REVIEW OF RELATED LITERATURE

The researcher has consulted many references to support this study on breathing and physiological functions with special reference to athletic performance. However, research literature revealed so far in relation to the topic is meager. However, the researcher attended many libraries, web machines and collected reviews available so far, have been summarized in this chapter.

Karambelkar et al. (1982) have made sixteen observations on those adult male who were well established in different type of Pranayamas over a period of one year. They have conducted this study with two experiments. In experiment no. 1 normal breathing was recorded, expired air was collected in the Douglas bag for 10 min. Same experiment was repeated with Bhashrika Pranayama with internal retention (Antar Kumbhaka) instead of normal breathing. in experiment No. 2, normal breathing was comparated with Bhashrika Pranayama, with external retention of breath (Bahya Kumbhaka) The study concludes that Bhashrika Pranayama with Bahya Kumbhaka (Patanjali type) and Antar Kumbhaka (Gheranda type) increase oxygen consumption and carbon dioxide tolerance.

Frostell et al., (1983) evaluated the effects of spontaneous high-frequency breathing (HFB) on lung function in three subjects highly trained in the practice of yoga. Transpulmonary pressure was measured by an esophageal balloon catheter and gas flow by pneumotachography. The abdominal and rib cage contributions to tidal breathing were measured separately by respiratory inductive plethysmography. Gas exchange was studied by the conventional technique and by multiple inert gas elimination. During HFB, respiratory rate increased to 232 cycles/min with a tidal volume of 0.35 liter. This resulted in a more than 10-fold increase in expired minute ventilation to approximately 90 1/min. The transpulmonary pressure varied by 20 cmH2O, with the calculated
elastic, resistive, and accelerative components varying by 2, 20, and 8 cmH2O, respectively. Respiratory work increased more than 200-fold in comparison with resting ventilation. A phase shift between thoracic and abdominal breathing was observed and was interpreted as a volume displacement of approximately 30 l/min between the two parts of the respiratory system. Arterial oxygen and carbon dioxide tension remained normal. Bohr dead space increased, while acetone dead space remained unaltered. A bimodal distribution of ventilation-perfusion ratios (VA/Q) was observed, with one mode in normal and another in "high" VA/Q regions.

'Pranayama' or yogic breathing as a method of re-expansion of lungs in patients with pleural effusion was studied by Prakasamma and Bhaduri (1984). Ten patients with pleural effusion practised alternate nostril breathing for 20 days after aspiration of fluid. An equal number matched for age and smoking habits underwent routine physiotherapy of the hospital for the same period. Lung function was measured: before aspiration; immediately after aspiration; and, 5, 10, 15 and 20 days after aspiration. The FVC, FEV1, MVV, PEFR, CE and RS, were used to measure lung function. The difference between the two groups in the gain in lung expansion as assessed by the above measures was tested for significance with appropriate nonparametric statistical tests at 0.1 level of significance. The results revealed that the patients practising Pranayama demonstrated a quicker re-expansion of the lungs in most of the measures of lung function. The findings are discussed in relation to implications for nursing care.

Mohan, Saravanane, Surange, Thombre and Chakrabarty (1986) conducted a study to see the effect of inspiratory and expiratory phases of normal quiet breathing, deep breathing and savitri Pranayama type breathing on heart rate and mean ventricular QRS axis in young, healthy untrained subjects. Pranayama type breathing produced significant cardio acceleration and increase in QRS axis during the inspiratory phase as compared to eupnoea.
On the other hand, expiratory effort during Pranayama type breathing did not produce any significant change in heart rate or QRS axis. The changes in heart rate and QRS axis during the inspiratory and expiratory phases of Pranayama type breathing were similar to the changes observed during the corresponding phases of deep breathing.

Raju et al., (1986) studied twelve normal healthy volunteers (6 males and 6 females) undergoing yoga training for 90 days for the effect of yoga on exercise tolerance. Their ages ranged from 18 to 28 years. The volunteers were taught only Pranayama for the first 20 days and later on yogic asanas were added. Sub-maximal exercise tolerance test was done on a motorized treadmill by using Balke's modified protocol, initially, after 20 days (Phase-I) and after 90 days of yoga training (Phase-II). Pyruvate and lactate in venous blood and blood gases in capillary blood were estimated immediately before and after the exercise. Minute ventilation and oxygen consumption were estimated before and during the test. Post exercise blood lactate was elevated significantly during initial and Phase-I, but not in Phase-II. There was significant reduction of minute ventilation and oxygen consumption only in males in Phase-I and II at the time when the volunteers reached their 80% of the predicted heart rate. Female volunteers were able to go to higher loads of exercise in Phase-I and II.

Singh (1987) studied twelve subjects with mild asthmatic episodes in the form of nocturnal precipitation. A two-week schedule of placebo administration, pranayamic breathing exercises using a Pink City lung exerciser alone, and exercises using the lung exerciser with hot, humid air were performed. Five of the 12 asthmatics showed highly significant increases in peak expiratory flow rate (PEFR) with the lung exerciser alone, while eight of the 12 cases showed highly significant increases in PEFR with exercise using hot, humid air. The frequency of nocturnal wheezing also declined. It can be inferred that slow breathing alone and in combination with hot, humid air has a nonspecific bronchoprotective or bronchorelaxing effect.
The effects of two pranayama yoga breathing exercises on airway reactivity, airway calibre, symptom scores, and medication use in patients with mild asthma were assessed by Singh et al., (1990) in a randomised, double-blind, placebo-controlled, crossover trial. After baseline assessment over 1 week, 18 patients with mild asthma practiced slow deep breathing for 15 min twice a day for two consecutive 2-week periods. During the active period, subjects were asked to breathe through a Pink City lung (PCL) exerciser—a device which imposes slowing of breathing and a 1:2 inspiration:expiration duration ratio equivalent to pranayama breathing methods; during the control period, subjects breathed through a matched placebo device. Mean forced expiratory volume in 1 s (FEV1), peak expiratory flow rate, symptom score, and inhaler use over the last 3 days of each treatment period were assessed in comparison with the baseline assessment period; all improved more with the PCL exerciser than with the placebo device, but the differences were not significant. There was a statistically significant increase in the dose of histamine needed to provoke a 20% reduction in FEV1 (PD20) during pranayama breathing but not with the placebo device. The usefulness of controlled ventilation exercises in the control of asthma should be further investigated.

