Review Article

Physiological Effects of Yogic Practices and Transcendental Meditation in Health and Disease

P A Balaji, Smitha R Varne[1], Syed Sadat Ali

Department of Physiology, Dr. B R Ambedkar Medical College, [1]Yoga Therapist/Instructor at Healing Touch Yoga Centre, and Nutrition Consultant at Heart Centre and Nagal Diagnostics, Bangalore, Karnataka, India

Abstract

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

Keywords: Health, Obesity, Pranayama, Transcendental Meditation, Yoga

Address for correspondence: Dr. Syed Sadat Ali, Department of Physiology, Dr. B R Ambedkar Medical College, Kadugondana Halli, Bangalore, Karnataka, India. E-mail: drsadatali@gmail.com

Introduction

Yoga is a psycho-somatic-spiritual discipline for achieving union and harmony between our mind, body, and soul and the ultimate union of our individual consciousness with the universal consciousness.[1] Pranayama is derived from two Sanskrit words, namely, prana, which means vital force or life energy, ayama means to prolong.[2]

Transcendental meditation (TM) is one of the techniques of meditation, which involves allowing the mind to dwell on a series of words (called a mantra) given by the meditation teacher, with no effort. If the attention wanders it is allowed to wander till it returns to the mantra.[2]

When a person practices yoga, with yogic attitude (attitude of patience, persistent practice, overcoming obstacles within self, that is, trouncing laziness, anger, delusion, and desire for being different or better than others), there are several changes in physiology.[2] In order to provide a general overview and understanding, we performed a Medline search to review relevant articles in English literature on physiological effects of yogic practices including pranayama and TM. Data were constructed and issues were reviewed from there.

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Schools of Yoga

Yoga is not only popular in India but also in Western countries. Example: Hatha yoga has become popular in North America in recent years.[3] In India, the widely practiced ones are hatha yoga, raja yoga, jnana yoga, integral yoga, karma yoga, bhakti yoga, mantra yoga, kundalini yoga, sahaja yoga, laya yoga, and many more. Hatha yoga includes practice of asanas, pranayamas, and kriyas (purification techniques including breathing cleansing techniques and shatkarmas—six groups of purification practices). Around 900 BC, the ancient sage Patanjali evolved the eight stages of yoga which is called as ashtanga yoga. As such, integral yoga incorporates hatha yoga, meditation, and pranayama. In the Indian subcontinent, integral yoga is also known as yoga of transformation.[2]

Physiological Basis Underlying the Effects of Yogasanas, Pranayamas, and TM

(a) Rejuvenation/regeneration of cells of pancreas due to abdominal stretching during yoga exercise, which may increase utilization and metabolism of glucose in peripheral tissues, liver, and adipose tissues through enzymatic process.[4,5] (b) More active practices followed by relaxing ones lead to deeper relaxation than relaxing practices alone, documented by research from Swami Vivekananda yoga research foundation near Bangalore city and possibility of neuroplasticity bringing about changes in the hypo-pituitary–pancreatic axis.[6] (c) Muscular relaxation, development and improved blood supply to muscles might enhance insulin receptor expression on muscles causing increased glucose uptake by muscles and thus reducing blood sugar.[7] (d) The improvement in the lipid levels after yoga could be due to increased hepatic lipase and lipoprotein lipase at cellular level, which affects the metabolism of lipoprotein and thus increase uptake of triglycerides by adipose tissues.[8,9]

Yoga postures can lead to improvement in the sensitivity of the b-Cells of the pancreas to the glucose signal and also the improvement in insulin sensitivity in turn can be due to the cumulative effect of performing the postures.[10]

Direct stimulation of the pancreas by the postures can rejuvenate its capacity to produce insulin.[11] Regeneration of pancreatic beta cells could occur by yoga exercises that promote blood circulation in the region of the pancreas and yoga asanas that stimulate the meridian of pancreas also could assist in some diabetic patients.[12]

Pranayama practices, stretches the lung tissue producing inhibitory signals from action of slowly adapting receptors and hyperpolarising currents. These inhibitory signals coming from cardiorespiratory region involving vagi are believed to synchronize neural elements in the brain leading to changes in the autonomic nervous system; and a resultant condition characterized by reduced metabolism and parasympathetic dominance.[13]

