American Heart Association | American Stroke Association

Embargoed until 1 pm ET/2 pm CT, Thursday, September 28, 2017

Meditation and Cardiovascular Risk Reduction

A Scientific Statement From the American Heart Association

Glenn N. Levine, MD, FAHA, Chair; Richard A. Lange, MD, MBA, FAHA, Vice Chair; C. Noel Bairey-Merz, MD, FAHA; Richard J. Davidson, PhD; Kenneth Jamerson, MD, FAHA; Puja K. Mehta, MD, FAHA; Erin D. Michos, MD, MHS, FAHA; Keith Norris, MD; Indranill Basu Ray, MD; Karen L. Saban, PhD, RN, APRN, CNRN, FAHA; Tina Shah, MD; Richard Stein, MD; Sidney C. Smith, Jr, MD, FAHA; on behalf of the American Heart Association Council on Clinical Cardiology; Council on Cardiovascular and Stroke Nursing; and Council on Hypertension

***Abstract*—**Despite numerous advances in the prevention and treatment of atherosclerosis, cardiovascular disease remains a leading cause of morbidity and mortality. Novel and inexpensive interventions that can contribute to the primary and secondary prevention of cardiovascular disease are of interest. Numerous studies have reported on the benefits of meditation. Meditation instruction and practice is widely accessible and inexpensive and may thus be a potential attractive cost-effective adjunct to more traditional medical therapies. Accordingly, this American Heart Association scientific statement systematically reviewed the data on the potential benefits of meditation on cardiovascular risk. Neurophysiological and neuroanatomical studies demonstrate that meditation can have long-standing effects on the brain, which provide some biological plausibility for beneficial consequences on the physiological basal state and on cardiovascular risk. Studies of the effects of meditation on cardiovascular risk have included those investigating physiological response to stress, smoking cessation, blood pressure reduction, insulin resistance and metabolic syndrome, endothelial function, inducible myocardial ischemia, and primary and secondary prevention of cardiovascular disease. Overall, studies of meditation suggest a possible benefit on cardiovascular risk, although the overall quality and, in some cases, quantity of study data are modest. Given the low costs and low risks of this intervention, meditation may be considered as an adjunct to guideline-directed cardiovascular risk reduction by those interested in this lifestyle modification, with the understanding that the benefits of such intervention remain to be better established. Further research on meditation and cardiovascular risk is warranted. Such studies, to the degree possible, should utilize randomized study design, be adequately powered to meet the primary study outcome, strive to achieve low drop-out rates, include long-term follow-up, and be performed by those without inherent bias in outcome. **(*J Am Heart Assoc*. 2017;6:e002218. DOI: 10.1161/JAHA.117.002218.)**

Key Words: AHA Scientific Statements • cardiovascular disease • cardiovascular risk • meditation • primary prevention • secondary prevention

Despite numerous advances in the prevention and treatment of atherosclerosis, cardiovascular disease (CVD) remains a leading cause of morbidity and mortality in the United States[1,2] and the developed world.[3–5] Although educational, lifestyle modifying, and pharmacological interventions have lowered the prevalence of cardiovascular risk factors, most Americans still have at least 1 major risk factor.[6,7] More than $200 billion are spent on care of patients with CVD in the United States annually, and this is expected to increase 2- to 3-fold over the next several decades.[2,8] Accordingly, novel and inexpensive interventions that are of benefit to patients and

The American Heart Association makes every effort to avoid any actual or potential conflicts of interest that may arise as a result of an outside relationship or a personal, professional, or business interest of a member of the writing panel. Specifically, all members of the writing group are required to complete and submit a Disclosure Questionnaire showing all such relationships that might be perceived as real or potential conflicts of interest.

This statement was approved by the American Heart Association Science Advisory and Coordinating Committee on March 13, 2017, and the American Heart Association Executive Committee on April 17, 2017. A copy of the document is available at http://professional.heart.org/statements by using either “Search for Guidelines & Statements” or the “Browse by Topic” area.

Accompanying Tables S1 through S9 are available at http://jaha.ahajournals.org/content/6/9/e002218/DC1/embed/inline-supplementary-material-1.pdf

The American Heart Association requests that this document be cited as follows: Levine GN, Lange RA, Bairey-Merz CN, Davidson RJ, Jamerson K, Mehta PK, Michos ED, Norris K, Ray IB, Saban KL, Shah T, Stein R, Smith SC Jr; on behalf of the American Heart Association Council on Clinical Cardiology; Council on Cardiovascular and Stroke Nursing; and Council on Hypertension. Meditation and cardiovascular risk reduction: a scientific statement from the American Heart Association. *J Am Heart Assoc.* 2017;6:e002218. DOI: 10.1161/JAHA.117.002218.

Expert peer review of AHA Scientific Statements is conducted by the AHA Office of Science Operations. For more on AHA statements and guidelines development, visit http://professional.heart.org/statements. Select the “Guidelines & Statements” drop-down menu, then click “Publication Development.”

can contribute to the primary and secondary prevention of CVD are of interest.

