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Review Article

Molecular Mechanisms for Beneficial Effects of Yoga on Health Promotion

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Abstract

Yoga is a bio-psycho and socio-spiritual approach for prevention of diseases. It is increasingly appreciated for its role in the modulation of central nervous system as well as in other body systems. Effects of yoga or meditation have been examined on risk of cardiovascular diseases (CVDs) and other metabolic diseases with some benefit. These studies examined the physiological response to stress, blood pressure decline, smoking cessation, insulin resistance and metabolic syndrome, endothelial function, inducible myocardial ischemia, and primary and in secondary prevention of CVDs. Reduction in oxidative stress and increase in vagal activity, resulting in to decrease in pro-inflammatory cytokines with increase in stretching induced resolven are mechanisms for beneficial effects of yoga on health promotion and disease prevention.

Keywords: *Health systems; stretching; meditation; pranayama breathing; asana*

Introduction

The ratification of an International Yoga Day by the General Assembly of the United Nations of Organizations emphasized yoga's potential role in the health promotion. This bio-psycho and socio-spiritual approach is increasingly appreciated for its role in the modulation of central nervous system as well as in other body systems. American Heart Association (AHA) has also reported on the beneficial effects of meditation [1]. AHA scientific statement systematically reviewed the data on the potential benefits of meditation on risk of cardiovascular diseases (CVDs). It has been demonstrated that meditation may provide long-standing effects on the brain, as revealed by neurophysiological and neuroanatomical studies [1]. In these studies, effects of meditation were examined on risk of CVDs. These studies examined the physiological response to stress, blood pressure decline, smoking cessation, insulin resistance and metabolic syndrome, endothelial function, inducible myocardial ischemia, and primary and secondary prevention of CVDs [1]. Many experts consider yoga as a unitary practice, because its content range from breathing exercises and meditation through a combination of mental and physical techniques to relatively intensive physical activity such as physically demanding asana [1,2]. This view point examines the role of yoga and its mechanisms of benefits in diseases prevention.

Prevalence of yoga practice

Apart from India, yoga has been accepted as a health promotion strategy in Australia by the 53.3% and in Germany 19.4%, population and it is rapidly emerging as a potential health tool in USA, UK and Canada [3-10]. In a cohort study among 34 525 adults from USA, the

lifetime and 12-month prevalence of yoga use were 13.2% and 8.9%, respectively [8]. Clinical characteristics of yoga practitioners who practiced in the past 12 months were; attending yoga classes (51.2%), breathing exercises (89.9%) and 54.9% used meditation (54.9%). Prevention of diseases (78.4%) and to improve energy and general wellness (66.1%) were major reasons for practicing yoga. It has been estimated that approximately 31 million U.S. adults have ever used yoga, and about 21 million practiced yoga in the past 12 months [8]. There is a rapid increase in the prevalence of yoga practice in India from 2015 after yoga was proposed as an important method for fitness of mind and body by the prime minister of India. In a case control study comprising of 435 cases of acute myocardial infarction (AMI) and 495 age and sex matched control subjects, the association of protective lifestyle factors were examined [9]. Coronary protective factors; healthy diet (Fruit, vegetable legume, and nuts(> 400 g/day) (31.0 *vs* 52.7%) moderate physical activity (23.4 *vs* 68.0%), meditation and yoga (> 5 days/week) 5.7 *vs* 25.2 %), moderate alcohol (< 10 drinks/week) (2.7 *vs* 24.6%), lean body weight (BMI < 25 $Kg/m^{2)}$ [7,8] *vs* 51.5%) and never tobacco intake (48.9 *vs* 68.0%) were significantly lower among AMI patients compared to control subjects. Meditation and yoga; OR 0.46, confidence interval 0.35 - 0.56) vs 0.48 (0.40 - 0.59) were significantly ($P < 0.002$) and inversely associated with AMI [9]. In a more recent survey involving 5,157 adults; (67.3% males vs females 33.7%), educated up to high school (62.5%) those who had 1 to 12 months of experience in the practice of yoga were 54.4% [10]. However, this sample is not the representative of urban population of India. In view of observations made during International Yoga Day, the prevalence of yoga in the urban population of India may be estimated up to 25% among adults above 18 years of age. There are several types of yoga practices such as Iyengar yoga [11], Shivanand yoga [12], Vishnudayanand yoga [13], yoga prayer [14], pranayama breathing [15] and restriction of feeding in the evening [16], but all of them have similar beneficial effects [17,18] in multiple diseases states [9,18-40].