Pranayama modified various inflatory and deflatory lung reflexes and interact with central neural element to bring new homeostasis in the body.[2]

TM seems to influence through modifying activity of ascending reticular activating system and thereby also interact with autonomic centers in the brainstem thus affecting cardiorespiratory and metabolic parameters.[14] Higher melatonin levels could be one mechanism through which the claimed health promoting effects of meditation occur.[15]

Effects of Transcendental Meditation

In a study conducted to know the anatomical correlates of long-term meditation, researchers found significantly larger gray matter volumes in meditators in the right orbito-frontal cortex, right thalamus and left inferior temporal gyrus.[16]

In a comparative study, the effects of sahaja yoga meditation on Electroencephalogram (EEG) in patients of major depression and healthy subjects found an increase in alpha activity in both the groups after 2 months practice of Sahaja yoga meditation.[17] In another study cyclic meditation enhanced cognitive processing underlying generation of the P300.[18]

A study involving Western meditators with 9.1 ± 7.1 years of meditation experience and practiced 6.2 ± 4.0 h per week demonstrated with structural changes using Kolmogorov–Smirnoff statistics (one-tailed, α-level $P = 0.05$), indicated significant differences in the 'distribution' of thickness between groups across both hemispheres in areas of the brain that are important for sensory, cognitive, and emotional processing.[19]

A study conducted in Denmark observed higher gray matter density in lower brain stem regions of experienced meditators compared with age-matched nonmeditators and showed that long-term practitioners of meditation had structural differences in brainstem regions concerned with cardiorespiratory control.[20]

Another study conducted in Germany involving eight Buddhist monks and nuns with 5 years (SD 2 years) training in meditation practices demonstrated that practicing meditation enhanced the speed with which attention can be allocated and relocated thus, increased the depth of information processing and reducing response latency.[21]

A cross-sectional survey involving 347 responses demonstrated long-term Sahaja Yoga meditation practitioners experienced better quality of life (QOL) and functional health than the general population.[22]

Studies at Harvard medical school found a decrease in oxygen consumption (on an average decrease of 17%) from a mean of 251.2 ml/min before meditation to 211.4 ml/min during meditation. Minute ventilation decreased by about 1 L/min and respiratory rate decreased by about 3 breaths/min during meditation, though neither were statistically significant.[14] The average heart rate decreased during meditation by 3 beats/min. The skin resistance increased markedly at the onset of meditation and decreased after meditation but maintained higher than before meditation.[14] The most notable change

in EEG pattern during TM was an increase in the alpha amplitude and regularity, with occasional slow alpha and low voltage theta. Alpha blocking to sound and light was present, and did not show habituation. Based on the EEG findings along with above variables, TM could also be described as a wakeful hypo-metabolic state.[14]

Effects of Yoga

Nervous system

In a study to assess the immediate effect of three yoga breathing techniques on performance of a letter-cancellation task, the authors reported that there were improved scores and fewer errors on letter cancellation task and suggested that yoga practice could bring improvement in the task which requires selective attention, concentration, visual scanning abilities, and a repetitive motor response.[23] A study on performance of participants on mirror-tracing task found that yoga group had improved reversal ability, eye-hand co-ordination, speed and accuracy which were necessary for mirror star tracing.[24] In another study conducted to assess changes in p300 following two yoga-based relaxation techniques reported a reduction in the peak latencies of P300 after yoga based relaxation technique and indicated that yogic meditation enhances cognitive processes underlying the generation of P300.[18]

Left-sided unilateral forced nostril breathing led to right-hemisphere dominance and improved spatial skills while maneuver on opposite side showed left hemisphere dominance with improved verbal skills.[25] Practicing asanas, pranayama, meditation, and tratakas (concentrated gazing practices), and attending devotional sessions for 10 days led to a significant improvement in fine coordinated movements.[26] Yoga practices for a month not only led to a reduced degree of optical illusion created by muller-lyer lines and raised the critical fusion frequency but also improved neural performance, higher critical fusion frequency indicating reduced fatigue and stress level.[27]