Stancak et al., (1991) studied topography of brain electrical activity in 11 advanced yoga practitioners during yogic high-frequency breathing kapalabhati (KB). Alpha activity was increased during the initial five min of KB. Theta activity mostly in the occipital region was increased during later stages of 15 min KB compared to the pre-exercise period. Beta 1 activity increased during the first 10 min of KB in occipital and to a lesser degree in parietal regions. Alpha and beta 1 activity decreased and theta activity was maintained on the level of the initial resting period after KB. The score of General Deactivation factor from Activation Deactivation Adjective Checklist was higher after KB exercise than before the exercise. The results suggest a relative increase of slower EEG frequencies and relaxation on a subjective level as the after effect of KB exercise.
Telles and Desiraju (1991) conducted a study to determine whether the yogic Ujjayi pranayamic type of breathing that involves sensory awareness and consciously controlled, extremely slow-rate breathing including at least a period of end-inspiration breath holding in each respiratory cycle would alter oxygen consumption or not, ten males with long standing experience in pranayama, and volunteering to participate in the laboratory study were assessed. These subjects aged 28-59 yr, had normal health appropriate to their age. Since kumbhak (timed breath holding) is considered as an important phase of the respiratory cycle in the pranayama, they were categorised into two groups of five each, one group practising the short kumbhak varieties of pranayama, and the other the long kumbhak varieties of pranayama. The duration of kumbhak phase was on an average 22.2 percent of the respiratory cycle in the short kumbhak group, and 50.4 per cent in the long kumbhak group. The oxygen consumption was measured in test sessions using the closed circuit method of breathing oxygen through the Benedict-Roth spirometer. Each subject was tested in several repeat sessions. Values of oxygen consumption of the period of pranayamic breathing, and of post-pranayamic breathing period, were compared to control value of oxygen consumption of the prepranayamic breathing period of each test session. The results revealed that the short kumbhak pranayamic breathing caused a statistically significant increase (52%) in the oxygen consumption (and metabolic rate) compared to the pre-pranayamic base-line period of breathing. In contrast to the above, the long kumbhak pranayamic breathing caused a statistically significant lowering (19%) of the oxygen consumption (and metabolic rate).

Telles et al., (1993) assessed two groups of 45 children each, whose ages ranged from 9 to 13 years, on a steadiness test, at the beginning and again at the end of a 10-day period during which one group received training in yoga, while the other group did not. The steadiness test required insertion of and holding for 15 sec. a metal stylus without touching the sides of holes of decreasing sizes in a metal plate. The contacts were counted as 'errors'. During the 10-day
period, one group (the 'Yoga' group) received training in special physical postures (asanas), voluntary regulation of breathing (Pranayama), maintenance of silence, as well as visual focussing exercises (tratakas) and games to improve the attention span and memory. The other group (control) carried out their usual routine. After 10 days, the 'Yoga' group showed a significant (Wilcoxon's paired signed-ranks test) decrease in errors, whereas the 'control' group showed no change.

Telles et al., (1993) showed that in a group of 40 physical education teachers who already had an average of 8.9 years physical training, 3 months of yogic training produced significant improvement in general health (in terms of body weight and BP reduction and improved lung functions). There was also evidence of decreased autonomic arousal and more of psychophysiological relaxation (heart rate and respiratory rate reduction), and improved somatic steadiness (decreased errors in the steadiness test). The changes at the end of 3 months in volar GSR in different directions (increase/decrease/no change), depending on the initial values, suggests that practicing yoga may help to bring about a balance in different autonomic functions, so that functioning is optimised.

Lim et al., (1993) investigated Qigong, a special form of breathing exercise, to examine its effect on cardiorespiratory changes. Ten volunteers (five males and five females) participated in a 20-minute group instructional session for 10 consecutive days before testing of its treatment effects. The testing protocol followed a C1-T-C2 design, where C1, T, and C2 represented the first, treatment, and second control period, respectively. Each period consisted of a 5-minute interval, and thus each testing session consisted of 15 minutes. The results indicated there were no statistically significant differences \((p > 0.05)\) in heart rate or tidal volume for the three 5-minute periods. There was a significant decrease \((p < 0.05)\) in respiratory exchange ratio between T and C2. A significant increase in ventilatory efficiency for carbon dioxide production
was found between C1 and T. Statistically significant differences (p < 0.05) were found in the volume of oxygen consumed and carbon dioxide produced, frequency of breath, expired ventilation, and ventilatory efficiency for oxygen produced between the T and the two control periods. This preliminary study of Qigong demonstrates that the subjects were able to learn the technique in a short period of time. The data also suggest that, with an improvement of nearly 20% in ventilatory efficiency for oxygen uptake and carbon dioxide production, this technique may have useful therapeutic value.

The effect of pranayama a controlled breathing practice, on exercise tests was studied by Raju et al., (1994) in athletes in two phases; sub-maximal and maximal exercise tests. At the end of phase I (one year) both the groups (control and experimental) achieved significantly higher work rate and reduction in oxygen consumption per unit work. There was a significant reduction in blood lactate and an increase in P/L ratio in the experimental group, at rest. At the end of phase II (two years), the oxygen consumption per unit work was found to be significantly reduced and the work rate significantly increased in the experimental group. Blood lactate decreased significantly at rest in the experimental group only. Pyruvate and pyruvate-lactate ratio increased significantly in both the groups after exercise and at rest in the experimental group. The results in both phases showed that the subjects who practiced pranayama could achieve higher work rates with reduced oxygen consumption per unit work and without increase in blood lactate levels. The blood lactate levels were significantly low at rest.

Stancak and Kuna (1994) studied the effects of 10 min forced alternate nostril breathing (FANB) on EEG topography in 18 trained subjects. One type of FANB consisted in left nostril inspiration and right nostril expiration and the other type in right nostril inspiration and left nostril expiration. Mean power in the beta bands and partially in the alpha band increased during FANB irrespective of the type of nostril breathing. In addition, hemisphere asymmetry
in the beta 1 band decreased in the second half of FANB suggesting that FANB has a balancing effect on the functional activity of the left and right hemisphere.

Telles, Nagarathna and Nagendra (1994) conducted a study with the aim to check whether breathing through a particular nostril can alter metabolism and autonomic activities. 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 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. The therapeutic implications of being able to alter metabolism by changing the breathing pattern have been mentioned.

Telles, Nagarathna and Nagendra (1996) 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.

Raju et al., (1997) measured the short-term effects of 4 weeks of intensive yoga practice on physiological responses in six healthy adult female volunteers using the maximal exercise treadmill test. Yoga practice involved daily morning and evening sessions of 90 minutes each. Pre- and post-yoga exercise performance was compared. Maximal work output (Wmax) for the group increased by 21%, with a significantly reduced level of oxygen consumption per unit work but without a concomitant significant change in heart rate. After intensive yoga training, at 154 Wmin(-1) (corresponding to Wmax of the pre-yoga maximal exercise test) participants could exercise more comfortably, with a significantly lower heart rate ($p < 0.05$), reduced minute ventilation ($p < 0.05$), reduced oxygen consumption per unit work ($p < 0.05$), and a significantly lower respiratory quotient ($p < 0.05$). The implications for the effect of intensive yoga on cardiorespiratory efficiency are discussed, with the suggestion that yoga has some transparently different quantifiable physiological effects to other exercises.

Adult asthmatics, ranging from 19 to 52 years from an asthma and allergy clinic in a university setting volunteered to participate in the study
conducted by Vedanthan et al., (1998). 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.