Dozens of studies have reported on the health benefits of meditation. According to the National Health Interview Survey, 8% of US adults practice some form of meditation.[9] Up to 14% to 24% of patients with CVD have been reported to use or to have used some form of mind-body therapy, and 2% to 3% use or have used some form of meditation.[10–13] In addition, half of CVD patients are interested in participating in a clinical trial of alternative therapies, and 17% are interested in participating in a clinical trial of meditation.[10–13] Many forms of meditation can be learned from publications, the internet, and audio media. Many meditation courses are available for a modest fee or voluntary contribution. Hence, meditation may be an attractive cost-effective adjunct to more traditional medical therapies. Accordingly, the American Heart Association commissioned this scientific statement to systematically and scientifically review the data on the potential benefits of meditation related to CVD.

Methodology

Studies on meditation and cardiovascular risk reduction were searched for on PubMed using search terms including meditation, stress, blood pressure, hypertension, smoking, tobacco use, insulin resistance, metabolic syndrome, atherosclerosis, endothelial function, myocardial ischemia, primary prevention, and secondary prevention. Additional searches were performed on Google and Google Scholar, because some articles on meditation are not listed in PubMed.

Practices such as tai chi, qigong, and yoga, although involving inner focus and a concentration on breathing, consist of both mental and physical practices. Regular physical activity and exercise has itself been associated with cardiovascular risk reduction,[14,15] and thus findings from such studies would be confounded. Therefore, this review was restricted to practices of sitting meditation.

For all sections examining the effects of meditation on aspects of cardiovascular risk, a primary author without relationships with industry and a secondary reviewer drafted the initial text and conclusions. All sections, tables, and conclusions were then reviewed by all writing group members and the manuscript revised based on this review. The manuscript was then reviewed by 4 external reviewers and revised accordingly. The finalized manuscript was approved by all writing group members.

Meditation

The practice of meditation dates as far back as 5000 BC.[16] Although associated with Eastern philosophies and religion, including Buddhism and Hinduism, references or inferences regarding meditation and the meditative process can be found in Christianity, Judaism, and Islam.[16] Over the past several decades, meditation is increasingly practiced as a secular and therapeutic activity.

In the traditional context, meditation refers to a family of mental practices that are designed to improve concentration, increase awareness of the present moment, and familiarize a person with the nature of their own mind.[16] In a more general and contemporary context, meditation can be categorized as primarily focused attention, mindfulness, loving kindness and compassion, or mantra repetition, although there is usually overlap between the focuses.[17–19] With focused attention ("samatha" meditation), the practitioner may focus on the breath or on an object, sound, sensation, visualization, thought, or repeated word or phrase ("mantra"). When the mind wanders, the meditator notices the mind wandering and learns to bring the mind back to the present moment or the object of meditation. In mindful meditation, the individual strives to be in the present moment and aware of internal sensations, thoughts, and external stimuli, without becoming engrossed in or distracted by them. Mindfulness-based stress reduction is a program based primarily on mindful meditation, as well as yoga; other mindfulness-based programs are similarly based on mindful meditation. Insight ("vipassana") meditation can be considered a form of mindful meditation. In loving kindness and compassion, the meditator cultivates a feeling of benevolence toward oneself and others. In Vedic or transcendental meditation, repeated thought of a word is used to relax and clear the mind. The "relaxation response" technique similarly uses focused silent repetition of a word, sound, or phase. These practices may be used to: (1) increase concentration, insight, or awareness of the present moment; (2) promote relaxation; (3) reduce stress; (4) settle the mind; (5) achieve a state of increased consciousness; and (6) reduce perceived suffering and increase happiness.

Table 1 provides a summary of common types of meditation. Most forms of meditation are practiced ≥20 minutes or once or twice daily. Although meditation was first practiced millennia ago as part of Buddhist and Hindu religions, it has recently been introduced in the West as a stand-alone secular activity.

Neurophysiology and Neuroanatomy of Meditation

Almost 2 decades of scientific studies, conducted at ≥20 universities, have identified the effects of meditation on the brain.[18] Most forms of meditation engage regions in the brain that regulate attention and emotion.[29] The adult brain can undergo changes through a process called neuroplasticity, which may include development of new circuits ("rewiring") and/or neurons.[30] The different psychological targets of meditation are instantiated in distributed neural circuits that

