

Evidence Based Cardiovascular Benefits of Yoga

Shashi K. Agarwal* *Agarwal Heart Center New Jersey, USA*

Abstract: *A plethora of properly designed human studies have emerged, documenting a myriad of positive anatomic and physiological changes resulting from the coordinated practice of willfully attaining a pose, breath managing and targeted focusing of the mind. These changes trigger neuro-endocrine and hemodynamic alterations that beneficially modify the initiation and/or progression of several disease processes. These favorable end results have been objectively proven in cardiovascular diseases.*

Cardiovascular disease is an extensive burden on human health. Despite major advantages in our understanding of its patho-physiology and the development and availability of novel pharmaceuticals, the world's number one malady has not exhibited any signs of regression. Given its disproportionately high morbidity and mortality, any benefits realized through a regular regimen of yoga practice is scientifically exciting and medically welcome.

This article objectively scrutinizes the published studies and presents a brief review of the evidence based data attesting to the cardiovascular disease ameliorating properties of this centuries old ancient practice.

Key words: *yoga, heart, cardiovascular disease*

Introduction

Cardiovascular Diseases are responsible for 31% of all global deaths - more deaths than from any other cause. It is estimated that in the year 2012, 17.5 million people died from cardiovascular diseases (CVDs) in the world, with three quarters of these occurring in low and middle income countries. These diseases include coronary artery disease, heart failure, stroke and peripheral vascular disease. Of the annual worldwide deaths, an estimated 7.4 million were due to coronary heart disease and 6.7 million were due to stroke. CVDs are also a leading cause of disability. Despite a wide range of conventional pharmacologic agents, surgical procedures, and non-pharmacologic interventions, the disease continues to exert a significant health, social and economic burdern. (WHO fact sheet) Yoga has demonstrated efficacy as a complementary therapy in these patients and has fostered considerable scientific

* Corresponding author: shashikagarwal@gmail.com

interest worldwide. (Jayasinghe, 2004) This review article uses comprehensive scientific and evidence-based published data to analyze the efficacy and safety of yoga as an adjunctive therapeutic tool in the management of CVDs.

Methods

A systematic literature search was carried out using the PubMed database on yoga and cardiovascular diseases. Additional studies were identified by searching bibliographies of reviews and were consulted, if relevant. Other published scientific material was also reviewed.

Results

There were 265 citations listed in PubMed under yoga and cardiovascular diseases, with the earliest one being listed in 1961. Other citations were also searched and reviewed. These included the following: Yoga and: smoking (42 citations dating back to 1974); inactivity (9 citations dating back to 2002); diet (127 citations dating back to 1974); obesity (70 citations dating back to 1979); hypertension (143 citations dating back to 1961); Diabetes mellitus (120 citations dating back to 1986); alcohol (45 citations dating back to 1961); Cholesterol (58 citations dating back to 1981); inflammation (44 citations dating back to 2001); Stress (597 citations dating back to 1968); depression (391 citations dating back to 1974); anxiety (425 citations dating back to 1966); coronary artery disease (23 citations dating back to 1979); heart failure (17 citations dating back to 1998); stroke (40 citations dating back to 1993); cardiac arrhythmias (17 dating back to 1971) and cardiovascular rehabilitation (29 citations dating back to 1979).

Discussion

Cardiovascular diseases remain the leading cause of death and disability worldwide. (Goyal et al, 2006) Risk factors that are non-modifiable include advancing age, gender, heredity and race. Modifiable risk factors include smoking, obesity, unhealthy diet, physical inactivity, excessive alcohol intake. Risk factors also include hypertension, diabetes mellitus, dyslipidemia, chronic inflammation, stress and depression. (Do et al, 2000) Yoga practice can help reduce several of these risk factors. (Schmidt et al, 1997; Yang, 2207; Bijlani et al, 2005; Parco et al, 2015) and result in a decrease in cardiovascular morbidity and mortality.

Smoking

Cigarette smoking is harmful to almost every bodily organ and increases the risk for death from all causes, in both men and women. (CDC, 2010) In the US, it is the leading preventable cause of death. (CDC, 2008) Smoking is especially detrimental to the cardiovascular system. (USDHHS, 2010) It is estimated that smoking increases the risk for coronary heart disease by 2 to 4 times (USDHHS, 1989) and for stroke by 2 to 4 times. (USDHHS, 2014) Yet, 45 million Americans

