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Exploring the Physiological Effects of Yoga: A State of the Art Review

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Abstract

The objective of this study is to review the results of selected articles regarding the physiological effects of Yoga and Diet counseling. According to B.K.S. Iyengar, yoga is an ancient Indian science which includes all aspects of one's being, from health to self-realization. Yoga is self-management of life, which includes changes in diet, mental attitude and the practice of specific techniques such as yoga asanas (postures), breathing practices (pranayamas), meditation, to attain the highest level of consciousness. There is an increase in scientific research on yoga, but we do find very few reviews regarding yogic practices and diet counseling in health and disease. Keeping this in mind, review of relevant articles was done to evaluate the physiological effects of yogic practices and diet counseling. Review found that there were considerable health benefits, including improved sleep pattern, cognition, body mass index, reproductive health, respiration, blood pressure, joint disorders, diabetes and recovery from and treatment of addiction. It reduced stress, anxiety, depression, chronic pain, cardiovascular and cancer risk. Yoga also influenced overall well-being, quality of life, autonomic function and immunity. Therefore Yoga and Diet counseling is a novel emerging clinical discipline of mind-body medicine which is increasingly used worldwide under alternative medicine.

Keywords: asana, pranayama, meditation, cognition, body mass index, mind-body medicine

Introduction

Complementary and alternative medicine (CAM) is a rapidly evolving field of medicine that consists of therapy used as an alternatives or adjuncts to conventional medicines/therapy. The National Center for Complementary and Alternative Medicine (NCCAM) ^[1] defines CAM as 'a group of diverse medical and health care systems, practices, and products that are not presently considered to be part of conventional medicine. A vast array of CAM therapies are have been broadly divided by the NCCAM into: biologically based therapies (e.g. herbs, aromatherapy, dietary supplement use, oxygen therapy), mind-body interventions (e.g. yoga, hypnotherapy, art therapy), energy therapies (e.g. Reiki, Tai Chi), manipulative and body based methods (e.g. chiropractic, reflexology) and alternative medical systems (e.g. homeopathy, Chinese herbal medicine, naturopathy). ^[1] The CAM therapies include major therapeutic lifestyle changes (TLCs) which are accessible, effective and cost effective when used alone or adjunctively ^[2, 3]. TLCs offer improvements in physical health, self-esteem, and quality of life. ^[4] Some TLCs—for example, exercise, diet, yoga and meditation are enjoyable and may therefore become healthy self-sustaining habits. ^[5] It may also be neuroprotective and reduce the risk of subsequent age-related cognitive losses and corresponding neural shrinkage. ^[6-8] Healthy lifestyle behaviors that encompass regular exercise, weight control and healthy nutrition, have the potential to greatly reduce cancer-treatment-associated morbidity and mortality in cancer survivors and can enhance quality of life. ^[9] Yoga may improve health through down regulation of the hypothalamo pituitary adrenal axis and the sympathetic nervous system. Exercise and nutritional counseling may benefit the metabolic and reproductive abnormalities associated with PCOS (Polycystic Ovary Syndrome). ^[10] Broad dietary advice (i.e. low intake of sodium chloride, saturated fat and energy), implemented by a nutritionist, may have a significant effect in uncomplicated, mild-to-moderate life style diseases. Dietary and possibly other lifestyle habits are strongly influenced by experiences and role models in childhood, suggesting that dietary interventions should probably always target

Whole families, e.g. in primary prevention of CHD (Coronary Heart Disease).^[11] Therefore there is a need for non-pharmacologic treatment e.g. yoga and diet counseling in uncomplicated lifestyle diseases. Although documented scientific evidence strongly indicates that yoga has promotive, preventive as well as curative potential but further studies are needed to examine how far the results of the present researches are valid for those having life style diseases.

Physiological Basis of Yoga

- a) Deeper relaxation during yoga may lead to neuroplasticity, changes in the hypo-pituitary–pancreatic axis and sympathetic nervous system ^[12].
- b) Pranayama, stretches the lung tissue producing inhibitory signals from cardio-respiratory region involving vagi, due to the action of slowly adapting receptors and hyperpolarizing currents. These inhibitory signals may lead to changes in the autonomic nervous system; and reduced metabolism and parasympathetic dominance ^[13]. Pranayama may modify various inflatory and deflatory lung reflexes and interact with central neural element to modify homeostasis ^[14].
- c) Regeneration of pancreatic cells during yoga may increase utilization and metabolism of glucose in peripheral tissues, liver, and adipose tissues ^[15, 16] Yoga 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 ^[17] Direct stimulation of the pancreas by the postures can rejuvenate its capacity to produce insulin ^[18]
- d) 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 ^[19].
- e) Yoga can lead to improved lipid levels which could be due to increased hepatic lipase and lipoprotein lipase at cellular level and increase uptake of triglycerides by adipose tissues ^[20, 21].
- f) Meditation seems to modify activity of ascending reticular activating system and autonomic centers in the brainstem thus affecting cardio-respiratory and metabolic parameters ^[22].
- g) A study observed higher gray matter density in lower brain stem regions of experienced meditators compared with age-matched non-meditators and experienced meditators had structural differences in brainstem regions with cardio-respiratory control ^[23]
- h) Practicing meditation enhanced the speed with which attention can be allocated and relocated thus, increased the depth of information processing and reducing response latency ^[24].
- i) The skin resistance increased markedly at the onset of meditation and decreased after meditation but maintained higher than before meditation ^[22].
- j) Higher melatonin levels could be one mechanism through which the claimed health promoting effects of meditation occur ^[25].