Respiratory system

In a randomized controlled trial (RCT) conducted on 57 adult subjects with mild or moderate bronchial asthma, there was a steady and progressive improvement in pulmonary functions, the change being statistically significant in case of forced expiratory volume in first second (FEV1) volume at 8 week, and peak expiratory flow rate at 2, 4, and 8 weeks as compared with the corresponding baseline value and also a significant reduction in exercise induced bronchoconstriction as well as in Asthma Quality of Life (AQOL) scores in the yoga group compared with control group.[28]

A study with a quest whether yoga could reduce the basic problem in asthma (i.e., airway hyper responsiveness), showed improvement on subjective measures as well as airway hyper responsiveness to methacholine after sahaja yoga meditation.[29]

In a setup of randomized, double-blind, crossover trial design there was a significant increase in the dose of histamine needed to provoke a 20% reduction in FEV1 during yoga breath, but not with the control.[30] Yoga group, compared with control group, showed greater improvement in scores for drug treatment, peak flow rate, and decreased weekly attacks of asthma, following 2 weeks of yoga practice.[31] Yogic exercise group showed maximum improvement in respiratory function when compared with that improved by national defense training.[32]

In a RCT conducted at All India Institute of Medical Sciences, Delhi, India, showed that adding a comprehensive yoga-based mind-body intervention to the conventional treatment improved several measures of pulmonary function in subjects having mild to moderate bronchial asthma, a decrease in exercise-induced bronchoconstriction in the yoga group, particularly in the exercise-sensitive subjects. Yoga improved the QOL and reduced rescue medication use in bronchial asthma, and achieved the reduction earlier than conventional treatment alone.[28]

Yoga training produced statistically significant ($P < 0.05$) increase in FEV, FEV1, peak expiratory flow rate (PEFR) also increased significantly ($P < 0.01$) after the yoga training. In contrast, the increase in these parameters in the control group were statistically not significant and demonstrated that yoga training for 6 months improved lung function, strength of inspiratory and expiratory muscles among school children aged 12–15 years. It is suggested that yoga be introduced at school level in order to improve physiological functions, overall health, and performance of students.[33]

In a study conducted in United States of America involving 22 patients suffering from chronic obstructive pulmonary disease (COPD) subjected to selected yoga exercises including breathing exercises, meditation, and yoga postures for 1 h, thrice a week for 6 weeks showed statistically significant improvements ($P < 0.05$) for the St. George Respiratory questionnaire [95% confidence interval (CI) 43.13–58.47], vital capacity (95% CI 2.53–7.65), maximal inspiratory pressure (95% CI 6.62–23.64), and maximal expiratory pressure (95% CI 1.63–13.81) thereby improved QOL and lung function on a short-term basis.[34]

In another RCT conducted at Brazil, the elderly healthy population had improved respiratory function and sympathovagal balance after yoga respiratory exercises.[35]

Cardiovascular system

In a prospective cohort study involving thirty three subjects with (30%) and without (70%) established coronary artery disease (CAD) subjected to a course in yoga and meditation showed significant reductions in blood pressure, heart rate, and body mass index (BMI).[36]

Another prospective, controlled, open trial including angiographically proved coronary artery disease patients showed yoga-based lifestyle modifications helped in regression of coronary lesions and in improving myocardial perfusion which was translated into clinical benefits and symptomatic improvement.[37]

Six healthy Asian Indian men and women (18–22 years) who were trained in Surya namaskar (sun salutation) for over 2 years participated in the study showed that regular practice of Surya namaskar might maintain or improve cardiorespiratory fitness, as well as promote weight management.[38]

An interventional study showed beneficial effects of short term (15 days) regular pranayama and meditation practice on cardiovascular functions (reduction in resting pulse rate, systolic blood pressure, diastolic blood pressure, and mean arterial blood pressure) irrespective of age, gender, and BMI in normal healthy individuals.[39]

A study involving 50 healthy male subjects of 18–25 years age group, subjected to Mukh Bhastrika (yogic bellows), a type of pranayama breathing training for 12 weeks showed an increase in parasympathetic activity, that is, reduced basal heart rate, increase in valsalva ratio and deep breathing difference in heart rate; and reduction in sympathetic activity, that is, reduction in fall of systolic blood pressure on posture variation.[40]