The vital capacity of the lungs is a critical component of good health. Vital capacity is an important concern for those with asthma, heart conditions, and lung ailments; those who smoke; and those who have no known lung problems. Hence Birkel and Edgren (2000) conducted a study to determine the effects of yoga postures and breathing exercises on vital capacity. Using the Spiropet spirometer, researchers measured vital capacity. Vital capacity determinants were taken near the beginning and end of two 17-week semesters. No control group was used. A total of 287 college students, 89 men and 198 women. Subjects were taught yoga poses, breathing techniques, and relaxation in two 50-minute class meetings for 15 weeks. Main Outcome Measures: Vital capacity over time for smokers, asthmatics, and those with no known lung disease. The result showed a statistically significant (P < .001) improvement in vital capacity across all categories over time. Conclusions: It is not known whether these findings were the result of yoga poses, breathing techniques, relaxation, or other aspects of exercise in the subjects' life. The subjects' adherence to attending class was 99.96%. The large number of 287 subjects is
considered to be a valid number for a study of this type. These findings are consistent with other research studies reporting the positive effect of yoga on the vital capacity of the lungs.

Sonetti et al., (2001) evaluated the effects of a 5 week (25 sessions); (30-35 min/day, 5 days/week), respiratory muscle training (RMT) program in nine competitive male cyclists. The experimental design included inspiratory resistance strength training (3-5 min/session) and hyperpnea endurance training (30 min/session), a placebo group which used a sham hypoxic trainer (n=8), and three exercise performance tests, including a highly reproducible 8 km time trial test. RMT intensity, measured once a week in terms of accumulated inspiratory pressure and the level of sustainable hyperpnea increased significantly after 5 weeks (+64% and +19%, respectively). The RMT group showed a significant 8% increase in maximal inspiratory pressure (P<0.05) while the placebo group showed only a 3.7% increase (P>0.10). RMT and placebo groups both showed significant increases in the fixed work-rate endurance test performance time (+26% and +16%, respectively) and in the peak work-rate achieved during the incremental maximal oxygen consumption (V(O2)max) test (+9 and +6%). The 8 km time trial performance increased 1.8+/−1.2% (or 15+/−10 sec; P<0.01) in the RMT group with 8 of 9 subjects increasing; the placebo group showed a variable non-significant change in 5 of 8 subjects (-0.3+/−2.7%, P=0.07). The changes observed in these three performance tests were not, however, significantly different between the RMT and placebo groups. Heart rate, ventilation, or venous blood lactate, at equal work-rates during the incremental exercise test or at equal times during the fixed work-rate endurance test were not changed significantly across these exercise trials in either group. The authors propose that the effect of RMT on exercise performance in highly trained cyclists does not exceed that in a placebo group. Significant placebo and test familiarization effects must be accounted for in experimental designs utilizing performance tests which are critically dependent on volitional effort.
Bernardi et al., (2001) conducted a study with a view to assess the influence of different breathing patterns on autonomic cardiovascular modulation during acute exposure to altitude-induced hypoxia. They measured relative changes in minute ventilation (VE), oxygen saturation (%SaO2), spectral analysis of RR interval and blood pressure, and response to stimulation of carotid baroreceptors (neck suction) at baseline and after acute (1 h) hypobraric hypoxia (equivalent to 5,000 m, in a hypobaric chamber). 19 human subjects participated in this study out of which nine controls and 10 Western yoga trainees of similar age, while breathing spontaneously, at 15 breaths/min (controlled breathing) and during ‘complete yogic breathing’ (slow diaphragmatic + thoracic breathing, approximately 5 breaths/min) in yoga trainees, or simple slow breathing in controls. RESULTS: At baseline %SaO2, VE and autonomic pattern were similar in both groups; simulated altitude increased VE in controls but not in yoga trainees; %SaO2 decreased in all subjects (P< 0.0001), but more in controls than in yoga trainees (17 versus 12%, 14 versus 9%, 14 versus 8%, all P< 0.05 or better, during spontaneous breathing, controlled breathing and yogic or slow breathing, respectively). Simulated altitude decreased RR interval (from 879 +/- 45 to 770 +/- 39, P < 0.01) and increased indices deducted from spectral analysis of heart rate variability (low frequency/high frequency (LF/HF) ratio from 1.6 +/- 0.5 to 3.2 +/- 1.1, P < 0.05) and systolic blood pressure (low-frequency fluctuations from 2.30 +/- 0.31 to 3.07 +/- 0.24 In-mmHg2, P< 0.05) in controls, indicating sympathetic activation; these changes were blunted in yoga trainees, and in both groups during slow or yogic breathing. No effect of altitude was seen on stimulation of carotid baroreceptors in both groups. Conclusions: Well-performed slow yogic breathing maintains better blood oxygenation without increasing VE (i.e. seems to be a more efficient breathing) and reduces sympathetic activation during altitude-induced hypoxia.

Sheel (2002) reviewed literature and able to found that the respiratory system has traditionally been capable of meeting the substantial demands for
ventilation and gas exchange and the cardiopulmonary interactions imposed by short-term maximum exercise or long-term endurance exercise. Recent studies suggest that specific respiratory muscle (RM) training can improve the endurance and strength of the respiratory muscles in healthy humans. The effects of RM training on exercise performance remain controversial. When whole-body exercise performance is evaluated using submaximal fixed work-rate tests, significant improvements are seen and smaller, but significant improvements have also been reported in placebo-trained individuals. When performance is measured using time-trial type performance measures versus fixed workload tests, performance is increased to a much lesser extent with RM training. It appears that RM training influences relevant measures of physical performance to a limited extent at most. Interpretation of the collective literature is difficult because most studies have utilized relatively small sample sizes and very few studies have used appropriate control or placebo groups. Mechanisms to explain the purported improvements in exercise performance remain largely unknown. However, possible candidates include improved ratings of breathing perception, delay of respiratory muscle fatigue, ventilatory efficiency, or blood-flow competition between respiratory and locomotor muscles. This review summarises the current literature on the physiology of RM training in healthy individuals and critically evaluates the possible implications for exercise performance.

Lolage and Bera (2002) trained forty (n=40) male college Kho Kho players aged ranged from 20 to 30 years from Pravra college of physical education. Their cardiovascular efficiency was assessed by administering three test viz., Harvard step test (r= 0.63 P<0.01) 8 minute run test (r = 0.60, P < 0.01) The experimental group underwent training of Pranayama (Viz., Anulom-Vilom, Ujjayi, Suryabhedana & Bhastrika) in two session of 45 minutes each day morning and evening 6 days a week for total period of 3 months. The subject of control group did not participate in the above interesting activities separately during experimental period. The result of ANCOVA revealed 1)
Treatment affect of pranayama on three test of cardiovascular efficiency were not effected 2) Harvard step test could measure C.V. efficiency with insufficient reliability (r = 0.30, P > 0.05) whereas the other tests i.e. 8 minute run test and 1600 M run test could measure this variables with acceptable reliability (r = 0.82, P< 0.01, r = 0.80, P< 0.03) selected Pranayama were found useful in improving cardiovascular endurance of Kho Kho players.

Dane et al., (2002) studied the effects of unilateral forced nostril breathing (UFNB) on systolic and diastolic blood pressures and heart rate (HR) in 88 male and 41 female right-handed subjects. In men, both the right and left unilateral forced nostril breathings significantly increased the systolic blood pressure (SBP) and HR, but had no effect on the diastolic blood pressure (DBP). In women, the right UFNB increased, but the left UFNB slightly decreased the SBP and DBP. The results suggested that there may be a nostril laterality affecting the autonomous nervous system differentially.