Effects of Yoga on different systems of Human Body

Nervous System: Yoga showed a significant reduction in the markers of intrinsic neurohormonal activity such as urinary excretion of catecholamines, aldosterone, as well as serum testosterone and luteinizing hormone levels. It also showed an increase in the urinary excretion of cortisol ^[26]. Relaxation exercises in Yoga reduced sympathetic activity with a

reduction in heart rate, skin conductance, oxygen consumption, and increase in breath volume, thus protecting against ischemic heart disease and myocardial infarction ^[27]. Yoga improves selective attention, concentration, visual scanning abilities, a repetitive motor response ^[28], reversal ability, eye-hand co-ordination, speed and accuracy ^[29]. Yogic meditation enhances cognitive processes underlying the generation of P300 ^[30]. 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 ^[31]. Practicing Yogic asanas improved fine coordinated movements ^[32]. And neural performance as well as higher critical fusion frequency indicating reduced fatigue and stress level ^[33].

Cardiac System: Yoga significantly decreased oxygen consumption, heart rate and diastolic blood pressure ^[34] It has been shown to be effective in the treatment of hypertension ^[35, 36] due to decrease in the frequency and intensity of proprioceptive and enteroceptive impulse traffic reaching the hypothalamus. Yoga helped in regression of coronary lesions, improving myocardial perfusion and symptomatic improvement in Angiographically proved coronary artery disease patients ^[37]. Pranayama breathing increased parasympathetic activity, i.e. reduced basal heart rate, increased valsalva ratio and deep breathing difference in heart rate; and reduced sympathetic activity, i.e. reduction in fall of systolic blood pressure on posture variation ^[38]. It improved cardiovascular risk factors (namely maximal O₂ consumption - VO_{2max} and high density lipoprotein cholesterol [HDL-C]) in middle-aged and older women ^[39]. Resting heart rate variability (HRV) and related physical and psychological parameters ^[40].

Respiratory System: In bronchial asthma patients, there was a steady and progressive improvement in pulmonary functions and significant reduction in exercise induced bronchoconstriction as well as in Asthma Quality of Life (AQOL) scores in the yoga group compared with control group ^[41]. It decreased exercise-induced bronchoconstriction in the yoga group, particularly in the exercise-sensitive subjects. ^[41]. Yoga improved the QOL and reduced rescue medication use in bronchial asthma, and achieved the reduction earlier than conventional treatment alone ^[42]. Yoga training produced statistically significant ($P < 0.05$) increase in FEV₁, FEV₁, peak expiratory flow rate (PEFR) also increased significantly ($P < 0.01$) after the yoga training.

Chronic obstructive pulmonary disease (COPD) patients subjected to yoga showed statistically significant improvements for the St. George Respiratory questionnaire, vital capacity, maximal inspiratory pressure, and maximal expiratory pressure, thereby improved QOL and lung function on a short-term basis ^[43]. The elderly had improved respiratory function and sympathovagal balance after yoga respiratory exercises ^[44]. Yoga practice results in a significant increase in maximum expiratory pressure, maximum inspiratory pressure, breath holding time after expiration, breath holding time after inspiration, and hand grip strength ^[45]. It resulted in improved ventilatory functions in the form of lowered respiratory rate, and increases in the forced vital capacity, forced expiratory volume at the end of first second, maximum voluntary ventilation, peak expiratory flow rate, and prolongation of breath holding time ^[46, 47]. An increase in inspiratory and

expiratory pressures suggests that yoga training improves the strength of expiratory and as well as inspiratory muscles.