A study conducted in northern Mexico involving four middle-aged and nine older conventional hatha yoga (CHY) practicing females subjected to 11-week intensive hatha yoga (IHY) program consisting of 5 sessions/week for 90 min (55 sessions) demonstrated improved cardiovascular risk factors (namely maximal O2 consumption -VO_{2max} and high density lipoprotein cholesterol [HDL-C]) in middle-aged and older women.[41]

In a parallel-arm RCT involving 67 sedentary office workers subjected to a 10-week, worksite-based yoga program delivered during lunch hour demonstrated improved resting heart rate variability (HRV) and related physical and psychological parameters.[42]

Diabetes

In an interventional research involving 98 subjects found fasting blood sugar (FBS), serum total cholesterol, low density lipoproteins (LDL), very low density lipoproteins (VLDL), the ratio of total cholesterol to HDL-C, and total triglycerides were significantly lower, and HDL-C significantly higher, on the last day of the course compared with the first day of the 8-days course.[43]

A comparison of yoga practice with physical training showed that yoga practice for 6 months reduced fasting blood glucose, lipid levels, markers of oxidative stress, while physical training also decreased fasting blood glucose but had few of the other beneficial effects.[44]

In a study, 44 type 2 diabetic patients were taught yoga (n = 22) and pranayama for three continuous months, 1 h every day in the morning by yoga expert had significant decrease in FBS, Postprandial blood sugar (PPBS), glycosylated hemoglobin (HbA1c), triglycerides and LDL of test group with $P < 0.001$, compared with control group (n = 22). The requirement of insulin in the yoga group was also significantly reduced.[45]

In a study involving 20 patients with type 2 diabetes mellitus were subjected to 40 days yoga routine by an expert yoga teacher. The postures performed were: Surya namaskar (sun salutation), Trikonasana (triangle pose), Tadasana (mountain pose), Padmasana (lotus pose), Bhastrika Pranayama (breathing exercise), Pashimottanasana (posterior stretch), Ardhmatsyendrasana (half spinal twist), Pawanmuktasana (joint freeing series), Bhujangasana (cobra pose), Vajrasana (thunderbolt pose), Dhanurasana (bow pose), and Shavasana (corpse pose). At the end of 40 days of performing the asanas, the study participants had a significant decrease in fasting glucose levels, waist–hip ratio and beneficial changes in insulin levels.[46]

Obesity

An observational study involving long-term yoga practitioners showed that a consistent, long-term Hatha yoga practice in a nonprobability sample of women over 45 years was linearly associated with declines in BMI even after correcting for nonyogic exercise hours and processed food consumption.[47] In a study involving 16 postmenopausal women with more than 36% body fat divided into yoga exercise group and control group, yoga group showed improved adiponectin level, serum lipids, and metabolic syndrome risk factors in obese postmenopausal women.[48]

A retrospective study involving 15,550 adults aged 53–57 years, found that regular yoga practice for 4 years or more was associated with attenuated weight

gain, especially among people who were overweight.[49] A week of intensive yoga course reduced the BMI as well as waist and hip circumference, decreased total cholesterol, improved posture, and stability.[50]

In a RCT involving 23 adults, the yoga group subjected to a 3-month yoga intervention of twice weekly yoga sessions and the education group received health information every 2 weeks. At the end of the study, the yoga group showed improvements in weight, blood pressure and insulin, when compared with the education group.[51]

In another RCT using a two-group, parallel design in individuals with coronary heart disease and the metabolic syndrome demonstrated significant difference in adjusted systolic blood pressure at the end of the study in the TM group versus the health education group ($P = 0.04$) and improved plasma glucose and insulin levels in the TM group versus the health education group at the conclusion of the study period ($P = 0.01$).[52]

Arthritis

A randomized controlled study to evaluate the efficacy of integrating hatha yoga therapy with therapeutic exercises for osteoarthritis (OA) showed that there were significant differences within (Wilcoxon's, $P < 0.001$) and between the yoga and control groups (Mann–Whitney U, $P < 0.001$) on all the studied variables, with better improvements in the yoga than the control groups.[53]

