

**A COMPREHENSIVE REHABILITATION APPROACH FOR
ENDOTHELIAL DYSFUNCTION IN
HYPERTENSION:MEDITATION AND YOGA**

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Abstract:Cardiovascular disease (CVD) is the leading cause of death worldwide and causes serious health and economic problems. Studies show that yoga and meditation can help prevent and manage CVD by improving vascular health. Review of research indicates that yoga practices, including body postures (Asanas),breathing exercises (Pranayama) and deep relaxation (Shavasana) can improve endothelial function an early marker of cardiovascular health. These practices help reduce stress, balance the nervous system and lower inflammation. They are safe, low-cost and can complement conventional medical treatments. However, results vary across studies due to differences in study design, duration and participant characteristics.

Keywords:Yoga, Meditation, Shavasana, Pranyama, Asanas

Introduction. Cardiovascular disease (CVD) continues to be the leading global cause of mortality, responsible for more than 30% of all deaths worldwide. Despite significant advances in healthcare, CVD accounts for over 17 million deaths each year and this figure is projected to increase to approximately 23 million by 2023. Low- and middle-income countries bear a disproportionate burden, contributing to nearly 80% of CVD-related deaths globally. In the United States, the annual economic burden of CVD is estimated at \$555 billion, with projections indicating a rise to \$1.1 trillion by 2035. Globally, the total cost of CVD is expected to increase from around US \$863 billion to more than US \$1 trillion by 2030.

Many studies have shown that stress-reducing methods such as meditation, progressive muscle relaxation and yoga can help prevent and manage cardiovascular disease. In 2017, the American Heart Association (AHA) also suggested that meditation may be a low-cost and useful addition to traditional medical treatments for reducing the risk of CVD.[1]

Shavasana (deep relaxation). Shavasana, commonly referred to as the “corpse pose, is a deep relaxation technique performed while lying flat on the back. In this position, the arms are placed approximately 15 cm away from the body with the palms facing upward, the legs are slightly apart and the eyes remain closed. The head and spine are aligned in a straight line and the participant remains still without falling asleep. During the practice, the instructor provides guided verbal instructions that direct attention to different parts of the body and to the breathing process, thereby facilitating a profound state of relaxation.[2]

Pranayama (breathing technique). Pranayama is a controlled breathing practice aimed at regulating the flow of vital energy, known as “prana” which is comparable to the concept of “chi” in Chinese medicine. This technique involves a structured breathing cycle consisting of four stages: slow and deep inhalation, breath retention, complete exhalation through a closed glottis and a second breath-holding phase. These stages are performed in a time ratio of 4:2:5:2. Throughout the breathing exercise, the hands are positioned in specific postures to help guide the flow of vital energy to different parts of the body.[3]

Asanas (postural exercises). Asanas are specific body postures designed to open and activate energy channels. During the practice of these postures, participants maintain awareness of their breathing. The

exercises are performed with an emphasis on avoiding overexertion and respecting individual physical limits.[4]

The review included 18 studies with a total of 1,024 participants. Ten of these were randomized controlled trials one was a cross-over study, four were non-randomized studies, and three used a before-and-after design. Yoga programs lasted from 10 days up to 52 weeks. In 12 of the 18 studies, yoga practice led to clear improvements in endothelial function in both healthy people and patients with conditions such as heart disease, heart attack, metabolic syndrome, high blood pressure, migraine and dysmenorrhea. However, six studies did not show significant benefits. Among the 15 controlled studies, seven measured flow-mediated dilation (FMD), while others assessed different markers of endothelial function, including nitric oxide, endothelin-1, asymmetric dimethylarginine and endothelial microparticles. A meta-analysis of the seven studies that measured FMD (involving 384 participants) showed that yoga practice significantly improved brachial artery FMD.[5]

Discussion. Current evidence suggests that yoga and meditation may beneficially influence vascular endothelial function, which is a key early marker of cardiovascular disease. A systematic review and meta-analysis of multiple interventional studies found that yoga practice significantly improved endothelial function as measured by flow-mediated dilation in healthy individuals and those with cardiovascular risk factors or disease, although a subset of studies reported no significant changes. However, differences in study design, intervention duration and participant characteristics make it difficult to generalize findings. Some studies reported no significant effects, highlighting the importance of consistency, adherence and baseline

health status. Future studies with larger samples and standardized yoga protocols are needed to clarify the independent contributions of physical postures, breathing exercises and meditation on vascular health.

Conclusion. Yoga and meditation provide measurable benefits to endothelial function and overall cardiovascular health. By reducing stress, improving autonomic balance and lowering inflammation, these interventions act as safe and low-cost complements to conventional therapies. While evidence supports their short-term effectiveness, further standardized, large-scale studies are needed to confirm long-term outcomes and identify optimal protocols for different populations.

References

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