Musculoskeletal System: Yoga improves dexterity, strength and musculoskeletal coordination of the practitioners. It involves co-ordinated action of synergistic and antagonistic muscles which brings increased steadiness, strength, stamina, flexibility, endurance, anaerobic power, better neuro-muscular coordination and improved orthostatic tolerance. Load bearing strengthens the bones and prevents age-related weakening, thus helping in prevention of osteoporosis. Yogic techniques are known to improve one's overall performance and work capacity [48]. Sharma *et al* [49] observed the effect of lifestyle intervention based on yoga, on subjective well-being in normal and diseased subjects. They reported significant improvement in the subjective well-being scores of 77 subjects within a period of 10 days as compared to controls. Therefore, even a brief intervention can make an appreciable contribution to primary prevention as well as management of lifestyle diseases. Oken *et al* [50] found that hatha yoga practices for by elderly resulted in significant improvement in quality of life and physical measures compared to walking exercise and wait-list control groups. Iyengar hatha yoga practice improved hip extension, increase stride length, and decrease anterior pelvic tilt in elderly and that yoga programs tailored to elderly adults may offer a cost-effective means of preventing or reducing age-related changes in these indices of gait function [51]

Reproductive System: Schmidt *et al* [52] reported a reduction in urinary excretion of adrenaline, noradrenaline, dopamine, and aldosterone, a decrease in serum testosterone and luteinizing hormone levels and an increase in cortisol excretion, indicating optimal changes in hormones. Narendran *et al* [53] observed that yoga practiced by pregnant women resulted in an increase in birth weight, decrease in preterm labor, and decrease in IUGR either in isolation or associated with PIH, with no increased complications. Women in their third trimester showed greater reductions in perceived stress and trait anxiety, [54]. Therefore yoga can be used to prevent or reduce obstetric complications.

Endocrine System: Practice of yoga leads to modulation of neuro-endocrine axis. Chaya *et al* [55] reported significant decrease in fasting plasma insulin in the yoga practitioners and is associated with increased insulin sensitivity and attenuation of the negative relationship between body weight or waist circumference and insulin sensitivity. Yogic asanas led to increased sensitivity of B cells of pancreas to the glucose signal [56]. Tooley *et al* [57] concluded that meditation can affect plasma melatonin levels resulting in health promoting effects of meditation. These observations suggest that yoga can be used to increase endogenous secretion of melatonin, which, in turn, might be responsible for improved sense of well-being.

Physiological Effects of Diet and Nutritional Counselling

There is now considerable evidence of the importance of nutrition for health, and researchers suggests that dietary factors are so important that the health of nations may be linked to them. The key principles for Diet counseling and TLCs are to emphasize a diet that

- 1) Consists predominantly of multicolored fruits and vegetables (a "rainbow diet").
- 2) Contains some fish (a "pescovegetarian diet"): Preference should be given to cold deep-seawater fish (e.g., salmon), which are high in beneficial omega-3 fish oils, while

avoiding the four species with high mercury levels (shark, swordfish, king mackerel, and tilefish) [58].

- 3) Reduces excessive calories: For societies confronting the "globesity" epidemic, reducing excess calories offers both economic and public health benefits [59]. For individuals, reducing excess calories offers medical and neuroprotective benefits [60]. This neuroprotection is especially important in light of recent findings suggesting that adult obesity may be associated with reduced cognitive function, as well as reduced white and gray-matter brain volume [61, 62]. Fortunately, pescovegetarian diets are low in calories.

Individual TLCs appear to counter many medical and psychological complications of contemporary pathogenic lifestyles. This raises a hopeful possibility: May be multiple TLCs will be even more effective and additive? There is evidence for this possibility in both animal studies and clinical medicine. For example, physical activity increases neurogenesis in the rat hippocampus. However, the effect is maximal only when the animals are exposed to a rich social environment rather than living in isolation [63]. Similarly, in his program to reverse coronary arteriosclerosis, Dean Ornish employed four TLCs - exercise, vegetarian diet, relaxation and stress management, and social support. Each proved beneficial, and the effects were additive [64]. This might also be true for other lifestyle disorders? Quite possibly, but as yet we have no clear answer. A report by the US Institute of Medicine [65] summarised the numerous health issues of cancer survivors and reviewed the potential benefits of lifestyle modifications. In this Review, US Institute of Medicine report (from 2004 to 2006), and address: the strength of evidence for recommendations in areas of diet and exercise, with an emphasis on weight management and osteoporosis prevention, as well as diet and exercise-related complementary and alternative treatments about healthy lifestyle practices.

Conclusion

Therapeutic life style changes that encompass yoga, healthy nutrition etc. have the potential to reduce morbidity and mortality and enhance quality of life. Since the effect of yoga and diet/nutritional counseling may be additive, therefore studies need be conducted to observe the additive effect of yoga and diet counseling on physiological parameters. To summarize, Yoga and Diet counseling is a novel emerging clinical discipline of mind-body medicine which is increasingly used worldwide as non-pharmacological form of promotive, preventive and curative treatment for life style diseases.

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