Reaction time (RT) is an index of the processing ability of central nervous system and a simple means of determining sensory-motor performance. It has been reported that yoga training improves human performance including central neural processing. Earlier studies from have shown that yoga training produces a significant decrease in visual reaction time (VRT) and auditory reaction time (ART). The present work by Bhavanani, Madanmohan and Udupa (2003) was planned to determine if mukh bhastrrika (a yogic technique in which breath is actively blasted out in 'whooshes' following a deep inspiration) has any effect on central neural processing by studying its effect on RT. 22 healthy schoolboys who were practising yoga for the past three months were recruited for the present study. VRT and ART were recorded before and after nine rounds of mukh bhastrrika. Mukh bhastrika produced a significant (P < 0.01) decrease in VRT as well as ART. A decrease in RT indicates an improved sensory-motor performance and enhanced processing ability of central nervous system. This may be due to greater
arousal, faster rate of information processing, improved concentration and/or an ability to ignore extraneous stimuli. This is of applied value in situations requiring faster reactivity such as sports, machine operation, race driving and specialised surgery. It may also be of value to train mentally retarded children and older sports persons who have prolonged RT.

Katayama et al., (2003) studied the influence of intermittent hypobaric hypoxia at rest on endurance performance and cardiorespiratory and hematological adaptations in trained endurance athletes. Twelve trained male endurance runners were assigned to either a hypoxic group (n = 6) or a control group (n = 6). The subjects in the hypoxic group were exposed to a simulated altitude of 4500 m for 90 min, three times a week for 3 weeks. The measurements of 3000 m running time, running time to exhaustion, and cardiorespiratory parameters during maximal exercise test and resting hematological status were performed before (Pre) and after 3 weeks of intermittent hypoxic exposure (Post). These measurements were repeated after the cessation of intermittent hypoxia for 3 weeks (Re). In the control group, the same parameters were determined at Pre, Post, and Re for the subjects not exposed to intermittent hypoxia. The athletes in both groups continued their normal training together at sea level throughout the experiment. In the hypoxic group, the 3000 m running time and running time to exhaustion during maximal exercise test improved. Neither cardiorespiratory parameters to maximal exercise nor resting hematological parameters were changed in either group at Post, whereas oxygen uptake (.V(O2)) during submaximal exercise decreased significantly in the hypoxic group. After cessation of intermittent hypoxia for 3 weeks, the improved 3000 m running time and running time to exhaustion tended to decline, and the decreased .V(O2) during submaximal exercise returned to Pre level. These results suggest that intermittent hypoxia at rest could improve endurance performance and submaximal exercise efficiency at sea level in trained endurance athletes, but these improvements are not maintained after the cessation of intermittent hypoxia for 3 weeks.
Patients with asthma are interested in the use of breathing exercises but their role is uncertain. The effects of the Buteyko breathing technique, a device which mimics pranayama (a yoga breathing technique), and a dummy pranayama device on bronchial responsiveness and symptoms were compared over 6 months in a parallel group study by Cooper et al., (2003). Ninety patients with asthma taking an inhaled corticosteroid were randomised after a 2 week run in period to Eucapnic Buteyko breathing, use of a Pink City Lung Exerciser (PCLE) to mimic pranayama, or a PCLE placebo device. Subjects practised the techniques at home twice daily for 6 months followed by an optional steroid reduction phase. Primary outcome measures were symptom scores and change in the dose of methacholine provoking a 20% fall in FEV(1) (PD(20)) during the first 6 months. Sixty nine patients (78%) completed the study. There was no significant difference in PD(20) between the three groups at 3 or 6 months. Symptoms remained relatively stable in the PCLE and placebo groups but were reduced in the Buteyko group. Median change in symptom scores at 6 months was 0 (interquartile range -1 to 1) in the placebo group, -1 (-2 to 0.75) in the PCLE group, and -3 (-4 to 0) in the Buteyko group (p=0.003 for difference between groups). Bronchodilator use was reduced in the Buteyko group by two puffs/day at 6 months; there was no change in the other two groups (p=0.005). No difference was seen between the groups in FEV(1), exacerbations, or ability to reduce inhaled corticosteroids. The Buteyko breathing technique can improve symptoms and reduce bronchodilator use but does not appear to change bronchial responsiveness or lung function in patients with asthma. No benefit was shown for the Pink City Lung Exerciser.

Vijayalakshmi et al., (2004) conducted a study on 13 essential hypertensive patients aged 41 to 60 years. They were given yoga training for 60 min daily, Monday through Saturday, for a total duration of 4 weeks. Blood pressure and heart rate (HR) were measured with non-invasive semi-automatic blood pressure monitor. Measurements were recorded before the training and at weekly intervals during the 4 week training period. Results of this study
show a significant (P<0.001) reduction in resting HR and rate-pressure-product (RPP) after 2 weeks of yoga training. Systolic pressure (SP), diastolic pressure (DP) (P<0.001) and mean pressure (MP) (P<0.05) showed a significant reduction at 3 weeks of training period. After 4 weeks of training, there was further fall in SP, DP, pulse pressure (PP) (P<0.05), MP (P<0.001), HR and RPP. Isometric handgrip test before yoga training produced a significant rise in SP and MP and insignificant rise in DP, HR and RPP. After yoga training, there was a significant rise in all these parameters. These results show that yoga training optimises the sympathetic response to stressful stimuli like isometric handgrip test and restores the autonomic regulatory reflex mechanisms in hypertensive patients.

Madanmohan et al., (2004) reported the effects of yoga training on cardiovascular response to exercise and the time course of recovery after the exercise. Cardiovascular response to exercise was determined by Harvard step test using a platform of 45 cm height. The subjects were asked to step up and down the platform at a rate of 30/min for a total duration of 5 min or until fatigue, whichever was earlier. Heart rate (HR) and blood pressure response to exercise were measured in supine position before exercise and at 1, 2, 3, 4, 5, 7 and 10 minutes after the exercise. Rate-pressure product [RPP = (HR x SP)/100] and double product (Do P = HR x MP), which are indices of work done by the heart were also calculated. Exercise produced a significant increase in HR, systolic pressure, RPP & DoP and a significant decrease in diastolic pressure. After two months of yoga training, exercise-induced changes in these parameters were significantly reduced. It is concluded that after yoga training a given level of exercise leads to a milder cardiovascular response, suggesting better exercise tolerance.

Practice of breathing exercises like pranayama is known to improve autonomic function by changing sympathetic or parasympathetic activity. Therefore, in the this study conducted by Pal, Velkumary and Madanmohan
(2004) the effect of breathing exercises on autonomic functions was performed in young volunteers in the age group of 17-19 yr. A total of 60 male undergraduate medical students were randomly divided into two groups: slow breathing group (that practiced slow breathing exercise) and the fast breathing group (that practiced fast breathing exercise). The breathing exercises were practiced for a period of three months. Autonomic function tests were performed before and after the practice of breathing exercises. The increased parasympathetic activity and decreased sympathetic activity were observed in slow breathing group, whereas no significant change in autonomic functions was observed in the fast breathing group. The findings of the present study show that regular practice of slow breathing exercise for three months improves autonomic functions, while practice of fast breathing exercise for the same duration does not affect the autonomic functions.