continue to smoke, and the numbers are high in developing countries. With the widespread publicity of its health dangers, however, nearly 70 percent of smokers want to quit. (CDC, 2011) Unfortunately, the vast majority of them fail. (Piasecki et al, 2002; Kassel et al, 2003) Prescription medications have seen only limited success. (Robles et al, 2008) Although the use of e-cigarettes is spreading rapidly, definite data regarding their success in smoking cessation remains lacking and Food and Drug Administration of America has yet to approve them as a cessation aid. (Priscilla Callahan-Lyon; 2014) Yoga practice in several studies have shown to help patients stop smoking. (Bock et al, 2012; Gaskins et al, 2015; Bock et al, 2010) Yoga practice results in a reduction in stress and negative affect and improved mood and wellbeing. These factors help smoking cessation. (Mishra, 1987; Emeroy et al, 1990; Khumar et al, 1993; Malathi et al, 2000; Piasecki et al, 2002; Woolery et al, 2004; Carlos et al, 2005)

Inactivity

Physical inactivity has been etiologically connected to several chronic metabolic diseases. (Booth et al, 2012) It was deemed responsible for an estimated 9.4% of all 57 million deaths in the world in 2008, or more than 5 million deaths. Its deleterious health effects are comparable to smoking and obesity, (Dick et al, 2010) with a major percentage developing cardiovascular diseases, (Chastin et al, 2015) Prolonged inactivity such as sitting, limited physical exercise, and sedentary lifestyles have deleterious effects on the vasculature, resulting in ischemic heart disease. (Kohl, 2001) It is widely acknowledged that exercise induces a number of physiological adaptations that have beneficial effects in the prevention and treatment of chronic metabolic diseases, (Bouchard et al, 2015) and specifically cardiovascular diseases. (Paffenbarger et al, 1993) with reductions in both primary (Myers et al, 2002) and secondary events. (Jolliffe et al, 2001) To reduce the risk of cardiovascular disease, most guidelines recommend at least 150 min of moderate-intensity aerobic physical activity per week or at least 90 min of vigorous aerobic exercise per week (Franzini-Pereira et al, 2008) However, lower levels of activity, such as walking, also translate into a cardiovascular benefit. (Boone-Heinonen et al, 2009) Yoga is a low intensity and low impact exercise. (Long, 2006) A statistically significant improvement occurs in overall physical health, endurance, strength, flexibility, posture and balance, with a regular yoga practice. (Cowan et al, 2005; Lollegen et al, 2009) Yoga, using the body's own weight and the natural gravity, puts the body through a wide range of motion. (McCall, 2007) Yoga routines, despite their low energy expenditure, (Ray et al, 2011) may be better for improving many cardiorespiratory fitness parameters than other aerobic activities recommended by current guidelines for cardiovascular disease prevention (Sonova et al, 2015).

Obesity

Obesity is now a global epidemic. (Caballero, 2007). It is estimated that over 2.1 billion people – nearly 30% of the world's population – are either obese or overweight and these numbers are on the increase. (Marie et al, 2014) The reasons are numerous, (McAllister et al, 2009) and include genetic, metabolic, behavioral, and environmental factors. (Wang et al, 2011) Obesity transmits a significant disease burden on the human population. (Must et al, 1999) The impact of obesity and its comorbidities on vascular function and the resultant cardiovascular disease is also significant, (Bray et al. 2004) and occur via various complex mechanisms. (Nakamura et al, 2014) Efforts to reduce weight are usually futile, despite medications. Lifestyle changes aimed at weight reduction through physical activity, proper diet, breathing exercises and stress relaxation appear to provide better results at weight reduction and the associated metabolic complications. (Goran et al, 2012) Yogic lifestyle modifications also result in weight loss, (Bera et al, 1993 Dhananjay et al, 2013) with significant reduction in cardiovascular risk. (Schmidt et al, 1997; Damodaran et al, 2002) Yogic intervention, through weight loss, can therefore be a promising option in reducing the burden of cardiovascular diseases. (Sarvottam et al, 2014)

