Review Article

JHSMR Journal of Health Science and Medical Research

Yoga in Arterial Stiffness: A Review

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Received 20 September 2021 ● Revised 16 December 2021 ● Accepted 28 December 2021 ● Published online 18 February 2022

Abstract:

Non-communicable diseases; especially cardiovascular disease (CVD), is expected to be a leading cause of death worldwide through till 2030. Controlling this disease and its complications requires early recognition and surveillance, and as a result the accompanying health-care expenses can be kept under control. Looking back over the past, since 5 to 6 decades, studies have revealed an increase in CVD in India; ranging from 1.0% to 9.0% and 1.0% to 4.0-6.0% in both urban and rural areas, respectively. Arterial stiffness is defined as a decrease in an artery's ability to expand and contract in response to changes in pressure. Pulse Wave Velocity (PWV), which is the speed at which forward pressure is conveyed from the aorta via the vascular tree, is one of the simplest and oldest methods for determining it. Yoga, a mind-body practice that dates back to 5,000 Before Christ in India. It is regarded as a Vedic, ancient science, as a means of mental, bodily, and social existence, and has been increasingly used as a remedial measure. An comprehensive search of the electronic databases in PubMed/Medline, Web of Science, Scopus, Science Direct, Google Scholar, and Semantic Scholar for relevant publications was conducted using the keywords "Yoga and Arterial Stiffness." This current review, based on the scientific evidence, suggests yoga to pose and deliver health favourable benefits on PWV; particularly in adolescents as opposed to middle and geriatric populations. In addition, yoga is useful for young people with obesity, hypertension, and for those who lead a sedentary lifestyle. Yoga's beneficial effects on cardiovascular disease are related to a reduction in sympathetic activity as well as concomitant mental and physical relaxation.

Keywords: arterial stiffness, cardio vascular disease, physical activity, yoga

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J Health Sci Med Res 2022;40(5):599-606
doi: 10.31584/jhsmr.2022863
www.jhsmr.org

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Introduction

Cardiovascular disease (CVD) is the leading cause of mortality around the globe. The progression of cardiovascular disease has been linked to arterial stiffness in the central arteries.[1] Early detection and monitoring are vital to control this disease and its comorbidities in additional to controlling the associated health costs. Advancements in controlling the prognosis of CVD has already progressed in developed parts of the world. In India, in the past 50 to 60 years, many studies have documented an escalation in CVD; extending from 1.0% to 9.0–10.0% and <1 to 4.0–6.0% in urban and rural locations.[2] Furthermore, 63.0% of deaths were reported from non-communicable diseases, of which 27.0% were from CVD.[3] Recent researches have shown the relationship between arterial stiffness and CVD. With an advancement in age, and associated cardiovascular risks; including, hypertension, diabetes mellitus, hypercholesterolemia, and end-stage renal failure, there occurs an increase in the chances of arterial stiffness; as per the surrogate measures of arterial stiffness.[4] An alteration in arterial stiffness can be predicted before the clinical appearance of vascular signs and symptoms. Additionally, it can help to predict atherosclerosis, or can be a marker of atherosclerotic disease. Thereby, this works as a precursor of risk assessment as ones age progresses.[5] Arterial Stiffness (AS) is best explained as a reduction in the capability of an artery to expand and contract with a change in pressure.[6]

AS is measured using one of the oldest and easy techniques: Pulse Wave Velocity (PWV), which is the speed at which the forward pressure is transmitted from the aorta through the vascular tree.[7] It is a potential risk indicator of CVD, and has gained remarkable clinical and research importance.

Yoga is a mind-body practice that originated in India around 5,000 BC, and is recognized as a Vedic ancient science as a way of mental, physical, social life, which as been increasingly applied as a therapeutic intervention.[8] The eight elements of Yoga asanas are: moral observances (Yama), self-disciplines (Niyamas), specific posture (asana), regulated breathing (Pranayama), Sensory withdrawal (Pratyahara), Concentration (Dharana), Meditation (Dhyana), and self-realization (Samadhi).[9]

Currently, limited data is available about the effect of different forms of Yoga on AS, with the first research being concluded in 2008, by CM Duren.