Spontaneous pneumothorax is the most common cause of pneumothorax. Johnson, Terney and Sadighi (2004) reported a case of a 29-year-old healthy woman who presented to the emergency department with a spontaneous pneumothorax caused by a yoga breathing technique called Kapalabhati pranayama, or breath of fire. Yoga breathing exercises are commonly practiced, and a limited number of studies have shown various physiologic benefits of yoga breathing. This is the only known report of spontaneous pneumothorax caused by pranayama, but some other rare causes are noted. This case should illustrate that adverse side effects can occur when one pushes the body to physiologic extremes.

Because yoga practitioners think they are benefiting from their breath training Villien, Yu, Barthelemv and James (2005) hypothesized that yoga respiration training (YRT) could modify the respiratory sensation. Yoga respiration (YR) ("ujjai") consisted of very slow, deep breaths (2-3 min(-1)) with sustained breath-hold after each inspiration and expiration. At inclusion in the study and after a 2-month YRT program, we determined in healthy subjects
their eupneic ventilatory pattern and their capacity to discriminate external inspiratory resistive loads (respiratory sensation), digital tactile mechanical pressures (somesthetic sensation) and sound-pressure stimulations (auditory sensation). Data were compared to a gender-, age-, and weight-matched control group of healthy subjects who did not undergo the YRT program but were explored at the same epochs. After the 2-month YRT program, the respiratory sensation increased. Thus, both the exponent of the Steven's power law (\(\Psi = k \Phi^p\)) and the slope of the linear-linear plot between \(\Psi\) and mouth pressure (\(P_m\)) were significantly higher, and the intercept with ordinate axis of the \(\Psi\) versus \(P_m\) relationship was lower. After YRT, the peak \(P_m\) developed against inspiratory loads was significantly lower, reducing the load-induced activation of respiratory afferents. YRT induced long-lasting modifications of the ventilatory pattern with a significant lengthening of expiratory duration and a modest tidal volume increase. No significant changes in somesthetic and auditory sensations were noted. In the control group, the respiratory sensation was not modified during a 15-min period of yoga respiration, despite the peak \(P_m\) changes in response to added loads were then significantly reduced. These data suggest that training to yoga respiration selectively increases the respiratory sensation, perhaps through its persistent conditioning of the breathing pattern.

Heart rate variability (HRV) at rest and heart rate recovery after exercise reflect cardiac vagal activity (Hepburn et al., 2005). The aim of this study was to determine whether increasing HRV during involuntary respiratory training induced by rebreathing air using a Hepburn heart and lung exerciser (HHALE) could, like exercise, improve vagal tone. Eighteen subjects (36-88 years) underwent a 6-week control period, then a 6-week training period with the HHALE following which half continued training for 6 weeks and half ceased training. Measurements were made of HRV, work at 60% predicted heart rate max for 15 min, heart rate recovery after exercise, resting blood pressure, heart rate, vital capacity and forced expiratory volume. After the first 6-week
HHALE training, there was a significant increase of 13.2 +/- 5.7 nu in the high frequency peak of the power spectrum of HRV at rest, whereas, the low frequency peak decreased. Similarly, exercise performance showed a significant improvement of 0.031 +/- 0.012 J per heartbeat from a pre-training 0.128 +/- 0.022. Also, heart rate recovery after exercise significantly faster (drop in the first 20 s improving by 3.3 +/- 1.5 beats from a pre-training 12.9 +/- 1.6). The subgroup that continued training maintained or slightly improved these values. In those that ceased training the speed of heart rate recovery at the end of the exercise test returned to pre-trained levels, whereas, other responses were either maintained or decreased slightly. We conclude that training with the HHALE can, without additional exercise, increase cardiac vagal tone and exercise performance.

Different procedures practiced in yoga have stimulatory or inhibitory effects on the basal metabolic rate when studied acutely. In daily life however, these procedures are usually practiced in combination. The purpose of the present study conducted by Chaya et al., (2006) was to investigate the net change in the basal metabolic rate (BMR) of individuals actively engaging in a combination of yoga practices (asana or yogic postures, meditation and pranayama or breathing exercises) for a minimum period of six months, at a residential yoga education and research center at Bangalore. The measured BMR of individuals practicing yoga through a combination of practices was compared with that of control subjects who did not practice yoga but led similar lifestyles. The BMR of the yoga practitioners was significantly lower than that of the non-yoga group, and was lower by about 13 % when adjusted for body weight (P < 0.001). This difference persisted when the groups were stratified by gender; however, the difference in BMR adjusted for body weight was greater in women than men (about 8 and 18% respectively). In addition, the mean BMR of the yoga group was significantly lower than their predicted values, while the mean BMR of non-yoga group was comparable with their predicted values derived from 1985 WHO/FAO/UNU predictive equations.
This study shows that there is a significantly reduced BMR, probably linked to reduced arousal, with the long term practice of yoga using a combination of stimulatory and inhibitory yogic practices.

Kaushik et al., (2006) compared mental relaxation and slow breathing as adjunctive treatment in patients of essential hypertension by observing their effects on blood pressure and other autonomic parameters like heart rate, respiratory rate, peripheral skin temperature, electromyographic activity of the frontalis muscle and skin conductance. One hundred patients of essential hypertension either receiving antihypertensive drugs or unmedicated were selected randomly. Various parameters were recorded during the resting state and then during mental relaxation and slow breathing for 10 min each, separated by a quiet period of 15 min. All parameters were recorded again after mental relaxation and slow breathing. Changes in various parameters observed after mental relaxation and slow breathing were analyzed and compared. Both mental relaxation and slow breathing resulted in a fall in systolic blood pressure, diastolic blood pressure, heart rate, respiratory rate and electromyographic activity with increase in peripheral skin temperature and skin conductance. Slow breathing caused a significantly higher fall in heart rate (p<0.05), respiratory rate (p<0.001), systolic blood pressure (p<0.05) and diastolic blood pressure (p<0.01). Increase in peripheral skin temperature (p<0.05) and reduction in electromyographic activity (p<0.05) occurred more with mental relaxation. No significant differences were seen between increases in skin conductance (p>0.2) observed with both the modalities. Even a single session of mental relaxation or slow breathing can result in a temporary fall in blood pressure. Both the modalities increase the parasympathetic tone but have effects of different intensity on different autonomic parameters.

De Godoy et al., (2006) conducted a study to clarify whether, in healthy individuals, practicing yoga can modify maximal inspiratory pressure and spirometric indices when compared with the practice of aerobic exercise. A
total of 31 healthy volunteers were allocated to practice aerobic exercise (n = 15) or to practice yoga (n = 16). Those in the first group served as controls and engaged in aerobic exercise for 45-60 minutes, twice a week for three months. Those in the second group practiced selected yogic techniques, also in sessions of 45-60 minutes, twice a week for three months. Forced vital capacity, forced expiratory volume in one second and maximal inspiratory pressure were measured before and after the three months of training. No significant alterations were seen in the spirometric indices. A slight, although not significant, improvement in maximal inspiratory pressure was seen in both groups. However, there was a significant difference, seen in both genders, between the absolute delta (final value minus baseline value) of maximal inspiratory pressure for the group practicing yoga and that obtained for the group engaging in aerobic exercise (males: 19.5 cm H2O versus 2.8 cm H2O, p = 0.05; females: 20 cm H2O versus 3.9 cm H2O, p = 0.01). Neither yoga nor aerobic exercise provided a statistically significant improvement in maximal inspiratory pressure after three months. However, the absolute variation in maximal inspiratory pressure was greater among those practicing yoga.