Table 1. Common Types of Meditation

Meditation	Description	Origins and Well-Known Teachers in the West
Samatha meditation	Samatha is translated to mean "calm" and samatha meditation is often referred to as calm, abiding meditation. Samatha meditation is the practice of calming the mind by practicing single-pointed meditation through mindful concentration focusing on the breath, image, or object.	Buddhist practice, dating to the time of the Buddha or even before
Vipassana meditation (insight meditation)	Vipassana is translated to mean, "to see things as they really are." Vipassana emphasizes awareness of the breath, tuning into the air passing in and out through the nose. Vipassana teaches one to label thoughts and experiences as they arise, taking mental notes as one identifies objects that grab one's attention. Vipassana meditation is often taught at 10-day retreats.	Traditional Buddhist and Indian meditation. Well-known teachers include Mahasi Sayadaw, S.N. Goenka, Sharon Salzberg, Joseph Goldestein, Jack Kornfield, and Michael Stone
Mindful meditation	An umbrella term for the category of techniques used to create awareness and insight by practicing focused attention, observing, and accepting all that arises without judgment. This type of meditation is also referred to as "open monitoring," in which one allows one's attention to flow freely without judgment or attachment.	Origins come from Buddhist teaching. Well-known Western teachers include Jon-Kabat Zinn, Tara Brach, Sharon Salzberg, Joseph Goldestein, Jack Kornfield, and Pema Chodron
Zen meditation (zazen)	A type of meditation where one focuses one's awareness on one's breath and observes thoughts and experiences as they pass through the mind and environment. In some senses similar to Vipassana meditation, but with an emphasis on a focus of the breath at the level of the belly and on posture while sitting.	Buddhist meditation from Japan. Well-known teachers include Thich Nhat Hanh and Joan Halifax Roshi
Raja yoga meditation	Referred to also as "mental yoga," "yoga of the mind," or Kriya yoga. A practice of concentration to calm the mind and bring it to one point of focus. Includes a combination of mantra, breathing techniques, and meditation on the chakras/spinal cord focus points.	Hindu practice dating back thousands of years. Introduced to the West in 1893 by Swami Vivekananda. Further clarified and taught by Paramhansa Yogananda for the Western audience
Loving-kindness (metta) meditation	Loving-kindness meditation involves sending loving kindness to oneself, then continuing to send it to a friend or loved one, to someone who is neutral in your life, to a difficult person, and then out to the universe. Through this practice, the meditator cultivates a feeling of benevolence toward oneself and others.	Originates from Buddhist teachings, mainly Tibetan Buddhism. Well-known instructors include Sharon Saltzberg and Pema Chodron
Transcendental meditation	Mantra-based meditation technique in which each practitioner is given a personal mantra that is used to help settle the mind inward. Transcendental meditation is taught by certified teachers through a standard 4-day course of instruction. Transcendental meditation is practiced for 20 minutes twice daily.	Origins in ancient Vedic traditions of India. Popularized in the West by the Maharishi Mahesh Yogi and now taught in the United States by the Maharishi Foundation
Relaxation response	A multifaceted practice that can involve awareness and tracking of breaths or repetition of a word, short phase, or prayer	A term and practice pioneered by Dr Herbert Benson in the 1970s, based in part of the practice of transcendental meditation

There is no definitive definition of most types of meditation. These descriptions represent a synthesis of numerous sources and are best viewed as a general overview of the techniques. Initial table concept from references 20 and 21. Additional data from references 16–19 and 22–28.
Table adapted with permission from Rakel,[21] *Integrative Medicine*, 3rd ed. Copyright Elsevier 2012.

include different sectors of the prefrontal cortex and anterior cingulate cortex, the insula, and the midline regions that are important in default mode function.[31] In addition, studies of loving-kindness and/or compassion meditation practices often lead to alterations in subcortical circuits directly implicated in emotional processing, such as the amygdala and ventral striatum.[29,32,33]

Studies of the effects on meditation on the brain include those using electroencephalography, magnetic resonance imaging, and functional magnetic resonance imaging. Whereas numerous studies have reported on the acute neurophysiological effects of meditation, more relevant to this scientific statement are long-term neurophysiological and neuroanatomical changes. In 1 of the first reports on the long-term effects of meditation on the brain, a 2-month mindfulness meditation program resulted in increased left-sided anterior brain electrical activation, a pattern associated with positive affect and emotion, whereas no such changes occurred in a wait-listed control group.[34] A study of long-standing Buddhist meditation practitioners demonstrated

durable electroencephalographic changes, suggesting that the resting state of the brain may be altered by long-term meditative practices.[35] A brain magnetic resonance imaging study of experienced meditators found, when compared with age-matched controls, higher gray matter density in lower brainstem regions involved in the autonomic system and cardiorespiratory control.[36] Some, though not all, longitudinal studies of 1 to 3 months of mindful meditation have demonstrated changes in brain structure and function not observed in control participants.[37] A meta-analysis of 21 neuroimaging studies examining ≈300 meditation practitioners found 8 brain regions consistently altered in meditators, including areas key to meta-awareness, body awareness, and self- and emotion regulation.[38] Anatomical changes have been reported in the cerebral cortex, subcortical gray and white matter, brainstem, and cerebellum of meditators.[37]

Neurophysiological and neuroanatomical studies suggest that meditation can have long-standing effects on the brain, which may have beneficial consequences on the physiological basal state, physiological responses, and cardiovascular risk. However, these studies generally were nonrandomized and involved modest numbers of participants, some of whom were highly experienced (>10 000 hours) meditators. Additionally, different forms of meditation (eg, focused attention, mindfulness, and loving kindness) will have different psychological and neurological effects. Thus, the neurophysiological and neuroanatomical findings associated with 1 type of meditation cannot be extrapolated to all forms. Extrapolation of the findings in the aforementioned studies to the general population who engage in meditation must be done with caution.

