRmax) during Round 2, 84% during Round 3, and 90% during Round 4. Average intensity during the four rounds was 80% HRmax, sufficient to elicit a cardiorespiratory training effect. Oxygen consumption averaged 26 ml/kg/min during each round, resulting in an energy expenditure of 230 kcals during a 30 min session for a 60 kg individual. Regular practice of Surya Namaskar may maintain or improve cardiorespiratory fitness, as well as promote weight management.

Exercise is considered an acceptable method for improving and maintaining physical and emotional health. A growing body of evidence supports the belief that yoga benefits physical and mental health via down-regulation of the hypothalamic-pituitary-adrenal (HPA) axis and the sympathetic nervous system (SNS). The purpose of this article by Ross and Thomas (2010)\textsuperscript{69} was to provide a scholarly review of the literature regarding research studies comparing the effects of yoga and exercise on a variety of health outcomes and health conditions. Using PubMed\textsuperscript{(R)} and the key word "yoga," 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. These studies were included in this review. 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. 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. Additional studies using rigorous methodologies are needed to examine the health benefits of the various types of yoga.

Cowen (2010)\textsuperscript{70} explored the benefits of yoga on functional fitness, flexibility, and perceived stress. A quasi-experimental design was used to measure benefits of yoga in sample of firefighters from a major metropolitan fire department. Yoga classes were conducted on-shift, in the fire stations


\textsuperscript{70} V. S. Cowen, “Functional fitness improvements after a worksite-based yoga initiative.” \textit{J Bodyw Mov Ther.}, 14, 1, 2010, pp.50-54.
over the period of 6 weeks. The classes included pranayama (breathing), asana (postures), and savasana (relaxation); 108 firefighters enrolled in the study, most were physically active but had no prior experience with yoga. Baseline and post-yoga assessments were completed by 77 participants. Paired t-tests revealed significant improvements in the Functional Movement Screen, a seven item test that measures functional fitness. Improvements were also noted in trunk flexibility and perceived stress. Participants also reported favorable perceptions of yoga: feeling more focused and less musculoskeletal pain. These findings - along with the retention of the majority of the participants - indicate that participants benefited from yoga.

Hafner-Holter, Kopp and Gunther (2009)\textsuperscript{71} conducted as study to describe and compare influences from a physical activity program and a yoga program on well-being, mood, stress coping, body-image and social competence in healthy people. 18 persons attending a gym and 21 taking part in a yoga program answered following questionnaires before entering the program and after taking part for 20 units: Body-Image-Questionnaire (25), Symptom-Checklist-90R (8), Complaint-List (31), Adjective Mood-Scale (32) and a Visual Analogue Scale for assessing stress-level (10). Statistical analyses show significant improvement in social competence in both training groups; the gym-group report reduced sexual discomfort, whereas people taking part in yoga-group show a reduction in somatization and body-related anxiety as well as an improvement in physical and emotional well-being. These findings support the evidence that physical activity in general improves psychological well-being, however, gym and yoga seem to have different psychological impacts. Future research should focus on comparing the psychological effects of different physical activity interventions in prevention programmes as well as exercise prescriptions in patients with mental illness.

Relaxation potential of yogic exercises seems to play a vital role in establishing psycho-physical health in reversing the psycho-immunology of emotions under stress based on breath and body awareness. However, mechanism of yogic exercises for restoring health and fitness components operating through psycho-neuro-immunological pathways is unknown. Therefore, Kulkarni and Bera (2009)\textsuperscript{72} proposed a hybrid model of human information processing psycho-neuro-endocrine (HIP-PNE) network to reveal the importance of yogic information processing. This study focuses on two major pathways of information processing involving cortical and hypothalamic-pituitary-adrenal axis (HPA) interactions with a deep reach molecular action on cellular, neuro-humoral and immune system in reversing stress mediated diseases. Further, the proposed HIP-PNE model has ample of experimental potential for objective evaluation of yogic view of health and fitness.