In a pilot study involving 27 women with musculoskeletal problems such as OA subjected to undergo 8 sessions (twice weekly for 4 weeks) of a yoga program indicated that poststudy values of patients' gait parameters were found to be statistically higher than their pre-study values ($P < 0.05$).[54] There was a decrease in the rheumatoid factor levels along with less pain and better function following a week of yoga.[55] Another pilot study involving 12 sessions of yoga for rheumatoid arthritis (RA) demonstrated statistically significant improvements in RA.[56] Sixteen postmenopausal women with RA subjected to three 75-min yoga classes a week over a 10-week period showed a significant decrease in Health assessment Questionnaire disability index, perception of pain and depression, and improved balance.[57]

Cancer

A new term, restorative yoga (This is a gentle, therapeutic style of Yoga that uses props to support the body to deepen the benefits of the poses. It is a soothing and nurturing practice that promotes the effects of conscious relaxation)[58] has been used to describe a gentle form of yoga which help females with ovarian or breast cancer to reduce depression as well as anxiety state, and better mental health and overall QOL. There was also a decrease in fatigue.[59] Yoga also helped patients with cancer to deal with distressful symptoms and treatment related toxicity of chemotherapy.[60] Yoga could influence immune system, especially increasing the natural killer cells.[61] Radiation causes DNA damage and yoga practice could reduce the damage.[62] Increased survival time were obtained by the association between neuroimmunotherapy with melatonin plus IL-2 and kriya yoga program (2 years), which was significantly longer with respect to that achieved by supportive care alone, Yoga alone, or IL-2 plus melatonin alone (1 year).[63]

Immunity

A study carried out on 60 first-year MBBS students randomly assigned to yoga group and control group (30 each). The yoga group underwent integrated yoga practices for 35 min daily in the presence of trained yoga teacher for 12 weeks. Control group did not undergo any kind of yoga practice or stress management. It was observed that the serum IFN-γ levels decreased with examination stress. Decreased serum IFN-γ levels indicate decline in cellular immunity. The decrease in serum IFN-γ in yoga group was less significant compared with that in the control group which indicated a decline in cellular immunity with examination stress more among the control group than the yoga group students.[64]

In another study, Yoga practice in patients suffering from pulmonary tuberculosis potentiated the body immunity and action of antitubercular drugs thereby improving sputum culture, radiography, Forced Vital Capacity (FVC), weight gain and symptoms.[65] Yoga postures that twist and compress organs, help massage and rejuvenate immune organs. Kurmasana (tortoise pose) which supports the thymus gland could create specific benefits to improve immune function.[66]

Conclusion

The various avenues of study of yoga practices reviewed in the present article indicated considerable health benefits, including improved cognition, respiration, reduced cardiovascular risk, BMI, blood pressure, and diabetes mellitus. It also influenced immunity and ameliorated joint disorders.

Despite extensive searches, recent research articles in sighting the Physiological basis underlying the effects of yogasanas, pranayamas and TM were limited. Further researches exploring the effects of yoga on different organ systems would be invaluable.

References

1. Madanmohan, Mahadevan SK, Balakrishnan S,

Gopalakrishnan M, Prakash ES. Effect of 6 wks yoga training on weight loss following step test, respiratory pressures, handgrip strength and handgrip endurance in young healthy subjects. Indian J Physiol Pharmacol 2008;52:164-70.