Meditation and Cardiovascular Risk Reduction

A summary of the findings on meditation and cardiovascular risk reduction is provided in Table 2. Summaries of the individual studies, as well as their limitations, evaluated in this scientific statement are provided in Tables S1 through S9. These summary tables are not all-inclusive but summarize the findings of those studies deemed most relevant to this scientific statement. Findings on the effects of meditation on specific aspects of cardiovascular health are given in the following sections.

Effects of Meditation on Psychological, Psychosocial, and Physiological Responses to Stress

Numerous studies, across both healthy and disease-based populations, have explored the effects of meditation on psychological and psychosocial outcomes. Most published studies report some improvements in levels of perceived stress, mood, anxiety, depression, quality of sleep, or overall well-being[39–45] (Table S1). A review by the Agency for Healthcare Research and Quality restricted to randomized, controlled trials with an active control concluded—with low strength of evidence—that mindfulness meditation programs show modest improvements in stress/distress and negative affect.[46]

Few studies have focused on patients with CVD. In a study of 60 patients recruited from a private cardiology clinic, those randomized to 8 weeks of mindfulness-based stress reduction (primarily using meditation techniques) had significantly lower perceived stress and anger[47] than a comparison control group. Similarly, a study of 59 elderly participants with stage I hypertension randomized to Zen meditation (20 minutes twice daily for 3 months) or a wait list found that meditation significantly improved psychological facets of and overall quality of life.[48]

A growing body of research has examined the mechanisms by which meditation alters the physiological response to stress, with salivary cortisol the most commonly studied biomarker and a few exploring salivary amylase,[49] proinflammatory cytokines (ie, interleukin-6), or telomerase activity. Overall, findings from these studies have been mixed, with some demonstrating improvements in physiological parameters with meditation and others finding no changes.[39,43,44,50–56]

Several recent studies have focused on the impact of meditation on proteomic and genomic regulators of the physiological stress response.[51,57,58] Although unique gene expression profiles have been noted with meditation, their association with established physiological parameters is unknown.[59] One study of 40 patients reported that mindfulness-based stress reduction downregulated proinflammatory nuclear factor kappa B gene expression profile compared to wait-list control, with a trend—but no statistically significant reduction—in C-reactive protein levels.[57]

Overall, many, though not all, studies have reported that meditation is associated with improved psychological and psychosocial indices. Differences in study populations, control of potential confounders, and type and length of meditation evaluated may account for discrepant findings. Furthermore, small sample sizes and lack of randomization are common study limitations. Further study is needed on how meditation influences physiological processes associated with stress.

Effects of Meditation on Blood Pressure

Few high-quality, randomized trials of meditation and lowering of blood pressure have been published (Table S2). The efficacy of mindfulness meditation for blood pressure reduction has been evaluated in a few studies.[48,60–62] The HARMONY (Hypertension Analysis of Stress Reduction Using Mindfulness Meditation and Yoga) trial assessed 24-hour ambulatory blood

Table 2. Summary of Findings on Studies of Meditations and Cardiovascular Risk Reduction*

Topic	Findings
Neurophysiology and neuroanatomy	• Neurophysiological and neuroanatomical studies suggest that meditation can have long-standing effects on brain physiology and anatomy • Studies generally are nonrandomized and involve modest numbers of participants, sometimes performed under the direction of extremely experienced (>10 000 hours) meditators • Different forms of meditation have different psychological and neurological effects, and thus the neurophysiological and neuroanatomic findings of 1 type of meditation cannot be extrapolated to other forms of meditation
Psychological, psychosocial, and physiological response to stress	• Many, although not all, studies report that meditation is associated with improved psychological and psychosocial indices • Differences in populations, control of potential confounders, and type and length of meditation evaluated may account for discrepant findings. Small sample sizes and lack of randomization are common study limitations • Further study is needed on how meditation influences physiological processes associated with the stress response
Blood pressure	• Magnitude of reductions of systolic blood pressure varies widely • Study limitations including the methods of blood pressure measurements and bias in data ascertainment, high dropout rates, and different populations studied
Smoking and tobacco use	• Some randomized data show that mindful meditation instruction improves smoking cessation rates
Insulin resistance and metabolic syndrome	• Limited data on the effects of meditation on insulin resistance and metabolic syndrome
Subclinical atherosclerosis	• A few suboptimal studies of meditation and lifestyle intervention suggest the potential for benefit on atherosclerosis regression • Studies limited by multimodality approach, attrition, and incomplete follow-up • No firm conclusions can be drawn on the effects of meditation on atherosclerosis
Endothelial function	• Three studies showed no benefit of meditation on brachial reactivity in the overall cohorts, although 1 study suggested a benefit in a subgroup of patients with coronary artery disease • No conclusions can be drawn on the effects of meditation on endothelial function
Inducible myocardial ischemia	• Limited older studies suggest that meditation can lead to improvement in exercise duration and decreased myocardial ischemia • No contemporary studies have evaluated effects of meditation on myocardial blood flow or ischemia with advanced imaging techniques
Primary prevention of CVD	• Two studies of short-term intervention report surprising mortality reductions, and thus these findings need to be reproduced in larger, multicenter studies • Overall, because of the limited evidence to date, no conclusions can be drawn as to the effectiveness of meditation for the primary prevention of CVD
Secondary prevention of CVD	• Data on the potential benefits of meditation in patients with established coronary artery disease can best be characterized as generally of modest quality and as suggesting, but not definitely establishing, benefit • Because of generally limited follow-up time, there are more data on reduction of cardiac risk factors and psychological indices than on hard end points (eg, death, myocardial infarction)