Birdee \textit{et al.}, (2009)\textsuperscript{73} evaluated the evidence for clinical applications of yoga among the pediatric population. An electronic literature search including CINAHL, Cochrane Central Register of Controlled Trials (CENTRAL), EMBASE, Medline, PsycINFO, and manual search of retrieved articles from inception of each database until December 2008. Randomized controlled trials (RCTs) and nonrandomized controlled trials (NRCTs) were selected that included yoga or yoga-based interventions for individuals aged 0 to 21 years. Data were extracted and articles critically reviewed using a modified Jadad score and descriptive methodological criteria, with summarization in tables. Thirty-four controlled studies published from 1979 to 2008 were identified, with 19 RCTS and 15 NRCTs. Many studies were of low methodological quality. Clinical areas for which yoga has been studied include physical fitness, cardiorespiratory effects, motor skills/strength, mental health and psychological disorders, behavior and development, irritable bowel syndrome,


and birth outcomes following prenatal yoga. No adverse events were reported in trials reviewed. Although a large majority of studies were positive, methodological limitations such as randomization methods, withdrawal/dropouts, and details of yoga intervention preclude conclusive evidence. There are limited data on the clinical applications of yoga among the pediatric population. Most published controlled trials were suggestive of benefit, but results are preliminary based on low quantity and quality of trials. Further research of yoga for children by using a higher standard of methodology and reporting is warranted.

Bhole (1973)\textsuperscript{74} has studied physiological consideration about asanas and revealed that Asanas can be looked upon as ‘Postural patterns’, even though they are seen to be performed as isometric and/or repetitive exercises. One should be able to experience stability, comfort, ease and lack of effort if asanas are performed as postures and in that case it can work on tone and equilibrium at physical and emotional level. Meditative postures provide broad triangular base and a balanced condition of the spine, which can help in correct breathing. Relaxative asanas can lead to physical and mental relaxation. Static and dynamic aspects of cultural asanas can be considered separately.

In another study Bhole (1977)\textsuperscript{75} examined that sports, games and physical exercises require active involvement and participation by the motor cortex for developing skill, co-ordination, efficiency, alertness and top performance. On the other hand, more importance seems to have been given on sensory – tonic activity rather than motor activity in yogasanas which can lead to the indirect training and education of the visceral organs and neuro-vegetative system rather than the extremities. The essential features of


meditative asanas are broad triangular base provided by the two knees and buttocks and straight and balances condition of the spine. Relaxative asanas are claimed to give rise to Chitta vishranti i.e. tranquility and peace. Corrective asanas are supposed to develop stability, steadiness and lightness of the body.

Swami Kuvalayananda (1926)\textsuperscript{76}, the pioneer in scientific research in yoga, has observed that the rise in blood pressure during asanas is much less in comparison to activities like running; weight lifting etc. done for same time indicates that asanas should be viewed in a different way than exercises. Emphasis on relaxation, taking help of gravity to ensure internal effects and tackling emotional aspects of the individual have been indicated as some of the points for this consideration.

Vinekar (1957)\textsuperscript{77} stated that Asanas could be done as exercises and as ‘postures’. Through the practice of both types of asanas, one can achieve organic and functional promotion of health and fitness. As postures they work on postural substrate and muscle tone and thus help to develop body awareness through proprioception and vestibular sense. Sensation of ‘pleasant pain’ felt by the individual is the limit for developing a particular asana and allowing that asana to work on various systems of the body.

Gore and Bhole (1982)\textsuperscript{78} observed that pulse rate was seen to increase by 16\% after performing forward bending exercise (predominantly of isotonic nature.) four times, by 9\% at the end of maintaining the bent condition with tensed muscles (predominantly of isometric nature) and by 4\% only after Paschimatana (having postural characteristics) for 15 secs. each.

\textsuperscript{76} Swami Kuvalayananda, “Yogic poses and blood pressure”. \textit{Yoga Mimamsa}, 2, 2, 1926, pp. 115 – 128.


\textsuperscript{78} M. M. Gore and M. V. Bhole, “Influence of paschimatana and similar type of muscular activity on pulse rate- a primary study”. \textit{Yoga Mimamsa}, 21, 1 & 2, 1982, pp. 21 – 30.
In another study Gore and Bhole (1982)\textsuperscript{79} has seen that heart rate increased by 32\% when Paschimottana was practised with an isometric base, by 13\% when it was repeated four times with an isotonic base and only by 6\% when was performed in a relaxed manner as a posture for one minute each.