2. Tandon OP. Yoga and its applications. In: Tandon OP, Tripathi Y, editors. Best and Taylor's Physiological Basis of Medical Practice. 13th ed. Gurgaon: Wolters Kluwer health/ Lippincott Williams and Wilkins publishers; 2012. p. 1217-30.
3. Junkin SE. Yoga and self-esteem: Exploring change in middle-aged women. (Accessed August 1, 2012, at http://connection.ebscohost.com/c/articles/25216420/yoga-self-esteem-exploring-change-middle-aged-women).
4. Dang KK and Sahay BK, Yoga and Meditation, Medicine update, volume 9, part 1, chapters 57 and 58(1999), p502-512. The Association of Physicians of India ed MM.Singh. APICON, The Association of Physicians of India conference, New Delhi.
5. Sahay BK and Murthy KJR, Long term follow up studies on effect of yoga in diabetes, Diab Res Clin Pract, 5(suppl.1)(1988) S655
6. McCall T. The Scientific Basis of Yoga Therapy. (Accessed Jun 16, 2012, at http://www.yogajournal.com/for_teachers/2016).
7. Chandratreya S. Diabetes & Yoga. (Accessed Jun 16, 2012, at http://www.yogapoint.com/therapy/diabetes_yoga.htm.
8. Delmonte MM. Biochemical indices associated with meditation practice: A literature review. Neurosci Biobehav Rev 1985;9:557-61.
9. Tulpule TH, Shah HM, Shah SJ, Haveliwala HK. Yogic exercises in the management of ischaemic heart disease. Indian Heart J 1971;23:259-64.
10. Manjunatha S, Vempati RP, Ghosh D, Bijlani RL, An investigation into the acute and long-term effects of selected yogic postures on fasting and postprandial glycemia and insulinemia in healthy young subjects. Indian J Physiol Pharmacol 2005;49:319-24.
11. Ramaiah SA. Yoga Therapy for Diabetes: Washington, D.C. Study, International Conference on Traditional Medicine, 1986, Madras. Published by Siddha Medical Board, Govt. of Tamil Nadu, Madras, India.
12. Yogalink. A community service donated by samyama yoga. (Accessed Jul 9, 2012, at http://www.yogalink.com.au).
13. Jerath RJ, Edry VA, Barnes VA, Jerath V. Physiology of long pranayamic breathing: Neural respiratory elements may provide a mechanism that explains how slow breathing shifts the autonomic nervous system. Med Hypotheses 2006;67:566-71.
14. Wallace RK, Benson H, Wilson AF. A wakeful hypo-metabolic physiological state. Am J Physiol 1971;221:795-9.
15. Tooley GA, Armstrong SM, Norman TR, Sali A. Acute increase in night time plasma melatonin levels following a period of meditation. Biol Psychol 2000;53:69-78.
16. Luders E, Toga AW, Lepore N, Gaser C. The underlying anatomical correlates of long-term meditation: Larger hippocampal and frontal volumes of gray matter. Neuroimage 2009;45:672-8.
17. Sharma VK, Das S, Mondal S, Goswami U, Gandhi A. Comparative effect of sahaj yoga on EEG in patients of major depression and healthy subjects. Biomedicine Journal 2007;27:95-9.
18. Sarang SP, Telles S. Changes in p300 following two yoga-based relaxation techniques. Int J Neurosci 2006;116:1419-30.
19. Lazar SW, Kerr CE, Wasserman RH, Gray JR, Greve DN, Treadway MT, *et al*. Meditation experience is associated with increased cortical thickness. Neuroreport 2005;16:1893-7.
20. Vestergaard-Poulsen P, van-Beek M, Skewes J, Bjarkam CR, Subberup M, Bertelsen J, *et al*. Long-term meditation is associated with increased gray matter density in the brain stem. Neuroreport 2009;20:170-4.