*Summaries of the individual studies, as well as their limitations, evaluated in this scientific statement are provided in Tables S1 through S9.
CVD indicates cardiovascular disease.

pressure measurements in patients with stage I hypertension randomized to an 8-week mindfulness-based stress reduction program or wait-list control and found no benefit of meditation.[63] In contrast, in a pilot study of 83 predominantly hypertensive blacks randomized to a mindful meditation program or control social support group, an 11/4 mm Hg decrease in systolic/diastolic blood pressure was observed in those randomized to 8 weeks of treatment and an analysis-adjusted 22/17 mm Hg difference in blood pressure between the 2 groups at follow-up.[64] Of note, this trial had 100% data ascertainment, over 80% compliance at each clinic visit, and measured blood pressure with an unattended manual device (a rigorous protocol with measurements 7–15 mm Hg lower than typical office readings). Other mind-body interventions that

involve both a physical and mental component have been associated with significant reductions in blood pressure,[65–69] but the specific contribution of meditation and meditation-like practices of inner focus and a concentration on the breath cannot be determined.

The effects of transcendental meditation on blood pressure have also been reported.[70–73] A study of 298 university students randomized to transcendental meditation or wait-list control found at 3-month follow-up no significant changes in systolic or diastolic blood pressure, although significant reductions in blood pressure (5/3 mm Hg, respectively) did occur in those at high risk of the development of hypertension.[71] In a randomized study of stress reduction in 201 black men and women with angiographically documented coronary artery disease randomized to transcendental meditation or health education, 5.4-year follow-up found a 4.9 mm Hg lower systolic blood pressure, 1 of numerous secondary study end points, in those randomized to transcendental meditation than in those randomized to health education, primarily because of an increase in blood pressure in the health education group.[70]

Numerous systematic reviews have been conducted on the effects of meditation on blood pressure. One 2007 systematic review assessed several methods of stress reduction in patients with hypertension and found modest benefit (ie, 5/3 mm Hg systolic/diastolic blood pressure reduction) with transcendental meditation; other popular types of meditation were not assessed.[74] Numerous meta-analyses in a 2007 Agency for Healthcare Research and Quality report on meditation and health generally found modest to no significant benefit with different meditation techniques when compared with active control groups (eg, health education), though the report also stated that meta-analyses based on low-quality studies and small numbers of hypertensive participants showed that transcendental meditation and Zen Buddhist meditation significantly reduced blood pressure.[75] A 2013 American Heart Association scientific statement on alternate approaches to lowering blood pressure concluded that transcendental meditation modestly lowers blood pressure and that its use may be considered.[75] The writing group also concluded at that time that there were insufficient high-quality studies assessing the benefit of other forms of meditative techniques to recommend them for blood pressure lowering. A 2015 analysis of 12 randomized, clinical trials of transcendental meditation involving a total of 996 predominantly black patients with or without hypertension found a mean reduction in blood pressure of 4/2 mm Hg (systolic/diastolic) over the study duration of 2 to 60 months (mean 4 months) when compared with control participants.[72] Benefit in systolic blood pressure reduction seemed to persist up to 12 months.[70–73,76] Of note, the completion rate (percentage of patients who completed all training and post-test) in these studies was a modest 63%.

The mechanism(s) whereby meditation lowers blood pressure when it occurs has not been fully elucidated.[77] Possibly, the long-term neurophysiological changes that occur with meditation[35–37,78] may lead to autonomic nervous system–mediated changes in blood pressure. One study of 15 participants with hypertension and chronic kidney disease reported a decrease in muscle sympathetic nerve activity and blood pressure during mindfulness meditation,[79] but no such long-term data exist. The impact of stress reduction on blood pressure remains to be better defined.

Reported reductions of systolic blood pressure with meditation vary widely. The heterogeneity in results reflects the various study populations, study designs, data ascertainment protocols, study duration, baseline blood pressure, and blood pressure measurement techniques used. Limitations to clinical interpretation include high drop-out rates, bias in data ascertainment, and lack of attention to statistical power, control participants, and methods of blood pressure measurements.[46,80] The ability to generalize the findings is limited by the lack of reproducibility of results.