Gharote (1977)\textsuperscript{80} found that skinfold measures were reduced significantly in 46 male than in 38 female patients, while estimated body fat percentage showed significant reduction in all the patients after 2 months of yoga training. Weight was reduced and grip strength was increased. No change was observed in BMR but score in Hypertension showed significant change.

Somani, Bhat, Bera and Hollinger (1996)\textsuperscript{81} reviewed the physiological, pharmacological and clinical findings to deduce whether yoga indeed contributes to better health. The report concludes that yoga seems to provide benefits in prevention or correction if the disease process such as hypertension, asthma, diabetes, cognitive and motor deficits, visual and auditory function and psychiatric disorders. The findings also propose the usefulness of yoga to release stress and most common stress-reduction techniques are derived from yoga. Reports of numerous scientific studies on yoga with controlled experiments carried out have been synthesized critically to prove the usefulness of yoga in conjunction with or without the use of drugs and meditation. Reports revealed that yoga helps also to reduce the drug dosages.

\textsuperscript{79} M. M. Gore and M. V. Bhole, “Heart rate during paschimotana and similar type of isometric and isotonic exercises- A comparison”. \textit{Yoga Mimamsa}, \textbf{21}, 1 & 2, 1982, pp. 31-34.


In one of the study Bera and Rajapurkar (1993) had taken forty male high school students, age 12-15 yrs., participated for a study of yoga in relation to body composition, cardiovascular endurance and anaerobic power. The Ss were placed into two subsets viz., yoga group and control group. Body composition, cardiovascular endurance and anaerobic power were measured using standard method. The duration of experiment was one year. The result of ANCOVA revealed that a significant improvement in ideal body weight, body density, cardiovascular endurance and anaerobic; power was observed as a result of yoga training. This study could not show significant change in body fat (mid axillary), skeletal diameters and most of the body circumferences. It was evident that some of the fat-folds (triceps, subscapular, suprailiac, umbilical, thigh and calf) and body circumferences (waist, umbilical and hip) were reduced significantly.

Cardiovascular responses in asanas of easy course recommended by Swami Kuvalayananda in different types of practitioners have been carried out by Bhagwat and Bhole (1988). 24 subjects were classified into three groups viz., beginners, irregular and regular practitioners of asanas of the easy course as recommended by Swami Kuvalayananda. They were investigated for changes in blood pressure, pulse rate and pulse pressure before, during and after the practice of asanas as per their understanding of performing the asanas. The result revealed that the response pattern of the beginner group indicated labile responses, while other two groups indicate more stabilized nature of responses.

Moorthy (1988) conducted a study to see the effect of selected yogic practices on cardiovascular fitness level of college men and women.

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Investigations carried out on 10 male and 5 females students of YMCA College, Madras, showed significant improvement in cardiovascular fitness after 6 weeks training in yogic practices when measured by Harvard Step Test.

Ganguly, Gharote and Jolly (1988) undertook a study on 15 male students of R.P.T.S. (Regional Police Training School), Khandala with a view to see the immediate effect of *kapalabhati* on cardiovascular endurance as measured through Harvard Step Test. Significant improvement (p<0.01) was seen in their cardiovascular endurance after performing one minute of *kapalabhati* as compared to hyperventilation.

Shrikrishna (1990) advocated behavioral correction by psychosocial guidelines in yogic disciplines. The author emphasizes that restructuring of daily routine like appropriate food, adequate rest, optimum physical activity and balanced mental activities; psycho-physiological re-conditioning are possible with the help of asanas, pranayamas and meditational practices. This comprehensive approach not only helps in reducing BP in basal condition but also reduces the episodes in which the casual rise in BP occurs due to emotional strain.