Material and Methods

An extensive search in PubMed/Medline, Web of Science, Scopus, Science Direct, Google Scholar and Semantic Scholar electronic database to review relevant articles, using the keywords "Yoga and Arterial Stiffness" was conducted. From this, a total of 1,079 articles were published from 1965 to June 1, 2021 (Figure 1). Ten articles found to fit into the inclusion and exclusion criteria. The inclusion criteria: included; clinical trials, controlled trials, randomized controlled trials that dealt with Yoga alone, or were in combination with any physical activity. Exclusion criteria: consisted of; research protocols, comments, articles having either abstract or conference proceedings, articles with lack or repetition of the same type of information.

Yoga and its effect on arterial stiffness (Figure 2)

Duren et al, in 2008, documented physical activity as having a great impact on arterial stiffness among the middle-aged population. Furthermore, the study concluded that yoga participants as having remarkably reduced arterial stiffness when compared to the sedentary lifestyle group. However, no difference was noted among the aerobic and yoga group.[1]

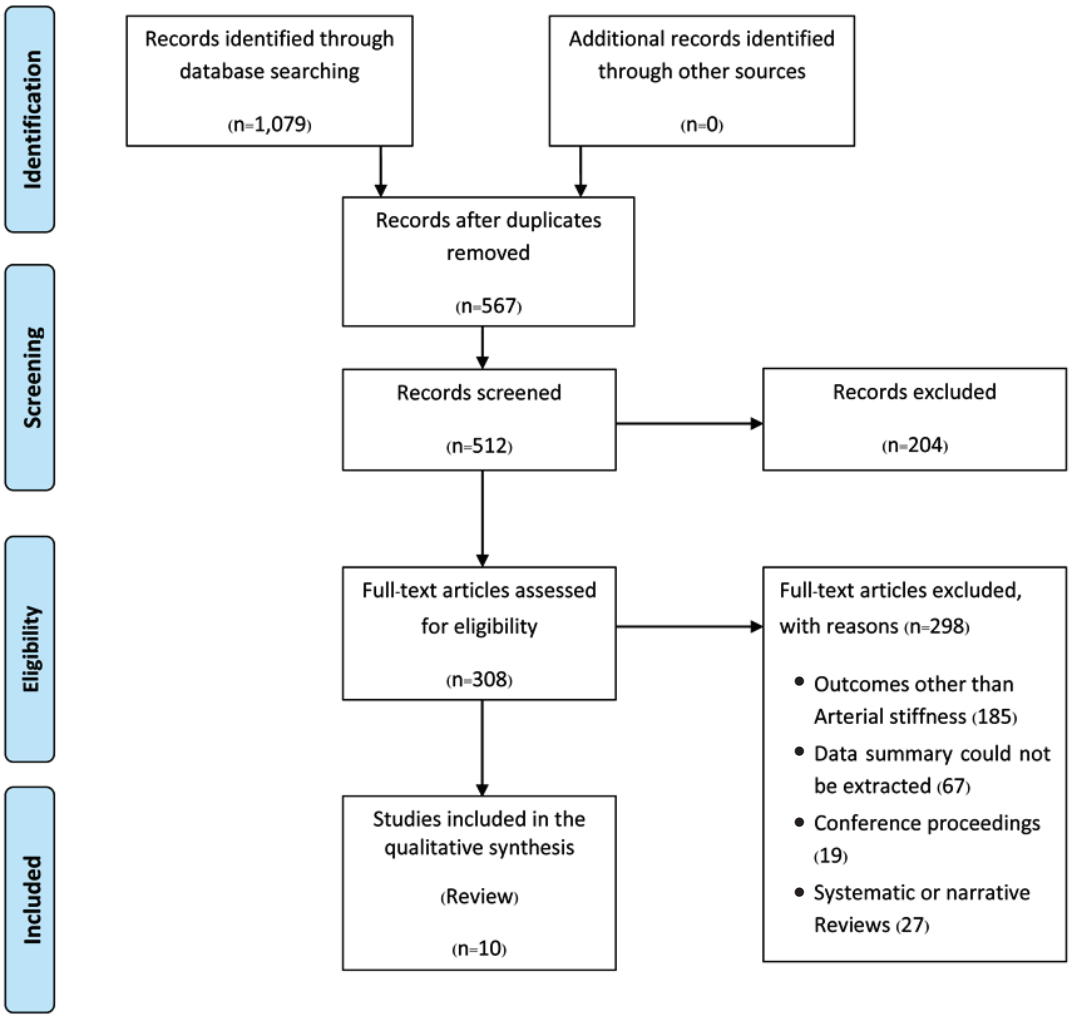


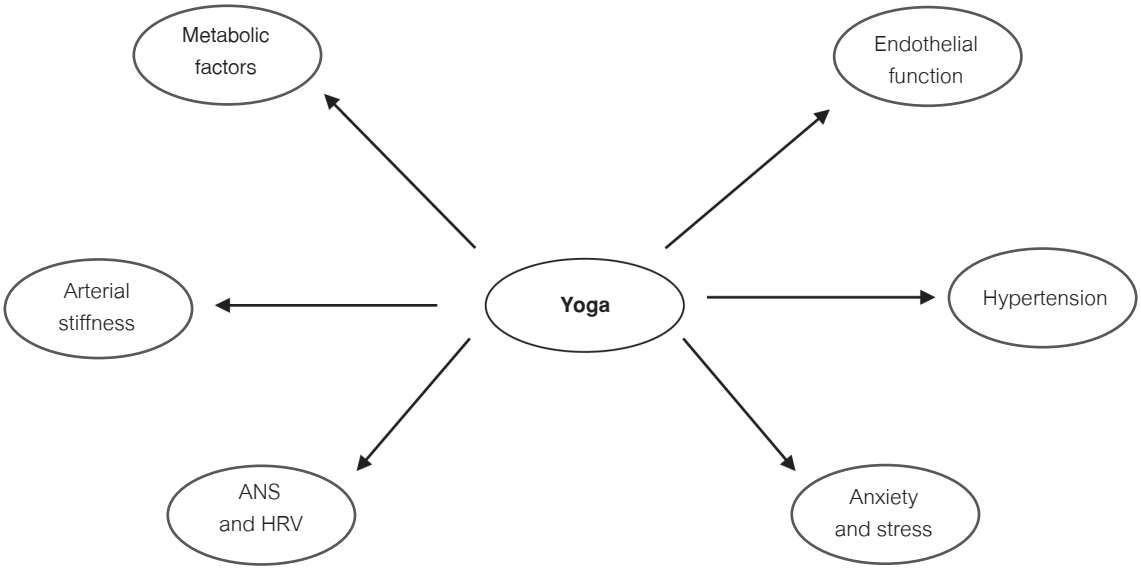
Figure 1 Prisma flow diagram on literature review

Hunter et al, 2013, demonstrated improvement in arterial stiffness with Bikram Yoga in the younger population (mean age±standard deviation, 30±1 years), not in the older population (mean age±standard deviation, 53±2 years), after 8 weeks of Bikram Yoga intervention. However, there was a significant decline in the insulin resistance index within the older group.[10] Similarly, in 2016, the same authors documented a decline in brachial–ankle PWV among overweight/obese subjects, while no significant changes were noted in normal body mass index subjects. However, emotional well–being and quality of life measures improved in both groups following 8 weeks of Bikram Yoga intervention.