Effects of Meditation on Smoking and Tobacco Use

Cigarette smoking is the leading cause of preventable disease and deaths in the United States, accounting for >480 000 deaths every year, or 1 of every 5 deaths.[81,82] Two thirds of American adults want to quit smoking, and yet only ≈6% achieve this goal annually.[83] Several types of meditation have been studied as interventions to facilitate smoking cessation (Table S3). Small studies[84–89] have shown that mindfulness training, a form of meditation, increases abstinence rates when compared with more traditional intervention programs. In 1 study of volunteers wishing to reduce stress, half of whom were smokers, who were randomized to either a 2-week program of integrative body-mind technique—a form of mindfulness meditation—or relaxation training, a 60% reduction in smoking was observed among those instructed in integrative body-mind technique, with no reduction in those instructed in relaxation training. In this study, resting-state brain scans before and after intervention showed increased activity in the anterior cingulate and prefrontal cortex—areas of the brain that are related to self-control—for the meditation group, but not the relaxation training group.[90] A meta-analysis of 4 randomized, controlled trials of mindfulness training involving a total of 474 patients found that it was more effective than group counseling, with 25% of mindfulness training participants remaining abstinent from smoking for >4 months, compared with 14% of those receiving more-traditional cessation instruction.[91] One study of transcendental meditation in 295 college students found no significant reduction in cigarette smoking at 3-month follow-up between

those randomized to transcendental meditation and those in a wait-list control group.[92]

Thus, some randomized data show that mindful meditation instruction improves smoking cessation rates. Potential mechanisms include management of cravings and decreasing negative effect, which has been shown to be a potent stimulus for drug-seeking behavior and smoking relapse. Meditation may also affect smoking behavior through changes in urge intensity[87] and improved self-control.[90]

Effects of Meditation on Insulin Resistance and Metabolic Syndrome

Metabolic syndrome, a cluster of conditions including hypertension, dyslipidemia, elevated fasting blood glucose, and abdominal obesity, is a risk factor for diabetes mellitus and CVD.[93–95] Data on the effects of meditation on insulin resistance and metabolic syndrome are sparse (Table S4). In a study of 103 patients with coronary artery disease randomized to transcendental meditation or active control (health education), transcendental meditation improved insulin resistance.[96] A study of the effects of meditation, yoga, and a vegetarian diet on parameters of metabolic syndrome[97] was too confounded by the multimodality approach to draw meaningful conclusions.

The relaxation response—the counterpart of the stress response—can be evoked by meditation. In 1 novel study,[98] 20 minutes of listening to a relaxation response instructional CD reduced expression of genes linked to inflammatory response and the stress-related pathway—mechanisms that contribute to metabolic syndrome[99,100]—and enhanced expression of genes associated with energy metabolism, mitochondrial function, and insulin secretion. Changes in gene expression were more pronounced in experienced practitioners of relaxation techniques than in novices who had recently undergone 8 weeks of relaxation response training. The clinical effects of these changes in gene expression, if any, remain unknown.

A comprehensive review of metabolic syndrome and mind-body therapies identified only 3 relevant clinical trials, 2 of which are discussed above and the third of which involved restorative yoga as the primary intervention.[101] In summary, data on the effects of meditation on insulin resistance and metabolic syndrome are limited.

Effects of Meditation on Subclinical Atherosclerosis

Limited evidence exists for the effects of meditation on subclinical atherosclerosis (Table S5). Only 1 randomized, controlled trial was identified that studied the effects of a meditation intervention on atherosclerosis progression.[102] In this study, carotid intimal thickness was assessed in 138 hypertensive blacks randomized to a transcendental meditation or control health education program and followed for a mean of 7 months. Attrition was high, with 57% of participants not completing follow-up. Among completers of the study, carotid intimal thickness regression was noted in the meditation group, whereas progression occurred in controls, with the difference between the 2 groups being statistically significant. In another randomized study, 57 healthy adults aged ≥65 years were randomized to 1 of 3 interventions: a transcendental meditation program that also included diet, exercise, and vitamin treatment; a diet/exercise/vitamin arm without the meditation component; or a usual care arm.[103] At 1 year, the meditation intervention group showed reduction in carotid intimal thickness that was not observed in the other groups.

Other studies on subclinical atherosclerosis evaluated more comprehensive multimodality lifestyle interventions that generally included components of dietary changes, exercise, and stress management (including components of meditative practice).[104–107] Study end points included changes in coronary artery atherosclerosis as assessed by quantitative coronary angiography[104–106] and ankle-brachial indices.[107] Although these studies showed favorable effects of lifestyle intervention on atherosclerosis regression, given the multimodality approach, it is difficult to discern the effects of the meditation component alone. Study result interpretation is also limited by attrition and incomplete follow-up. In summary, although a few studies of meditation and lifestyle intervention suggest the potential for benefit on atherosclerosis progression, no firm conclusions can be made on the effects of meditation alone on atherosclerosis.