Rao (1963) has compared various cardiovascular responses occurring in horizontal supine position, erect standing position and headstand posture. The subjects, six make medical school students, had some experience with the headstand posture and could maintain it for up to fifteen minutes. Measurements in the headstand posture were recorded after about five minutes had elapsed in the posture, to help assure that the readings were

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taken with the subject in stable state. In part of this study the average blood flow in a toe and a finger were determined by plethysmography. It was found that blood flow in the toe was less and blood flow in the finger was greater during the headstand than during either the horizontal supine position or the erect standing position. The average value for the blood flow in the toe was greater than that for the finger in the supine and erect positions but slightly less than that for the finger in the headstand posture. Rao also measured the forehead temperature and the top-of-the-foot skin temperature. The forehead skin temperature increased and the skin temperature of the dorsum of the foot decreased during the headstand as compared to other body position.

Wenger (1961)\textsuperscript{88} found little change either in finger temperature or in finger pulse volume as his practiced shavasana (corpse posture). Wenger also measured finger temperature and finger pulse volume before, during and after the breathing practices of ujjayi, bhasrika (bellows), hyperventilation after bhasrika, kapalabhati (skull shining) and hyperventilation after kapalabhati. In all cases the average finger temperature decreased during the exercise period and the decreased was slightly greater in the pranayama exercise than in the non-yogic practices of hyperventilation. Finger pulse volume decreased during all practices except kapalabhati, during which it increase. The post-exercise finger pulse volumes returned to the pre-exercise level or higher after the pranayama exercised, but remained lower that the pre-exercise level when measured shortly after hyperventilation. Finger pulse volume was highest in the practices of kapalabhati, next in ujjayi, next in bhasrika, and lowest in hyperventilation.

In 2 studies, Udupa \textit{et al.}, (1971)\textsuperscript{89} considered various physiological effects of yoga practices. In the first study 12 males, average age 23 years,


\textsuperscript{89} K. N. Udupa, R. H. Singh and R. M. Shettiwar, ”Studies on physiological, endocrine and metabolic response to the practice of yoga in young normal volunteers”. Journal of Research in Indian Medicine, 6, 3, 1971, pp. 345- 353.
underwent a systematic training in various hatha yoga practices. The daily one-hour training sessions continued for 6 months. Yoga practices that were progressively introduced to subjects included the following: bhujangasana (cobra posture), ardha-halasana (half-plough posture), eka-pada hastasana (head-knee posture), vakrasana (twisted posture), chakrasana (wheel posture), padmasana (lotus posture), halasana (plough posture), paschimottanasana (posterior stretching posture), shalabhasana (locust posture), viparitakarani (inverted action), samba-mudra (symbol of the lion), dhanurasana (bow posture), sputa vaajrasana (supine pelvic posture), ardhamatsyendrasana (half-spinal twist), yoga mudra (symbol of yoga), sarvaugasana (shoulder stand), kapalabhati (skull shining), shirshasana (headstand), kukutasana (cock posture), garbhasana (child-in-womb posture), neti jala (nostril cleansing with water), neti sutra (nostril cleansing with string), ujjayi, bhastrika (bellows), uddiyana-bhadha (abdominal lock), nauli. Measurements were reported initially and after 3 and 6 months of training. In the second study only four subjects, average age 20 years, were considered, and the practices involved lasted for three months. Two subjects practiced surya-namaskar (sun salutation) seven minutes a day. Suryanamaskar is not considered to be in the group of yogic practices; it is considered as a preliminary to hatha yoga, to make the body supple. One subject practiced shirshasana (headstand) seven minutes daily mayursana (peacock posture) three minutes daily; one subject practiced sarrvangasana (shoulder stand) nine minutes, matsyasana (fish posture) two minutes and halasana (plough posture) three minutes, all on a daily basis. Measurements were noted before and after the three months of practice. After three months of hatha yoga practice by the 12 subjects, average pulse rate in resting state was found by Udupa 11 to have decreased somewhat; this lower level was maintained after three more months of practice. The amount by which the pulse rate increased in response to the physical stress of fast running was, after 6 months practices of yoga by Udupa’s 12 subjects, less than initially; the difference between these values was not statistically significant, however, The direction of heart rate change, whether an increase or decrease, in
response to various asanas and breathing practices was found by Gopal to be similar for subjects whether or not they were trained in hatha yoga. For both trained and untrained group, heart rate was greatest in the practices of setubandhasana (bridge posture). In several breathing practices, heart rate was greatest for both groups during a deep inspiration with bandhas (locks); it was least for the trained group in deep expiration without the bandhas and least for the untrained group in rhythmic expiration retention.