Hypertension

Hypertension affects an estimated 26% of the world population. (Kearney et al, 2005) Hypertension is a major cause for the development of coronary heart disease, stroke, heart failure and arterial aneurysm – the main causes of cardiovascular morbidity and mortality. (Pierdomenico et al, 2009) Even pre-hypertensives experience an increased risk for cardiovascular complications when compared to normotensives. (Vasan et al, 2001) Hypertension is primarily treated with pharmaceuticals. (Hackam et al, 2010) NIHCG, 2013) Lifestyle changes (salt and alcohol reduction, calorie restriction and physical exercise) are also included in most guidelines, (Erdine et al, 2006) and widely accepted as being beneficial. (Amamd, 1999) Despite these measures, a significant number of patients do not reach goal, and are labelled resistant. (Wanpen, 2014) Yoga may help improve the blood pressure beyond that achieved by the guidelines. (Mamtani, 2005) Its adjunct role in hypertension has recently been gaining intense interest. (Okonta, 2012; Wolff et al, 2013) Clinical studies have documented a reduction in blood pressure in normotensive individuals, with a regular practice of yoga. Blood pressure has also been normalized in pre-hypertensives. In a recent meta-analytic review of 17 studies (22 trials), yoga was associated with a small but significant decline in both systolic and diastolic blood pressure (–4.17 and –3.26 mmHg, resp. (Hagins et al, 2013) Several other analyses have reached similar conclusions. (Okonta, 2012; Tyagi et al, 2014) Reductions were also documented in patients with heart failure of both systolic (6.12 mm Hg) and diastolic blood pressure (13.25 mm Hg). (Hartley et al, 2014) Clinically significant anti-hypertensive

effects have also been noted in patients with coronary artery disease and stroke. (Lakshmikanthan et al, 1979) A reduction in blood pressure is instrumental in reducing cardiovascular morbidity and mortality. (Bangalore et al, 2014) Though the yoga induced reductions may be small, they are similar to that achieved by other lifestyle modifications advocated by current guidelines, (Subramanian et al, 2011) and result in clinically meaningful outcomes (Jain et al, 2010; Hegde et al, 2011) Yoga also improves the quality of life in these patients. (Wolff et al, 2013) The recently concluded SPRINT trial conclusively proved that reducing systolic blood pressure to 120 mm Hg decreased heart attacks, heart failure and stroke by one third and mortality by a quarter when compared to a goal of 140 mm Hg. (NIH, 2015) Yoga may help reach this lower goal in hypertensives without additional polypharmacy.

Diabetes Mellitus

Diabetes mellitus is a powerful independent risk factor for cardiovascular and atherosclerotic disease. According to World Health Organization, in 2014, 9% of adults 18 years and older had diabetes in the world. it was responsible for 1.5 million deaths, (WHO, 2014) and more than 80% of diabetes deaths occurred in low- and middle-income countries. The worldwide prevalence of diabetes mellitus is growing and it is estimated that by 2030, it will be the seventh leading cause of death. (Mathews et al, 2006) Unfortunately, high blood pressure is reported in over two-thirds of patients with type 2 diabetes. (Ferrannini et al, 2012) This combination strongly predisposes people to atherosclerotic cardiovascular disease, (Epstein, 1997) and doubles the risk of cardiovascular death. (Mahler, 1990) Pharmacological and lifestyle intervention in patients with diabetes greatly reduces morbidity and mortality. (Smolen et al, 2014) Yoga may play a complementary role in reducing the risks associated with prediabetes, (Innes et al, 2005; Innes et al, 2007; McDermott et al, 2014) and established diabetes. (Gina et al, 2008; Monro et al, 1992; Badr et al, 2010) Yoga is beneficial even if the diabetes is poorly controlled, (Kerr et al, 2002) or burdened with complications. (Monro et al, 1992; Jain et al, 1993)

Alcoholism

Although drinking small amounts of alcohol is cardio-protective, (Bradley et al, 1993) excessive drinking can lead to high blood pressure, heart failure and stroke. Alcohol also increases caloric intake, which can lead to obesity and diabetes.

Alcoholism is also associated with other serious cardiovascular problems including fetal alcohol syndrome, cardiomyopathy, cardiac arrhythmia and sudden cardiac death. (Heart.org) The overall mortality rises with increasing alcohol intake. (Doll et al, 1994) There is a paucity in the number of published studies regarding the helpful role played by yoga on alcohol moderation or on stopping alcoholism. One study suggested that yoga may be helpful in these patients. (Reddy et al, 2014)

Hypercholesterolemia

There is a close direct relationship between dyslipidemia and coronary heart disease risk. (Stamler et al, 1986; Neaton et al, 1992) Intervention trials have convincingly established that reduction in low density lipoprotein cholesterol (LDL-C) is cardio-protective, and reduces coronary heart disease events, both primary and secondary. (Gotto et al, 2000; HPSG, 2002) A reduction is usually achieved with the use of statin drugs, (3-hydroxy-3-methylglutaryl coenzyme A [HMG-CoA] reductase inhibitor therapy) resulting in a 20% to 60% decrease in LDL-C levels, a modest increase in high density lipoprotein cholesterol and a modest decrease in triglyceride levels. Many studies have reported that yoga improves lipid profiles in not only healthy individuals, (Acharya et al, 2010; Yadav et al, 2014) but also in hypertensive patients, (Gokal et al, 2007) in those with established coronary artery disease (Mahajan et al, 1999) and in those with diabetes mellitus. (Bhaskaracharyulu et al, 1986)