[11] This is further supported by the study of Kumar et al, 2017, who concluded a remarkable decline in arterial stiffness in the young age obese population in comparison to the older population with obesity and non–obese adults, following a one–week integrated approach of yoga therapy in all three groups.[12] In addition, Patil et al, 2015, concluded in a 12 weeks randomized control study that yoga is effective in reducing arterial stiffness with blood

pressure, more so than brisk walking in elderly subjects with enhanced pulse pressure. Furthermore, yoga helps to improve endothelial function, with enhancement in the nitrous oxide bioavailability and a decline in sympathetic activity.[13] Finally, Wooten et al, 2020, documented the improvement in cardiovascular ankle index, and non-invasive index of arterial stiffness in both groups (inflated and deflated blood flow restriction band) at a similar pattern among 20 healthy, young individuals.[14]

On the flip side, Kim in 2012, demonstrated no significant alteration in the arterial compliance and cardiovascular variables in the small and larger arteries, following 32 weeks of supervised yoga intervention in healthy premenopausal women.[15] Similarly, Hunter et al, 2013; in a cross-sectional study, documented no difference in carotid arterial compliance and vascular functions among Hatha Yoga practitioners, and sedentary adults matched for age, body mass index, and aerobic activity level of fitness. Additionally, the same study documented no change in carotid artery compliance and β-stiffness in the interventional group. However, in both cross-sectional and interventional designs there occurred a reduction in HbA1c, after 12 weeks of intervention.[16]