Recently, several studies revealed that daily slow-breathing exercise lowered blood pressure and increased baroreflex sensitivity. With this interesting finding, we have been contemplating to design a compact breath-controllable device for relaxation to stress reaction during daily living for home as well as ambulatory use, as a final goal, towards reduction of cognitive hemodynamic disorders, hypertension, and acute stress-induced hemodynamic disorders. The present study conducted by Nogawa et al., (2007) thereby describes, as a first step, to design a prototype system combining a compact multipurpose non-invasive beat-by-beat cardiovascular monitor developed previously with a wrist-type vibrator to make a respiration rhythm, and to assess an effect of slow-breathing relaxation on the cardiovascular hemodynamics in response to acute stressful conditions. The cardiovascular hemodynamic monitor can measure beat-by-beat systolic (SBP), mean (MBP)
and diastolic (DBP) pressure in a finger based on the volume-compensation method, cardiac output (CO) by the electrical admittance method and the other hemodynamic-related parameters (e.g., total peripheral resistance (TPR=MBP/CO), heart rate (HR), respiratory rate, pulse wave velocity, etc.). The wrist-type vibrator can give various breathing rhythms quietly to a subject using a small vibration motor. The stressful tasks loaded to healthy volunteers (3 males, 23-34 yrs.) in the experiments were cold pressor and arithmetic ones as a representative of daily passive and active coping tasks, respectively, under conditions with (respiratory rate of 6 1/min) and without breath control. The results showed that the slow-breathing technique could have a significant effect on improvement of the hemodynamic changes following the acute stressful tasks, especially in the passive coping task.

Danucalov et al., (2008) 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.
The practice of yoga regulates body physiology through control of posture, breathing, and meditation. Effects of yoga on autonomic functions of patients with refractory epilepsy, as quantified by standardized autonomic function tests (AFTs), were determined by Sathyprabha et al., (2008). The yoga group (n=18) received supervised training in yoga, and the exercise group (n=16) practiced simple routine exercises. AFTs were repeated after 10 weeks of daily sessions. Data were compared with those of healthy volunteers (n=142). The yoga group showed significant improvement in parasympathetic parameters and a decrease in seizure frequency scores. There was no improvement in blood pressure parameters in either group. Two patients in the yoga group achieved normal autonomic functions at the end of 10 weeks of therapy, whereas there were no changes in the exercise group. The data suggest that yoga may have a role as an adjuvant therapy in the management of autonomic dysfunction in patients with refractory epilepsy.

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 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.

Peak expiratory flow rate (PEFR) measurement is the easiest and cheapest method to evaluate respiratory functions. So, the study was carried out by Debray et al., (2008) to evaluate PEFR of healthy Nepalese adults and compare their values with healthy Indian counterparts to know whether Indian prediction equations for PEFR can be used for Nepalese adult population or not. One hundred twenty-three healthy, young, non smoker adult Indian (64: 28 Males, 36 Females) and Nepalese (59: 32 Males, 27 Females) medical students of 18 to 20 years of age participated in the study. The mean PEFR of Indian (male: 490.4 liter/min, female: 386.0 liter/min) and Nepalese (male: 485.9 liter/min, Female: 365.2 liter/min) young adults were found to have no significant differences. As there is no significant difference in the mean PEFR of Indian and Nepalese young adults, prediction equations made for Indian adults can be used to predict PEFR of Nepalese subjects. Therefore, an attempt has been made to formulate a regression equation from the combined Indian and Nepalese subjects. A stepwise, multiple, linear, regression analysis was performed for this purpose. The analysis showed that height is the best predictor for PEFR in the present study. The regression equation based on height for the combined Indian and Nepalese young adults is calculated as: PEFR = 5.687 x Height (cm) - 495.787. However, a stepwise, multiple, linear, regression equation with residual analysis for the best fit model was performed to formulate prediction equation for PEFR and this showed a change of the earlier regression equation to PEFR = 5.930 x Height (cm) - 536.131.

Joshi and Telles (2008) assessed the immediate effect of two yoga breathing techniques on verbal and spatial memory tasks, considered hemisphere-specific. Forty-five participants (24 males; age range 20 to 45 years (mean age 27.1 +/- 8.1 years) were randomly allocated to three groups (n = 15
each) and were assessed immediately before and after 45 minutes of three breathing practices i.e., right nostril yoga breathing, left nostril yoga breathing, or breath awareness as a control intervention. Spatial memory scores increased after left nostril yoga breathing compared to before (by 16 percent, P = 0.03, paired t-test). Hence, breathing through the left nostril increased performance in a spatial cognitive task, corresponding to the cerebral hemisphere contralateral to the patent nostril.

Pranayama (breathing exercise), one of the yogic techniques can produce different physiological responses in healthy individuals. The responses of Alternate Nostril Breathing (ANB) the Nadisudhi Pranayama on some cardio-respiratory functions were investigated by Upadhyaya et al., (2008) in healthy young adults. The subjects performed ANB exercise (15 minutes everyday in the morning) for four weeks. Cardio-respiratory parameters were recorded before and after 4-weeks training period. A significant increment in Peak expiratory flow rate (PEFR L/min) and Pulse pressure (PP) was noted. Although Systolic blood pressure (SBP) was decreased insignificantly, the decrease in pulse rate (PR), respiratory rate (RR), diastolic blood pressure (DBP) were significant. Results indicate that regular practice of ANB (Nadisudhi) increases parasympathetic activity.

Exercise training programs can increase strength and improve submaximal force control, but the effects of yoga as an alternative form of steadiness training are not well described. Therefore, Hart and Tracy (2008) explored the effect of a popular type of yoga (Bikram) on strength, steadiness, and balance. Young adults performed yoga training (n = 10, 29 +/- 6 years, 24 yoga sessions in 8 weeks) or served as controls (n = 11, 26 +/- 7 years). Yoga sessions consisted of 1.5 hours of supervised, standardized postures. Measures before and after training included maximum voluntary contraction (MVC) force of the elbow flexors (EF) and knee extensors (KE), steadiness of isometric EF and KE contractions, steadiness of concentric (CON) and eccentric (ECC) KE
contractions, and timed balance. The standard deviation (SD) and coefficient of variation (CV, SD/mean force) of isometric force and the SD of acceleration during CON and ECC contractions were measured. After yoga training, MVC force increased 14% for KE (479 +/- 175 to 544 +/- 187 N, p < 0.05) and was unchanged for the EF muscles (219 +/- 85 to 230 +/- 72 N, p > 0.05). The CV of force was unchanged for EF (1.68 to 1.73%, p > 0.05) but was reduced in the KE muscles similarly for yoga and control groups (2.04 to 1.55%, p < 0.05). The variability of CON and ECC contractions was unchanged. For the yoga group, improvement in KE steadiness was correlated with pretraining steadiness (r = -0.62 to -0.84, p < 0.05); subjects with the greatest KE force fluctuations before training experienced the greatest reductions with training. Percent change in balance time for individual yoga subjects averaged +228% (19.5 +/- 14 to 34.3 +/- 18 seconds, p < 0.05), with no change in controls. For young adults, a short-term yoga program of this type can improve balance substantially, produce modest improvements in leg strength, and improve leg muscle control for less-steady subjects.