21. van Leeuwen S, Singer W, Melloni L. Meditation Increases the Depth of Information Processing and Improves the Allocation of Attention in Space. Front Hum Neurosci 2012;6:133.
22. Manocha R, Black D, Wilson L. Quality of life and functional health status of long-term meditators. Evid Based Complement Alternat Med 2012;2012:350674.
23. Sarang SP, Telles S. Immediate effect of two yoga-based relaxation techniques on performance in a letter cancellation task. Percept Mot Skills 2007;105:379-85.
24. Telles S, Praghuraj P, Ghosh A, Nagendra HR. Effect of a one-month yoga training program on performance in a mirror-tracing task. Indian J Physiol Pharmacol 2006;50:187-90.
25. Jella SA, Shannahoff-Khalsa DS. The effects of unilateral forced nostril breathing on cognitive performance. Int J Neurosci 1993;73:61-8.
26. Tells S, Hanumanthaiah BH, Nagarathna R, Nagendra HR. Plasticity of motor control systems demonstrated by yoga training. Indian J Physiol Pharmacol 1994;38:143-4.
27. Telles S, Nagarathna R, Vani PR, Nagendra HR. A combination of focusing and defocusing through yoga reduces optical illusion more than focusing alone. Indian J Physiol Pharmacol 1997;41:179-82.
28. Vempati R,Bijlani RL, Deepak KK. The efficacy of a comprehensive lifestyle modification programme based on yoga in the management of bronchial asthma: A randomized controlled trial. BMC Pulm Med 2009;9:37.
29. Manocha R, Marks GB, Kenchinton P, Peters D, Salomezzz CM. Sahaja yoga in the management of moderate to severe asthma: A randomized controlled trial. Thorax 2002;57:110-15.
30. Singh V, Wisniewski A, Briton J, Tattersfield A. Effects of yoga breathing exercises on airway reactivity in subjects with asthma. Lancet 1990;335:1381-3.
31. Nagarathna R, Nagendra HR. Yoga for bronchial asthma: A controlled study. Br Med J (Clin Res Ed) 1985;291:1077-9.
32. Nayar HS, Mathur RM, Kumar SR. Effects of yogic exercises on human efficiency. Indian J Med Res 1975;63:1369-76.
33. Reddy TP. Effect of yoga training on handgrip, respiratory pressures and pulmonary function. Br J Sports Med 2010;44:i68.
34. Fulambarker A, Farooki B, Kheir F, Copur AS, Srinivasan L, Schultz S. Effect of yoga in chronic obstructive pulmonary disease. Am J Ther 2012;19:96-100.
35. Santaella DF, Devesa CR, Rojo MR, Amato MB, Drager LF, Casali KR, *et al*. Yoga respiratory training improves respiratory function and cardiac sympathovagal balance in elderly subjects: A randomised controlled trial. BMJ Open 2011;1:e000085.
36. Sivasankaran S, Pollard-Quintner S, Sachdeva R, Pugeda J, Hoq SM, Zarich SW. The effect of a six-week program of yoga and meditation on brachial artery reactivity: Do psychosocial interventions affect vascular tone? Clin Cardiol 2006;29:393-8.
37. Yogendra J, Yogendra HJ, Ambardekar S, Lele RD, Shetty S, Dave M, *et al*. Beneficial effects of yoga lifestyle on reversibility of ischaemic heart disease: Caring heart project of International Board of Yoga. J Assoc Physicians India 2004;52:283-9.
38. Mody BS. Acute effects of Surya Namaskar on the cardiovascular & metabolic system. J Bodyw Mov Ther 2011;15:343-7.