In addition, Hunter et al, in 2018, found no change in brachial-ankle PWV among the middle aged sedentary population (40-60 years), following 12 weeks of intervention in the Hot, Thermoneutral Yoga and control group population.[17] Finally, Pina et al, 2021, concluded that a single bout of Vinyasa Yoga helps in a reduction in the augmented index (AIx), with no change in the PVW among 30 people with a mean age group of 32 years and a history of yoga practice. Furthermore, this study documented the improvement in mood and lipid concentration.[18]



ANS=autonomic nervous system, HRV=heart rate variability

Figure 2 Effects of yoga on precursors of cardiovascular disease

Yoga on autonomic nervous system (ANS) and heart rate variability (HRV) (Figure 2)

A study by Bhaskar et al, documented that long Sudarshan Kriya Yoga has a beneficial effect on cardiac autonomic tone, improvement in parasympathetic activity, and a reduction in sympathetic activity; thereby, creating balance in sympathovagal tone and psychophysiological relaxation. It may act as an aid to improve heart rate variability; a marker of cardiovascular health.[19] Moreover, Trivedi et al, in a comparative study among women, documented the improvement in mood and heart rate variability within the Parasympathetic nervous system.[20] This is in support of our review findings of a decrease in sympathetic activity in conjuction with psychological relaxation of the mind and body.

Yoga in hypertension (Figure 2)

Murugesan et al, concluded in their study that yoga is more effective in controlling systolic blood pressure, pulse rate and body weight in hypertensive subjects.[21] It is in direct support of our review findings; in that yoga is more effective in controlling arterial stiffness in hypertensive and obese young adults.

In addition to this, the effects of yoga on blood pressure have been linked to a variety of mechanisms; including, age-related progression. However, supporting data suggests a strong link between oxidative stress and blood pressure.[22] By influencing cell development and inflammatory responses through reduction-oxidation-dependent signalling pathways, reactive oxygen species affect cardiovascular structures and functions.[23] Increased vascular oxidative stress damages the endothelium, reduces nitric oxide production; by inhibiting Endothelial-Nitric Oxide Synthase (e-NOS) pathways, and impairs endothelium-dependent vasodilation. This results in an increased vascular tone, causing hypertension; thereby, increasing arterial stiffness.[24] Furthermore, oxidative stress produces vascular media thickening, by stimulating smooth muscle cell proliferation and hypertrophy as well as collagen deposition, resulting in vascular lumen constriction.[25] These findings suggest that oxidative stress may play a key role in hypertension development.

Yoga in anxiety, and stress (Figure 2)

Li et al, in their review documented the reduction of stress and anxiety via yoga.[26] Additionally, Azeez et al, in their findings of a randomized controlled trial, the short-duration breathing patterns of yoga, reduces the anxiety level in pre and post-operative cardiac surgery.[27] Furthermore, Parswani et al, concluded that a mind-based stress reduction program is beneficial in lowering anxiety, depression, perceived stress, body mass index, and blood pressure in coronary heart disease subjects.[28] This supports our review findings of the mood-boosting effect of yoga. There is an underlying notion that yoga has the ability to positively affect the biochemical and neurophysiological systems, by regulating the autonomic nervous system and stress response; thus, decreasing stress, anxiety and depression levels.[29] Yoga inhibits the posterior or sympathetic part of the hypothalamus and restores autonomic regulatory reflex processes linked with stress, resulting in lower production of Adrenocorticotropic Hormones from the anterior pituitary gland.[30] Yoga has become a popular stress-reduction technique for people suffering from anxiety, depression, and other mood disorders.

Yoga on endothelial functions and metabolic factors (Figure 2)