Mechanisms of benefits of yoga on physiological functions

It has been demonstrated that improvement in the risk factors of CVDs via physical postures or breathing exercises or meditation may be due to decline in sympathetic activity and increase in parasympathetic activity resulting in to vagal nerve stimulation leading to increase in circulating nitric oxide which has anti-inflammatory effects [27,35]. It can be further hypothesized that apart from parasympathetic activation, release of extracellular factors, possibly anti-inflammatory cytokines IL-4,IL-10 and IL-14, as well as lipoxins, resolvins, protectins, maresins and nitrolipids may be activated by the effects of yoga induced stretching on various body systems including hypothalamus, amygdala and circadian clock [21,36-46]. Yoga improves the quality of sleep which may be associated with decrease in cortisol and increase in melatonin and leptin, due to improvement in circadian disruption leading to decreased risk of psychological disorders as well as CVDs and diabetes [36]. The beneficial effects by practicing yoga may be decline in perceived stress, and musculoskeletal stimulation and relaxation which can influence release of neurotransmitters in providing benefits among subjects practicing asana [21,32,36].

We know from physiology, that massaging the vagal nerve in the neck, may be associated with increased parasympathetic activity, resulting in to decline in blood pressure, heart rate and improved heart rate variability (HRV), and similar benefits in the metabolic and psychological factors resulting in an improved outcome in quality of sleep and depression [27-30]. Improvement in sleep may improve the circadian disruption and function of circadian clock by resetting the clock resulting in to beneficial effects on risk of visceral fat adipocytes, central obesity and metabolic syndrome [31,32]. The physiological effects of stretching (similar to vagal nerve massage) is another mechanism of yoga that has been labeled as musculoskeletal massage [41,42]. In a randomized trial of stretch versus no stretch for 48h, among rats, treatment via stretching was associated with significant reduction in inflammatory lesion thickness and neutrophil count and increase in levels of resolven within lesions. Treatment with a resolven injection subcutaneously, mimicked the effect of stretching. Interestingly, stretching of connective tissue was associated with decline in the migration of neutrophils and increased tissue levels of resolven in *ex vivo* experiments [42]. In a experiment, mechanical stretch was applied in vivo tissue for 10 minutes twice a day for 12 days. In vivo tissue stretch mitigated the inflammation-induced changes leading to restored stride length and intra-step distance, decline in mechanical sensitivity of the back and reduction in macrophage expression in the nonspecialized connective tissues of the low back indicating that further research in required in humans [42].

Recent studies have shown that gentle daily stretching such as yoga asan and other such methods; aerobic exercises of stretching for 10 minutes can reduce local connective tissue inflammation and fibrosis and provide benefit in most of the body systems including cardiovascular function [42-45]. The mechanical factors within the stroma may also regulate the tumor microenvironment, thus stretching may also reduce the growth of tumors. In a mouse orthotopic breast cancer model, mice were randomized to stretch vs. no stretch, and treated for 10 minutes daily. After four weeks, tumor volume at end-point was 52% smaller in the stretch group, compared to the no-stretch group ($p < 0.001$) in the absence of any other treatment. In the stretch group, both; cytotoxic immune responses and Specialized Pro-Resolving Mediators, such as resolvins, were activated with rise in levels indicating a link between immune exhaustion, inflammation resolution and tumor growth [43]. It seems that stretching which is a gentle, non-pharmacological intervention that may become an important component of treatment and prevention of non-communicable diseases. Previous studies indicate that exosomes can act as intercellular communication packets carrying factors such as receptors, transmembrane proteins, kinases, mRNA, miRNA, long noncoding RNA, DNA, and lipids for providing further protection [44].