39. Ankad RB, Herur A, Patil S, Shashikala GV, Chinagudi S. Effect of Short-Term Pranayama and Meditation on Cardiovascular Functions in Healthy Individuals. Heart Views 2011;12:58-62.
40. Veerabhadrappa SG, Baljoshi VS, Khanapure S, Herur A, Patil S, Ankad RB *et al*. Effect of yogic bellows on cardiovascular autonomic reactivity. J Cardiovasc Dis Res 2011;2:223-7
41. Ramos-Jimenez A, Hernandez-Torres RP, Wall-Medrano A, Munoz-Daw MD, Torres-Duran PV, Juarez-Oropeza MA. Cardiovascular and metabolic effects of intensive Hatha Yoga training in middle-aged and older women from northern Mexico. Int J Yoga 2009;2:49-54.
42. Cheema1 BS, Marshall PW, Chang D, Colagiuri B, Machliss B. Effect of an office worksite-based yoga program on heart rate variability: A randomized controlled trial. BMC Public Health 2011;11:578.
43. Bijlani RL, Vempati RP, Yadav RK, Ray RB, Gupta V, Sharma R, *et al*. A brief but comprehensive lifestyle education program based on yoga reduces risk factors for cardiovascular disease and diabetes mellitus. J Altern Complement Med 2005;11:267-74.
44. Gordon LA, Morrison EY, McGrowder DA, Young R, Fraser YT, Zamora EM, *et al*. Effect of exercise therapy on lipid profile an oxidative stress indicators in patients with type 2 diabetes. BMC Complement Altern Med 2008;8:21.
45. Balaji PA, Varne SR, Sadat-ali S. Effects of yoga - pranayama practices on metabolic parameters and anthropometry in type 2 diabetes. International Multidisciplinary Research Journal 2011;1:1-4.
46. Malhotra V, Singh S, Tandon OP, Sharma SB, The beneficial effect of yoga in diabetes. Nepal Med Coll J 2005;7:145-7.
47. Moliver N, Mika EM, Chartrand MS, Burrus S, Haussmann RE, Khalsa S. Increased Hatha yoga experience predicts lower body mass index and reduced medication use in women over 45 years. Int J Yoga 2011;49:77-86.
48. Lee JA, Kim JW, Kim DY. Effects of yoga exercise on serum adiponectin and metabolic syndrome factors in obese postmenopausal women. Menopause 2012;19:296-301.
49. Kristal AR, Littman AJ, Benitez D, White E. Yoga practice is associated with attenuated weight gain in healthy, middle-aged men and women. Altern Ther Health Med 2005;11:28-33.
50. Telles S, Naveen KV, Balakrishna A, Kumar S. Short term health impact of a yoga and diet change program on obesity. Med Sci Monit 2010;16:35-40.
51. Yang K, Bernardo LM, Sereika SM, Conroy MB, Balk J, Burke LE, *et al*. Utilization of 3-Month Yoga Program for Adults at High Risk for Type 2 Diabetes: A pilot study. Evid Based Complement Alternat Med 2011;2011:257891.
52. Paul-Labrador M, Polk D, Dwyer JH, Velasquez I, Nidich S, Rainforth M, *et al*. Effects of a randomized controlled trial of transcendental meditation on components of the metabolic syndrome in subjects with coronary heart disease. Arch Intern Med 2006;166:1218-24.
53. Ebnezar J, Nagarathna R, Yogitha B, Nagendra HR. Effects of an integrated approach of hatha yoga therapy on functional disability, pain, and flexibility in osteoarthritis of the knee joint: A randomized controlled study. J Altern Complement Med 2012;18:463-72.
54. Ulger O, Yağlı NV. Effects of yoga on balance and gait properties in women with musculoskeletal problems: A pilot study. Complement Ther Clin Pract 2011;17:13-5.
55. Telles S, Naveen KV, Gaur V, Balakrishna A. Effect of one week of yoga on function and severity in rheumatoid arthritis. BMC Res Notes 2011;4:118.
56. Badsha H, Chhabra V, Leibman C, Mofti A, Kong KO. The benefits of yoga for rheumatoid arthritis: Results of a preliminary, structured 8-week program. Rheumatol Int 2009;29:1417-21.
57. Bosch PR, Traustadóttir T, Howard P, Matt KS. Functional Physiological effects of yoga in women with rheumatoid arthritis: A pilot study. Altern Ther Health Med 2009;15:24-31.
58. Restorative Yoga. (Accessed Jul 7, 2012, at http://www.santosha.com/restorative-yoga.html).
59. Danhauer S, Tooze JA, Farmer DE, Campbell CR, McQuellon RP, Barrett R, *et al*. Restorative yoga for women with ovarian or breast cancer: Findings from a pilot study. J Soc Integr Oncol 2008;6:47-58.
60. Raghavendra RM, Nagarathna R, Nagendra HR, Gopinath KS, Srinath BS, Ravi BD, *et al*. Effects of an integrated yoga programme on chemotherapy-induced nausea and emesis in breast cancer patients. Eur J Cancer Care (Engl) 2007;16:462-74.
61. Kochupillai V, Kumar P, Singh D, Aggarwal D, Bhardwaj N, Bhutani M, *et al*. Effect of rhythmic breathing (Sudarshan Kriya and Pranayama) on immune functions and tobacco addiction. Ann N Y Acad Sci 2005;1056:242-52.
62. Banerjee B, Vadiraj HS, Ram A, Rao R, Jayapal M, Gopinath KS, *et al*. Effects of an integrated yoga program in modulating psychological stress and radiation-induced Genotoxic stress in breast cancer patients undergoing radiotherapy. Integr Cancer Ther 2007;6:242-50.
63. Messina G, Anania S, Bonomo C, Veneroni L, Andreoli A, Mameli F. The importance of spirituality in supportive care. Int J Yoga 2011;4:33-8.
64. Gopal A, Mondal S, Gandhi A, Arora S, Bhattacharjee J. Effect of integrated yoga practices on immune responses in examination stress - A preliminary study. Int J Yoga 2011;4:26-32.
65. Visweswaraiah NK, Telles S. Randomized trial of yoga as a complementary therapy for pulmonary tuberculosis. Respirology 2004;9:96-101.
66. Arora S, Bhattacharjee J. Modulation of immune responses in stress by Yoga. Int J Yoga 2008;1:45-55.

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