Gururaja et al., (2011)90 conducted a study in Japan to find the effect of yoga on mental health between young and senior people. Twenty-five normal healthy volunteers of both sexes were divided into two groups according to age. Fifteen participants of the age group between 65 to 75 years and 10 participants of the age group between 20 to 30 years were selected. This study was approved by the ethical committee of Kawasaki University of Medical Welfare. Selected individuals were subjected to 90 min of yoga classes once or twice a week for a month. Salivary amylase activity was assessed before and after yoga practice. State Trait Anxiety Inventory (STAI) was given before yoga on the first day and after one month of practice to assess the change in State anxiety and Trait anxiety. Senior group – Salivary amylase activity decreased from 111.2±42.7 to 83.48±39.5 kU/L [average±standard deviation]. Younger group – Salivary amylase activity reduced from 60.74±31.8 to 42.39±24 kU/L. Senior group – State anxiety score decreased from 41.13±8.43 to 30.8±6.49, Trait anxiety score reduced from 45.66±7.5 to 40.73±8.3. Younger group – State anxiety score reduced from 38.7±4.8 to 30.8±4.1, Trait anxiety score reduced from 46.2±7.9 to 42.9±9.1. Changes were statistically significant with \( P<0.05 \). Decrease in Salivary amylase activity may be due to reduction in sympathetic response. Reduction in State and Trait anxiety score signifies that yoga has both

immediate as well as long-term effect on anxiety reduction. Thus yoga helps to improve the mental health in both the groups.

Planning skills play a key role in higher developmental processes. The Tower of London test not only measures planning skills, but also the ability to execute plans. Yoga practices aim to bring about higher development. Can a Yoga-based education system be shown to meet this challenge? Hence, Rangan, Nagendra and Bhat (2008)\textsuperscript{91} carried out a study which aimed at comparing a Modern Education System (MES) with the ancient Yoga-based system of education, the Gurukula Education System (GES), in developing planning skills. Forty-nine boys with ages ranging from 11 to 13 years were selected from each of two residential schools, one MES and the other GES, providing similar ambience and daily routines. The boys were matched for age and socio-economic status. The GES educational program is based around integrated yoga modules while the MES provides a conventional modern education program. Planning and executive abilities were assessed using the Tower of London test at the start and the end of an academic year. Results: Within groups, the pre-post test differences were significant for both groups. However, the between-groups results showed improvement in the GES group compared to the MES group at a $P < 0.001$ significance level. Conclusion: The study suggests that whereas both MES and GES Yoga-based education improve planning and execution skills in school boys, GES is more effective of the two systems.

The aim of study conducted by Deshpande, Nagendra and Nagarathna (2009)\textsuperscript{92} was to see the efficacy of yoga on Gunas (personality) and self esteem in normal adults. Of the 1228 persons who attended motivational lectures, 226 subjects aged 18-71 years, of both sexes, who satisfied the

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inclusion and exclusion criteria, and who consented to participate in the study were randomly allocated into two groups. The Yoga (Y) group practiced an integrated yoga module that included asanas, pranayama, meditation, notional correction, and devotional sessions. The comparison group practiced mild to moderate physical exercises (PE). Both groups had supervised practices for one hour daily, six days a week, for eight weeks. Guna (personality) was assessed before and after eight weeks using the self-administered "The 'Gita" Inventory of Personality" (GIN) to assess Sattva, Rajas, and Tamas. Self esteem in terms of competency (COM), global self esteem (GSE), moral and self esteem (MSE), social esteem (SET), family self esteem (FSE), body and physical appearance (BPA), and the lie scale (LIS) were assessed using the self esteem questionnaire (SEQ). The baseline scores for all domains for both the groups did not differ significantly ($P > 0.05$ independent samples $t$-test). There were significant pre-post improvements in all domains in both groups ($P < 0.001$ paired $t$-test). The number of persons who showed improvement in Sattva and decrease in Tamas was significant in the Y but not in the PE group (McNemar test). The effect size for self esteem in the Y group is greater than for the PE group in three out of seven domains. This randomized controlled study has shown the influence of Yoga on Gunas and self esteem in comparison to physical exercise.