Vascular Inflammation

Inflammation is a predictor of all-cause mortality. (Krabbe et al, 2004) Pro-inflammatory cytokines like IL-6 and TNF- α play a role in coronary heart disease, (Janice et al, 2013) and other cardiovascular diseases. Inflammation has been implicated in all stages of atherosclerosis - initiation, growth, and complication of the atherosclerotic plaque. (Tracy, 1998; Ross, 1999; Libby et al, 1999) CRP levels are routinely measured in clinical practice to ascribe cardiovascular risk and evaluate prognosis. (Pearson, 2002) Regular practice of yoga lowers basal TNF- α , IL-6 levels, (Vijayaraghava et al, 2015) and CRP levels. (Kiecott-Glaser et al, 2015) These beneficial effects have also been validated by other studies. (Janice et al, 2010; Wolff et al, 2015)

Stress and Depression

Stress, anxiety, anger and depression have all been associated with an increase in the incidence and severity of cardiovascular diseases. (Rozanski et al, 1999; Lichtman et al, 2008; Dimsdale et al, 2008) Yoga has been reported to decrease perceived stress and reactivity to stressors, (Schell et al, 1994; Brown et al, 2005) enhance stress-related coping, (Nespor, 1993; Shannahoff-Khalsa et al, 1999; Waelde et al, 2004).reduce symptoms of depression (Khumar et al, 1993; Ernst et al, 1998; Anakiramaiah et al, 2000; Ray et al, 2001; Woolery et al, 2004) anxiety, (Ray et al, 2001; Mishra et al, 2001; Woolery et al, 2004; Lavey et al, 2005) decrease anger, tension and fatigue, (Berger et al, 1992; Lavey et al, 2005) enhance psychological well-being, (Schell et al, 1993; Malathi et al, 2000; Ray et al, 2001) and reduce sleep disturbances. (Sahajpal et al, 2000; Cohen et al, 2004) Overall wellbeing is better and the quality of life is improved (Malathi et al, 2000; Carlson et al, 2005; Chung et al, 2012). A review of over 25 randomized control studies also provide evidence based data supporting a decrease in depression and

anxiety in a wide range of populations, with a regular practice of yoga (Pascoe et al, 2015).

Coronary Artery Disease

Coronary artery disease is the leading cause of heart disease, and is responsible for about 370,000 deaths annually in the United States (CDC, 2015). It is also a major killer globally. More than 95 percent of all coronary artery disease is due to atherosclerosis. Yoga and yogic lifestyle have been shown to reduce most risk factors for coronary artery disease. These include reductions in high blood pressure, obesity, hypercholesterolemia, diabetes mellitus, smoking and inactivity (Tulpule et al, 1971). Several studies have also reported an improved heart rate variability due to increased parasympathetic and reduced sympathetic activity in the yoga patients. There are also reductions in inflammatory biomarkers such as CRP, interleukin IL-6 and tumor necrosis factor TNF- α . Biomarkers of stress, namely, cortisol and beta-endorphin are also reduced. These positive modulations suggest a potential role in primary prevention of coronary artery disease. Its role in secondary prevention has been suggested. (Lau et al, 2012) Studies have also reported a regression in coronary atherosclerosis (Manchanda et al, 2000; Yogendra et al, 2004). Yoga also improves functionality as well as mentation in patients following a heart attack and can play an important role in cardiac rehabilitation (Oldridge et al, 1988; O'Connor et al, 1989).

Heart Failure

Heart failure is a common cardiovascular disease, affecting almost 5.1 million people in the United States and over 23 million worldwide. (McMurray et al, 1998; Llyod-Jones et al, 2010) Despite novel drug and device innovations, it remains a costly and deadly disease, with almost 50% of the people diagnosed with heart failure dying within 5 years. In its more severe stages, heart failure patients have a life expectancy that is similar to aggressive cancers. The health burden is tremendous. (Norton et al, 2011) Further, its prevalence in the world may be on the increase. The role of yoga in the management of heart failure has been investigated in several trials. These trials have shown that heart failure patients on a yoga regimen demonstrate a reduction in heart rate, systolic and diastolic blood pressures and the heart rate pressure product when compared to a similar group without yoga. An improvement in heart rate variability indicating increased vagal tone has also been noted. Yoga also decreases biomarkers of inflammation in these patients. There is improved functionality and symptom stability in patients, (Howie-Esquivel et al, 2010) including African Americans. (Pullen et al, 2010) A meta-analysis of two major studies revealed a 22% improvement in peak VO₂ during cardiopulmonary exercise testing in the yoga group, indicating an increased exercise capacity. There was also a major improvement noted in the quality of life by 24% using the Minnesota Living with Heart Failure Questionnaire. (Gomes-