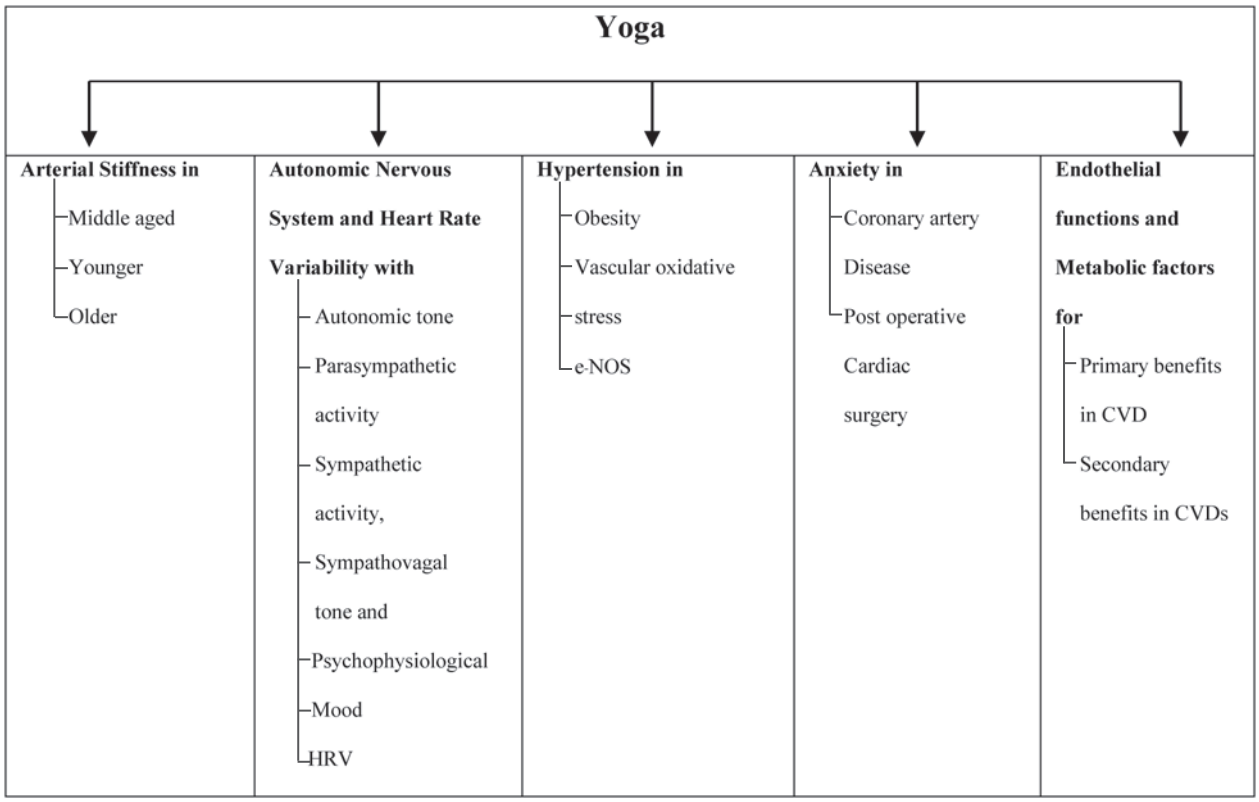
A study by Esfahani HN et al, supports our findings of endothelial functional improvement; a precursor of arterial stiffness, by their results in that yoga helps to improve the endothelial functions in subjects with migraine headaches.[31] Yang, in her review documented the reduction in body weight, blood pressure, glucose level, and high cholesterol

following yoga intervention.[32] This is in support of our review findings in controlling metabolic factors; such as, blood glucose levels and, lipid profiles in young people practicing yoga.

Yoga's primary and secondary benefits in CVDs have been demonstrated in research; including people of all ages. In today's environment, stress has been discovered to be a major contributory factor in many diseases, including CVD; particularly among the younger population.[33] In multiple studies, yoga has been found to lower CVD risk factors; such as, body weight, lipid profile, blood pressure, smoking, psychosocial stress, and type 2 diabetes mellitus.[34-36] It is worth mentioning that yoga's secondary effects for CVD have only been documented in a few studies. After coronary bypass surgery, yoga-based cardiac rehabilitation on Left Ventricular Ejection Fraction (LVEF), lipid profile, and psychological stress clearly reveals that yoga improves LVEF, lipids, hyperglycemia, stress, anxiety, and depression, and is shown to be an effective lifestyle intervention.[37]

On the flip side, no study has documented the direct and positive impact on arterial stiffness. Moreover, studies currently available are subject to the limitation of having a small group from the population. Further, studies with larger population sizes, and conducted over a longer duration are needed to formulate the reliable benefits of yoga on arterial stiffness.

Table 1 Benefits of yoga on cardiovascular disease



HRV=heart rate variability, e-NOS=endothelial nitric oxide synthase, CVD=cardiovascular disease

Conclusion

Gleaned from the scientific literature, the present review (Table 1) concludes yoga as having beneficial effects on pulse wave velocity; especially, in the young age group as compared to middle aged and elderly people. Furthermore, yoga proves to be more beneficial for young obese, hypertensive, and the sedentary lifestyle generation. The beneficial effects of yoga on cardiovascular disease are due to the decrease in sympathetic activity and psychological relaxation of both the mind and body.

Conflict of interest

There is no conflict of interest among the authors.

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