Memory and selective attention are important skills for academic and professional performance. Techniques to improve these skills are not taught either in education or company training courses. Any system which can systematically improve these skills will be of value in schools, universities, and workplaces. Therefore, the aim of this study conducted by Pradhan and Nagendra (2009)$^{93}$ was to investigate possible improvements in memory and selective attention, as measured by the Digit-Letter Substitution Task (DLST), due to practice of Cyclic Meditation (CM), a yoga relaxation technique, as compared to Supine Rest (SR). Subjects consisted of 253 school students,

156 boys, 97 girls, in the age range 13-16 years, who were attending a 10-day yoga training course during summer vacation. The selected subjects had English as their medium of instruction in school and they acted as their own controls. They were allocated to two groups, and tested on the DLST, immediately before and after 22.5 minutes practice of CM on one day, and immediately before and after an equal period of SR on the other day. The first group performed CM on day 9 and SR on day 10. For the second group, the order was reversed. Within each group pre-post test differences were significant for both the relaxation techniques. The magnitude of net score improvement was greater after SR (7.85%) compared to CM (3.95%). Significance levels were $P < 0.4 \times 10^{-9}$ for SR and $P < 0.1 \times 10^{-3}$ for CM. The number of wrong attempts also increased significantly on both interventions, even after removing two outlier data points on day 1 in the SR group.

Conclusions: Both CM and SR lead to improvement in performance on the DLST. However, these relaxation techniques lead to more wrong cancellation errors.

Kauts and Sharma (2009)\textsuperscript{94} conducted a study with a view to assess the effect of yoga on academic performance in relation to stress. The study started with 800 adolescent students; 159 high-stress students and 142 low-stress students were selected on the basis of scores obtained through Stress Battery. Experimental group and control group were given pre test in three subjects, i.e., Mathematics, Science, and Social Studies. A yoga module consisting of yoga asanas, pranayama, meditation, and a value orientation program was administered on experimental group for 7 weeks. The experimental and control groups were post-tested for their performance on the three subjects mentioned above. The results show that the students, who practiced yoga performed better in academics. The study further shows that low-stress students performed better than high-stress students, meaning thereby that stress affects the students' performance. Memory is more

associated with the temporal cortex than other cortical areas. The two main components of memory are spatial and verbal which relate to right and left hemispheres of the brain, respectively. Many investigations have shown the beneficial effects of yoga on memory and temporal functions of the brain. This study conducted by Rangan, Nagendra and Bhat (2009)\textsuperscript{95} was aimed at comparing the effect of one Gurukula Education System (GES) school based on a yoga way of life with a school using the Modern Education System (MES) on memory. Forty nine boys of ages ranging from 11-13 years were selected from each of two residential schools, one MES and the other GES, providing similar ambiance and daily routines. The boys were matched for age and socioeconomic status. The GES educational program is based around integrated yoga modules while the MES provides a conventional modern education program. Memory was assessed by means of standard spatial and verbal memory tests applicable to Indian conditions before and after an academic year. Between groups there was matching at start of the academic year, while after it the GES boys showed significant enhancement in both verbal and visual memory scores than MES boys ($P < 0.001$, Mann-Whitney test). This study showed that the GES meant for total personality development adopting yoga way of life is more effective in enhancing visual and verbal memory scores than the MES.

Pradhan and Nagendra (2010)\textsuperscript{96} investigated the effect of two yoga-based relaxation techniques, namely, cyclic meditation (CM) and supine rest (SR), using the six letter cancellation task (SLCT). The subjects consisted of 208 school students, (132 boys, 76 girls) in the age range of 13 - 16 years. The subjects were assessed on SLCT before and immediately after both yoga-based relaxation techniques. After both practices, the total and net scores were significantly increased, although the magnitude of change was


more after CM than after SR in the net scores (14.5 versus 11.31%). The net score change in the CM session was significantly larger than the change in the SR, whereas, there was no significant change in the wrong cancellation score. After either practice, the total and net scores were significantly increased, irrespective of gender and age. Conclusions: Both CM and SR led to improvement in performance, as assessed by SLCT, but the change caused by CM was larger than SR.