It is possible that above, clinical, anthropometric, metabolic and psychological, benefits may be associated with improvement in coagulation and inflammatory profiles. It is clear that yoga can promote increased fibrinolysis, decreased free-radical production, decreased oxidative stress, and improvement in endothelial function [46]. Understanding that atherosclerosis is an inflammatory process and cardiovascular events are in part dependent on endothelial function, the literature supports that yoga can reduce progression while improving management and clinical endpoints of atherosclerosis, hypertension, cardiovascular disease, and risk factor reduction [28,29,39,40]. Brachial artery reactivity improved after a 6-week yoga pilot study on patients with coronary artery disease (CAD) or at high risk for CAD [47]. Impaired endothelial function is one of the mechanisms related to an increased risk of MI. Interestingly, the yoga intervention significantly improved brachial artery reactivity in the participants that had known CAD and had little association with the high-risk group. In heart failure, the underlying mechanisms of blunted vasodilatation with sympathetic activation are modulated by yoga during mental stress. The combination of the previous two studies, with the inclusion of yoga treatment, could further elucidate the role of yoga on sympathetic down regulation mechanisms [13].

In a randomized, controlled study among yoga (60 minutes, three times in a week) subjects ($n = 19$) compared to walking reported greater improvement in mood and greater decreases in anxiety than the walking group ($n = 15$) [48]. There were positive correlations between improved mood and decreased anxiety and thalamic GABA levels. The yoga group had positive correlations between changes in mood scales and changes in GABA levels. This may be the first study to report that increased GABA levels in thalamus are associated with improved mood and decreased anxiety. It is also the first time that a behavioral intervention (i.e. yoga postures) has been associated with a positive correlation between acute increases in thalamic GABA levels and improvements in mood and anxiety scales. Yoga can also improve baroreflex sensitivity with increase in heart rate variability, decline in catecholamines response to hypoxia and hypercapnia [49,50]. In a clinical study, a 12-week intervention with yoga was associated with significant improvement in parasympathetic activity, decreased sympathetic stimulation, and reduced N-terminal pro-B-type natriuretic peptide in New York Heart Association Class I and II HF patients in conjunction with standard medical therapy [51,52]. In a clinical comparison, yoga practitioners have been found to have higher metabolic variability compared to non-yoga group and subjects with metabolic syndrome, which may be due to reduced oxygen requirements during resting conditions and more rapid post-stress recovery [53]. Bernardi and co-workers have demonstrated that breathing rate and breathing quality can influence baro-reflex sensitivity, oxygen saturation and exercise performance [54,55], whereas verbalization during prayer can provide benefits on heart rate variability due to increase in vagal activity and increased release of nitric oxide and decline in cortisol [56].

Effects of yoga on management of diseases

Yoga has been successfully used for the management of emotional stress, anxiety and depression [19-23], CVDs [9,15-18,24]; heart failure [25], acute coronary syndrome [9,27], hypertension [26-29] and coronary artery disease [30]. Apart from CVDs, yoga has been used for the management of metabolic syndrome [26,31], diabetes mellitus [32-34] and insulin resistance [35]. The beneficial effects of yoga on cardio-metabolic diseases could be because of improving sleep quality by yoga therapy [36]. Yoga has been used for weight reduction in obese subjects [37-39] and for improvement in low back pain [40]. The scientific evidence is emerging to explain the mechanisms of yoga and its effects on physiological functions [27,35]. In a review of studies on the role of yoga on health, 70 studies that met specific

inclusion criteria were concerned with the role of yoga and the reduction of insulin resistance, metabolic syndrome, and CVDs [35]. Yoga practice reduces tumor growth and cancer [59] as well as provides wellness by reducing fatigue [58]. Spirituality and mindfulness are part of yoga philosophy and practicing mindfulness can also inhibit emotional stress and prevent psychological disorders [59,60]. Functional magnetic resonance imaging(fMRI) studies indicate that effects of yoga on components of brain, can be visualized to identify new therapeutic targets, in human beings [61-63]. Yoga therapy may be used to advance the sustainable development goals.

Conclusion

In brief, yoga practice includes, asana, meditation, pranayama breathing and yoga philosophy. All the techniques of yoga have been found to provide benefit in health and prevention of CVDs and other chronic diseases. Yoga treatment decreases sympathetic activation and increases parasympathic tone with increased vagal activity, resulting in to increase in nitric oxide and decrease in cortisol leading decline in oxidative stress and inflammation. Yoga therapy induced stretching induces increase in resolven in the body tissues, which is a potential anti-inflammatory molecule. Further research is required to provide proof for effects of yoga on health.

Conflict of Interest

Conflict of interest has not been declared by any of the authors.

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