Effects of Meditation on Endothelial Function

Endothelial function can be indirectly assessed by evaluating brachial artery endothelial vasomotor response. In a pilot study of 41 participants (33 of whom completed the study), a 6-week combined yoga and meditation intervention failed to significantly improve endothelial function, although there was improvement in the cohort of 10 patients with coronary artery disease.[108] In a trial of 103 patients with coronary artery disease (84 of whom completed follow-up) randomized to 16 weeks of transcendental meditation or control health education, meditation had no significant effect on brachial artery reactivity testing.[96] In a trial of 68 black Americans with metabolic syndrome risk factors, consciously resting meditation improved flow-mediated dilation at 12-month follow-up, but compared with changes in the control

health-education group, this improvement was not significantly different.[109] Only 38 participants (56%) completed the 12-month follow-up.

Limitations of these studies variably include modest sample size, relatively short durations of intervention, high attrition rates, and incomplete follow-up (Table S6). Given these factors, as well as the different patient populations studied and variable findings in those with established coronary artery disease, no definitive conclusions on the effects of meditation on endothelial function can be made.

Effects of Meditation on Inducible Myocardial Ischemia

A paucity of studies has examined the effects of meditation on inducible myocardial ischemia (Table S7). In a 1996 study of 21 participants with coronary artery disease, 7.6 months of transcendental meditation led to significant increases in exercise duration (15%) and maximal workload (12%) compared with wait-listed controls, as well as lower rate-pressure products at given workloads and significantly delayed onset of ST depression.[110] In a 1983 study of 46 patients with ischemic heart disease that combined stress management (meditation and stretching/relaxation exercises) and a vegan-based diet, after 24 days those randomized to the lifestyle-intervention group had a 44% increase in exercise duration, 55% increase in total work, and improved exercise ejection fraction and regional wall motion, whereas no significant changes occurred in those randomized to the control group.[111]

No contemporary studies have evaluated the impact of meditation on myocardial blood flow or ischemia with techniques such as stress echocardiography, single-photon emission computed tomography, cardiac positron emission tomography, or cardiac magnetic resonance imaging. Larger, randomized, clinical studies that evaluate the impact of meditation-based interventions on inducible myocardial ischemia, ideally using more sophisticated modalities to assess and quantify ischemia, are needed.

Meditation and Primary Prevention of CVD

Although studies have assessed the effect of meditation on cardiovascular risk factors, recent Cochrane reviews[112–115] have concluded that no properly conducted randomized, controlled trials have assessed its role in the primary prevention of cardiovascular mortality or nonfatal primary end points. This is largely because the relevant studies are small, with short-term follow-up and carried out in predominantly healthy participants.

One study[116] measured survival rate in 73 elderly participants randomly assigned to 3 months of transcendental meditation, mindfulness training, mental relaxation, or a no-treatment control group. The survival rate after 3 years for the transcendental meditation group was significantly better; 100% compared with 65% to 87% for other groups. In a second study, mortality and cause of death were assessed from vital statistics over 8 years of follow-up in 109 older black patients who had participated in a hypertension study. Participants were randomly assigned to 2 stress reduction approaches—either transcendental meditation or progressive muscle relaxation—or to a health education (ie, control) group for 3 months. The adjusted relative risk for CVD mortality was significantly reduced by 81% in the transcendental meditation group when compared with the control group.[117] In both studies, mortality was assessed 3 to 8 years after the intervention period, so the results may not be attributed to transcendental meditation. This and other methodological issues raise concerns about the validity of their findings.

When patient data from the abovementioned 2 randomized, controlled trials were combined in a post-hoc analysis,[8] the transcendental meditation group reportedly showed a 23% reduction in all-cause mortality compared with the control patients, a 30% reduction in cardiovascular mortality, and a nonstatistically significant 51% reduction in rate of cancer mortality (Table S8). These studies of short-term intervention applied to a limited number of participants report surprising mortality reductions that are on par with, or greater than, those observed in long-term intervention, large-scale, primary prevention studies of cholesterol therapy[118] and of blood pressure reduction.[119,120] Accordingly, these findings need to be reproduced in larger, multicenter studies.

In summary, data regarding the effectiveness of meditation for primary prevention of CVD are lacking, and because of the limited evidence to date, no conclusions can be drawn as to the effectiveness of meditation for the primary prevention of CVD.