Numerous scientific studies have reported beneficial physiological changes after short- and long-term yoga training. Suryanamaskar (SN) is an integral part of modern yoga training and may be performed either in a slow or rapid manner. As there are few studies on SN, Bhavanani, Udupa, Madanmohan and Ravindra (2011) conducted this study to determine the differential effect of 6 months training in the fast and slow versions. 42 school children in the age group of 12-16 years were randomly divided into two groups of 21 each. Group I and Group II received 6 months training in performance of slow suryanamaskar (SSN) and fast suryanamaskar (FSN), respectively. 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 present 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. It 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.

Certain psychological and health variables are commonly measured in India. This study Conducted by Khemka, Nagendra, Ramarao and Hankey (2011) evaluated the effects of integral yoga practices on these variables and also the consistency of correlations observed between them. The study was a pre-post intervention study. The variables were measured at the beginning and the end of a one-month yoga course. There was no control group. The study was carried out at Swami Vivekananda Yoga Anusandhana Samsthana (S-VYASA) University, in its rural campus south of Bangalore. Based on health criteria, 108 subjects were selected out of 198 volunteers to form the experimental yoga group. Ages ranged from 17 to 63 years. The yogasanas (postures), pranayama (breathing exercises), relaxation techniques, meditation, chanting and lectures were the components of yoga intervention. The variables measured were sustained attention, emotional intelligence - EQ, general health - GHQ, guna personality - sattva, rajas and tamas. Significant pre-post changes were found in all variables. Significant correlations were found between the following pairs: The two sustained attention variables; emotional intelligence and general health; GHQ and tamas; sattva and tamas; and rajas and tamas. The study shows that there were significant changes in all variables (P< 0.001) except in sattva. It also confirms that EQ and general health variables correlate significantly with each other and negatively with tamas. EQ and tamas form positive and negative predictors of health respectively. Sattva correlates positively with EQ suggesting that a sattvic personality indicates better self-control. This suggests that, by improving guna personality, long-term yoga practice may stabilize EQ.

Yadav et al., (2012) assessed the efficacy of a short-term comprehensive yoga-based lifestyle intervention in reducing anxiety, improving subjective well-being and personality. Participants ($n=90$) included patients with chronic diseases attending a 10-day, yoga-based lifestyle intervention program for prevention and management of chronic diseases, and healthy controls ($n=45$) not attending any such intervention. Primary Outcome Measures: Change in state and trait anxiety questionnaire (STAI-Y; 40 items), subjective well-being inventory (SUBI; 40 items), and neuroticism extraversion openness to experience five factor personality inventory revised (NEO-FF PI-R; 60 items) at the end of intervention. Following intervention, the STAI-Y scores reduced significantly ($P<0.001$) at Day 10 ($66.7 \pm 13.0$) versus Day 1 ($72.5 \pm 14.7$). Also, positive SUBI scores (F1- F6) improved significantly ($P<0.01$) at Day 10 versus Day 1. Similarly NEO-FF PI-R scores improved significantly ($P<0.001$) at Day 10 versus Day 1. Control group showed an increase in STAI-Y while SUBI and NEO-FF PI-R scores remained comparable at Day 10 versus Day 1. The observations suggest that a short-term, yoga-based lifestyle intervention may significantly reduce anxiety and improve subjective well-being and personality in patients with chronic diseases.

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The effectiveness of yoga training to improve health and fitness greatly depends on the population who undergoes the yoga training considering its frequency and duration of the yoga training. Although there are numerous studies conducted in various populations to see the effect of yoga but very few studies have been conducted so far to see its effectiveness on health related physical fitness in school children. Further, schools are potentially attractive settings to promote positive health and behaviors because students spend large amounts of time in the school environment, elements of the traditional school curriculum relate directly to health, and schools typically provide extracurricular programs that can also promote health. The literature as presented above did not find any reference especially on health related physical fitness of school going girls. In fact, no training strategy is available so far for enriching their health related physical fitness. Hence, this study seems to be logical and justified.