Hypoxic exposure lasting a few hours results in an elevation of ventilation and a lowering of end-tidal P(CO2) (P(ET(CO2))) that persists on return to breathing air. Therefore, Herigstad, Fatmian and Robbins (2008) determined whether this increment in ventilation is fixed (hypothesis 1), or whether it increases in proportion to the rise in metabolic rate associated with exercise (hypothesis 2). Ten subjects were studied on two separate days. On 1 day, subjects were exposed to 8h of isocapnic hypoxia (end-tidal P(O2) 55 Torr) and on the other day to 8 h of euoxia as a control. Before and 30 min after each exposure, subjects undertook an incremental exercise test. The best fit of a model for the variation in P(ET(CO2)) with metabolic rate gave a residual squared error that was approximately 20-fold less for hypothesis 2 than for hypothesis 1 (p<0.005, F-ratio test). From the results it was concluded that the alterations in respiratory control induced during early ventilatory
acclimatization to hypoxia better reflect those associated with hypothesis 2 rather than hypothesis 1.

Peak expiratory flow rate (PEFR) variability follows a specific pattern in asthmatics as well as in healthy individuals. There is scarcity of data for Indian healthy subjects. The PEFR (L/min.) was measured by Goyal et al., (2008) with Wright's portable peak flow meter at 05:00, 8:00, 11:00, 14:00, 17:00, 20:00 and 23:00 hours in 42 healthy, non-smoking adults of age group between 18-26 years. The variability of PEFR revealed a circadian pattern. PEFR levels tend to increase from morning at 5:00 hours till evening at 17:00 hours, with peak PEFR in evening at 17:00 hours, after which there was a progressive fall in PEFR levels, till morning 5:00 hours. This study provides the preliminary reference data of circadian pattern of PEFR in healthy individuals.

Yoga-derived breathing has been reported to improve gas exchange in patients with chronic heart failure and in participants exposed to high-altitude hypoxia. Pomidori et al., (2009) investigated the tolerability and effect of yoga breathing on ventilatory pattern and oxygenation in patients with chronic obstructive pulmonary disease (COPD). Patients with COPD (N = 11, 3 women) without previous yoga practice and taking only short-acting beta2-adrenergic blocking drugs were enrolled. Ventilatory pattern and oxygen saturation were monitored by means of inductive plethysmography during 30-minute spontaneous breathing at rest (sb) and during a 30-minute yoga lesson (y). During the yoga lesson, the patients were requested to mobilize in sequence the diaphragm, lower chest, and upper chest adopting a slower and deeper breathing. We evaluated oxygen saturation (SaO2%), tidal volume (VT), minute ventilation (E), respiratory rate (i>f), inspiratory time, total breath time, fractional inspiratory time, an index of thoracoabdominal coordination, and an index of rapid shallow breathing. Changes in dyspnea during the yoga lesson were assessed with the Borg scale. During the yoga lesson, data showed the adoption of a deeper and slower breathing pattern (VTsb L 0.54±0.04, VTy L
and a significant improvement in SaO2% with no change in E (SaO2%sb 91.5%[1.13], SaO2%y 93.5%[0.99], P = .02; Esb L/min 11.2[1.1], Ey L/min 10.2[0.9]). All the participants reported to be comfortable during the yoga lesson, with no increase in dyspnea index. From the result it was concluded that short-term training in yoga is well tolerated and induces favorable respiratory changes in patients with COPD.

Pramnik et al., (2009) evaluated the immediate effect of slow pace bhashrika pranayama (respiratory rate 6/min) for 5 minutes on heart rate and blood pressure and the effect of the same breathing exercise for the same duration of time (5 minutes) following oral intake of hyoscine-N-butylbromide (Buscopan), a parasympathetic blocker drug. Heart rate and blood pressure of volunteers (n = 39, age = 25-40 years) was recorded following standard procedure. First, subjects had to sit comfortably in an easy and steady posture (sukhasana) on a fairly soft seat placed on the floor keeping head, neck, and trunk erect, eyes closed, and the other muscles reasonably loose. The subject is directed to inhale through both nostrils slowly up to the maximum for about 4 seconds and then exhale slowly up to the maximum through both nostrils for about 6 seconds. The breathing must not be abdominal. These steps complete one cycle of slow pace bhashrika pranayama (respiratory rate 6/min). During the practice the subject is asked not to think much about the inhalation and exhalation time, but rather was requested to imagine the open blue sky. The pranayama was conducted in a cool, well-ventilated room (18-20 degrees C). After 5 minutes of this breathing practice, the blood pressure and heart rate again were recorded in the aforesaid manner using the same instrument. The other group (n = 10) took part in another study where their blood pressure and heart rate were recorded following half an hour of oral intake of hyoscine-N-butylbromide 20 mg. Then they practiced the breathing exercise as stated above, and the abovementioned parameters were recorded again to study the effect of parasympathetic blockade on the same pranayama. It was noted that
after slow bhastrika pranayamic breathing (respiratory rate 6/min) for 5 minutes, both the systolic and diastolic blood pressure decreased significantly with a slight fall in heart rate. No significant alteration in both blood pressure and heart rate was observed in volunteers who performed the same breathing exercise for the same duration following oral intake of hyoscine-N-butylbromide. Pranayama increases frequency and duration of inhibitory neural impulses by activating pulmonary stretch receptors during above tidal volume inhalation as in Hering Bruer reflex, which bring about withdrawal of sympathetic tone in the skeletal muscle blood vessels, leading to widespread vasodilatation, thus causing decrease in peripheral resistance and thus decreasing the diastolic blood pressure. After hyoscine-N-butylbromide, the parasympathetic blocker, it was observed that blood pressure was not decreased significantly as a result of pranayama, as it was observed when no drug was administered. Vagal cardiac and pulmonary mechanisms are linked, and improvement in one vagal limb might spill over into the other. Baroreceptor sensitivity can be enhanced significantly by slow breathing (supported by a small reduction in the heart rate observed during slow breathing and by reduction in both systolic and diastolic pressure). Slow pace bhastrika pranayama (respiratory rate 6/min) exercise thus shows a strong tendency to improving the autonomic nervous system through enhanced activation of the parasympathetic system.

Joshi and Telles (2009) studied bilateral hand-grip strength in 21 male volunteers (M age = 25.6 yr., SD = 5.2). All were assessed before and after five practice sessions of 20 min. duration: right-nostril yoga breathing, left-nostril yoga breathing, alternate-nostril yoga breathing, breath awareness, and a no-intervention session. Data were analyzed with analyses of variance and an analysis of variance using the no-breath awareness control condition as a covariate. There were no significant changes. The left-hand-grip strength reduced after left-nostril yoga breathing. However, findings were not
considered significant, so methodological issues in yoga research which could contribute to null findings and even mask actual changes were discussed.