Neto et al, 2014) Other benefits reported in individual trials have been an increase in flexibility and muscle strength, along with an improvement in mood and balance. Heart failure patients demonstrate numerous hemodynamic abnormalities, a dysfunctional autonomic nervous system, diminished effort tolerance, sarcopenia and a negatively altered mood. The evidence based positive modulation of these abnormalities in heart failure patients through a regular yoga practice appears to be statistically significant and reproducible. These findings also prognosticate a reduction in future morbidity and mortality in these patients.

Stroke

The worldwide prevalence of stroke was 33 million in 2010. It is the second-leading global cause of death behind heart disease, accounting for 11.13% of total deaths worldwide. (Heart.org2) It is also a leading cause of disability. Yoga induced modification of stroke risk factors should translate into a clinical reduction in primary strokes. There is a documented reduction in carotid atherosclerosis, (Castillo-Richmond et al, 2000) Most studies have focused on the value of yoga in stroke rehabilitation, resulting in an improvement in flexibility, muscle strength, fatigue and balance. (Bastille et al, 2004; Lynton et al, 2007; Garrett et al, 2011) There is a major positive effect on cognitive dysfunction and depression in these patients. (Schmid et al, 2014; Immink et al, 2014) Yoga is easy to learn and can be self-administered as a complementary therapeutic intervention in this group.

Cardiac Arrhythmias and Sudden Cardiac Death

Yoga practice has been shown to improve symptoms, arrhythmia burden, heart rate, blood pressure, anxiety and depression scores, and several domains of quality of life in patients suffering from paroxysmal atrial fibrillation. The improvements are probably related to yoga mediated decrease in systemic stress and down regulation of the hypothalamic-pituitary-adrenal axis, resulting in a reduction in sympathetic nervous system activity and an increase in parasympathetic activity. (Lakkireddy et al, 2013) Yogic practices may also have a protective role in ventricular arrhythmias (Ravindra et al, 2006; Dabhade et al; 2012) Further studies are needed to better evaluate the potential role of yogic practices in the management of cardiac arrhythmias.

Cardiac Rehabilitation

Exercise-based cardiac rehabilitation appears to be effective in reducing cardiac deaths. Following a myocardial infarction, it results in a statistically significant reduction in all-cause and cardiac mortality, of about 20 to 25% compared to patients receiving conventional care (Oldridge et al, 1988; O'Connor et al, 1989).

Yoga practice may play a role in this rehabilitative process. (Bera et al, 1993; Telles et al, 1997; Madanmohan et al, 2004) Positive results have been seen with the integration of yoga in rehabilitation of patients following coronary artery bypass surgery. Cardiac rehabilitation has also decreased hospital admissions and improved mortality and quality of life in patients with heart failure. (Taylor et al, 2014) Yoga has also shown benefits in this population. (Gomes-Neto et al, 2014) Yoga improves many physical and mental parameters in stroke patients. (Lazaridou et al, 2013; Schmid et al, 2014) The beneficial effects of yoga in stroke patients results from multifactorial effects, including reduced cardiovascular risk factors and improved function, along with a decrease in stress, anxiety, depression and negative affect. (Nagarathna et al, 2014)

Conclusions

It is estimated that in 2009, yoga was regularly practiced by about 30 million people worldwide. (Dangerfield, 2009) Its popularity in the US is growing rapidly, and recent estimates indicate that almost 9.5% of U.S. adults (21 million) practiced yoga in 2012. (NCCIH, 2015) The scientific community has also taken the healing properties of yoga seriously and an increasing number of randomized controlled clinical trials are exploring and establishing the therapeutic potential of yoga. (Khalsa, 2004; Holger et al, 2014) There is growing evidence that yoga is effective as an adjunctive safe and cost-effective intervention for cardiovascular diseases. Yoga can be done anywhere, requires no special equipment, is gentle on the joints and can be modified for each person. It uses the body and gravity as resistance, preventing excessive impact. It also incorporates breathing control and meditation, with significant added benefits. Yoga is simple to follow and cost-effective with high compliance. Yoga has a low rate of side effects, and the risk of serious injury from yoga is quite low (NCCAM)

The evidence based data on the adjunctive therapeutic benefit of yoga in CVDs is persuasive. Public-health strategies aimed at promoting yoga and insurance reform aimed at reimbursing yoga practice could substantially lower the burden of cardiovascular related death and disability worldwide.

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