Vempati, Bijlani and Deepak (2009) conducted a study on 57 adult subjects with mild or moderate bronchial asthma who were allocated randomly to either the yoga (intervention) group (n = 29) or the wait-listed control group (n = 28). The control group received only conventional care and the yoga group received an intervention based on yoga, in addition to the conventional care. The intervention consisted of 2-wk supervised training in lifestyle modification and stress management based on yoga followed by closely monitored continuation of the practices at home for 6-wk. The outcome measures were assessed in both the groups at 0 wk (baseline), 2, 4 and 8 wk by using Generalized Linear Model (GLM) repeated measures followed by post-hoc analysis. In the yoga group, there was a steady and progressive improvement in pulmonary function, the change being statistically significant in case of the first second of forced expiratory volume (FEV1) at 8 wk, and peak expiratory flow rate (PEFR) at 2, 4 and 8 wk as compared to the corresponding baseline values. There was a significant reduction in EIB in the yoga group. However, there was no corresponding reduction in the urinary prostaglandin D2 metabolite (11beta prostaglandin F2alpha) levels in response to the exercise challenge. There was also no significant change in serum eosinophilic cationic protein levels during the 8-wk study period in either group. There was a significant improvement in Asthma Quality of Life (AQOL) scores in both groups over the 8-wk study period. But the improvement was achieved earlier and was more complete in the yoga group. The number-needed-to-treat worked out to be 1.82 for the total AQOL score. An improvement in total AQOL score was greater than the minimal important difference and the same outcome was achieved for the sub-domains of the AQOL. The frequency of rescue medication use showed a significant decrease over the study period in both the groups. However, the decrease was achieved relatively earlier and was more marked in the yoga group than in the control group. The present
randomized controlled trial has demonstrated that adding the mind-body approach of yoga to the predominantly physical approach of conventional care results in measurable improvement in subjective as well as objective outcomes in bronchial asthma. The trial supports the efficacy of yoga in the management of bronchial asthma. However, the preliminary efforts made towards working out the mechanism of action of the intervention have not thrown much light on how yoga works in bronchial asthma.

Yoga breathing is an important part of health and spiritual practices in Indo-Tibetan traditions. Considered fundamental for the development of physical well-being, meditation, awareness, and enlightenment, it is both a form of meditation in itself and a preparation for deep meditation. Yoga breathing (pranayama) can rapidly bring the mind to the present moment and reduce stress. In this paper, Brown and Gerbarg (2009) reviewed data indicating how breath work can affect longevity mechanisms in some ways that overlap with meditation and in other ways that are different from, but that synergistically enhance, the effects of meditation. They also provided clinical evidence for the use of yoga breathing in the treatment of depression, anxiety, post-traumatic stress disorder, and for victims of mass disasters. With the review the authors concluded that by inducing stress resilience, breath work enables us to rapidly and compassionately relieve many forms of suffering.

Breathing exercises practiced in various forms of meditations such as yoga may influence autonomic functions. This may be the basis of therapeutic benefit to hypertensive patients. Therefore, Mourya et al., (2009) conducted a 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. 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 pressor 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.

Joshi and Telles (2009) conducted a study to compare the P300 event-related potentials recorded before and after (1) high-frequency yoga breathing (HFYB) and (2) breath awareness. The P300 was recorded in participants of two groups before and after the intervention session (1 minute in duration). All participants were receiving yoga training in a residential yoga center, Swami Vivekananda Yoga Research Foundation in Bangalore, India. Thirty (30) male participants formed two groups (n = 15 each) with comparable ages (within an age range of 20-35 years) and comparable experience of the two techniques, the minimum experience being 3 months. The two groups were each given a separate intervention. One group practiced a HFYB at a frequency of approximately 2.0 Hz, called kapalabhati. The other group practiced breath awareness during which participants were aware of their breath while seated, relaxed. The P300 event-related potential, which is generated when attending to and discriminating between auditory stimuli, was recorded before and after both techniques. The P300 peak latency decreased after HFYB and the P300 peak amplitude increased after breath awareness. Both practices (HFYB and Breath awareness), though very different, influenced the P300. HFYB reduced the peak latency, suggesting a decrease in time needed for this task, which requires selective attention. Breath awareness increased the P300 peak amplitude, suggesting an increase in the neural resources available for the task.
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 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.

Swami, Singh and Gupta (2010) conducted study to see any effect on respiratory functions in hypothyroid patients after pranayama (yoga). The subjects for the study were 20 hypothyroid females, 39.70 +/- 8.27 years of mean age referred from medicine department of UCMS & G.T.B. Hospital.
Spiro metric recordings were taken with hypair (version-1.28). Baseline (first) recordings were taken when patient came for the first time. Patients came to yoga lab in physiology department for 21 days continuously where they were trained by the yoga instructors and then told to do pranayama at home and called at regular intervals after 7 days to see the compliance. The breathing exercises were done for 45 minutes everyday. After 6 months of pranayama second recording was taken and compared with the baseline. There were significant improvement in forced expiratory volume in first second (FEV1), Maximum voluntary ventilation (MVV) and Inspiratory Capacity (IC). Thus Pranayama and meditation has beneficial effect on pulmonary functions of hypothyroid patients along with conventional treatment.

Ahmed, Sau and Kar (2010) investigated how far the short term practice of yoga (30 and 60 days) for an hour daily can improve the respiratory function. Male subjects (n=50, age 30-50 years) were randomly selected. Respiratory parameters (FVC, FEV1, PEFR, FEF(25-75%) and MVV) were determined by using a multifunctional computerized spirometer. Yoga (posture and pranayamas) practice for a month produced no significant improvement in pulmonary parameters. Nevertheless, when the subjects continued it for next 30 days, i.e., after 60 days significant changes were noted in FVC (p<0.001), FEV, (p<0.01) and PEFR (p<0.05). The result also revealed that amongst them 30 days yoga training resulted in a significant increase in FVC in elder group of people (age 41-50 yrs) where as in younger group (age 30-40 yrs) the changes were not so prominent. Result indicated that short term (30 days) yoga practice quickly improves respiratory functions in relatively elder people (age 41-50 yrs), when many of them in our tropical country suffer from primary level of respiratory problem. Regular practice of Yoga (posture and pranayamas) can prevent it by increasing the efficacy of respiratory muscles.
The literature presented above could reveal that although many of us are not aware of nostril breathing, it has direct relation to our physiological functioning. Yogic literature also claims that controlled nostril breathing works as a purificatory process. The studies also revealed that breath holding reduces the nasal resistance while hyperventilation causes an increase in the nasal congestion. A relationship has also been reported between the controlled breathing and healthy organic functions. All these literatures, presented above, support to formulate a hypothesis that consideration of pranayamic breathing may play an important role in achieving better level of circulo-respiratory functions. The present study, therefore, is an attempt to verify whether pranayama, as suggested by our ancient literature can play any role in achieving circulo-respiratory functions of collegiate students.