Meditation and Secondary Prevention of CVD

Limited and limited-quality data are available from studies of meditation for secondary prevention of CVD (Table S9). Such studies, which generally have enrolled patients with stable coronary artery disease, have variably reported reductions in systolic blood pressure, insulin resistance, serum lipids, clinical symptoms, and anxiety and stress.[70,96,106,110,121–127] Most, although not all, studies randomized patients to either meditation or some type of "usual care." These studies are generally limited by modest sample size and limited duration

follow-up, and a few assessed multifactorial interventions that combined meditation with other interventions (ie, yoga, diet). A systematic review and meta-analysis of randomized, controlled trials of mind-body practices, including meditation but other interventions as well, found that such interventions were associated with improvements in physical and mental quality of life, depression and anxiety, and systolic and diastolic blood pressure, but rated the overall quality of the studies as low.[128]

One commonly cited study involves 201 patients with angiographically documented coronary artery disease randomized to transcendental meditation or health education.[70] After a mean of 5.4 years, the primary composite end point of all-cause mortality, nonfatal myocardial infarction, or nonfatal stroke was significantly lower in the meditation group (adjusted hazard ratio, 0.52). Post-hoc analysis found greater benefit (hazard ratio, 0.34) in those with high adherence. There was a nonsignificant 24% reduction in the broader secondary composite endpoint, which also included coronary revascularization or hospitalization for cardiac causes. The study, though, was conducted in 2 phases after a 1-year hiatus with 58 patients not participating in phase 2 of the study, and some concerns about analysis of the data have been raised.[129,130]

Overall, data on the potential benefits of meditation in patients with established coronary artery disease can best be characterized as of modest quality and suggesting, but not definitely establishing, benefit in secondary prevention. Because of the generally limited follow-up time, more data on reduction of cardiac risk factors and psychological indices (eg, stress, anxiety, and depression) exist than on hard end points (eg, death or myocardial infarction).

Summary

Studies of meditation to date suggest a *possible*, though not definitively established, benefit of meditation on cardiovascular risk reduction. A 2008 review of >400 trials of meditation and health care rated the methodological quality of clinical trials as poor, but noted that the quality of these trials had significantly improved over time.[80] Methodological issues in research to date include modest study size, limited and often incomplete follow-up, high drop-out rates, lack of randomization and/or appropriate control group, and unavoidable patient non-blinded study design. As with many other novel interventions, there is the possibility of publication bias toward positive studies of the beneficial effects of meditation.[37,38] Many investigators who conducted studies of meditation may have a strong belief in the benefits of meditation and may be enthusiastic meditators themselves,[37] thereby introducing the possibility of unintended bias. Many studies of meditation techniques are performed by the same groups of researchers, so there is a need for independent verification of reported positive findings. Whereas these studies are important in that they serve to suggest that meditation may reduce cardiovascular risk, these limitations prevent definitive conclusions regarding efficacy of meditation on cardiovascular risk reduction.

Table 3. Summary of Findings and Suggestions on Meditation and Cardiovascular Risk Reduction

- Studies of meditation suggest a *possible* benefit on cardiovascular risk, although the overall quality and, in some cases, quantity of study data is modest
- The mainstay for primary and secondary prevention of CVD is ACC/AHA guideline-directed interventions
- Meditation may be considered as an adjunct to guideline-directed cardiovascular risk reduction by those interested in this lifestyle modification with the understanding that the benefits of such intervention remain to be better established
- Further research on meditation and cardiovascular risk is warranted. Such studies, to the degree possible, should meet the following criteria:
  - Utilize a randomized study design
  - Blinded adjudication of end points
  - Adequate power to meet the primary study outcome(s)
  - Include long-term follow-up
  - Have <20% dropout rate
  - Have >85% follow-up data
  - Be performed by investigators without inherent financial or intellectual bias in outcome

ACC indicates American College of Cardiology; AHA, American Heart Association; CVD, cardiovascular disease.

Currently, the mainstay for primary and secondary prevention of CVD is American College of Cardiology/American Heart Association guideline-directed interventions. However, considering the generally low costs and risks associated with meditation, meditation may be considered as a reasonable adjunct to guideline-directed cardiovascular risk reduction by those so interested in this lifestyle modification, with the understanding that the benefits of such intervention remain to be better established.

Further research on meditation and cardiovascular risk is warranted. Such studies, to the degree possible, should utilize randomized study design, be adequately powered to detect clinically meaningful benefit, include long-term follow-up, and be performed by those without inherent bias in outcome. One such example is the ongoing Yoga-CaRe study for secondary prevention of myocardial infarction.[131] A summary of findings on meditation and cardiovascular risk reduction and on suggested methodology for future research are given in Table 3.

Disclosures

Writing Group Disclosures

Writing Group Member	Employment	Research Grant	Other Research Support	Speakers' Bureau/ Honoraria	Expert Witness	Ownership Interest	Consultant/ Advisory Board	Other
Glenn N. Levine	Baylor College of Medicine	None	None	None	None	None	None	None
Richard A. Lange	Paul L. Foster School of Medicine, Texas Tech University Health Science Center	None	None	None	None	None	None	None
C. Noel Bairey-Merz	Cedars-Sinai Heart Institute	WISE HFpEF†; RWISE†; Microvascular*; Normal Control*; FAMRI*	None	Pri-Med*; Practice Point*; Annenberg Center for Health Science*; American Diabetes Assn.*; Expert Exchange*; Japanese Circulation Society*; Kaiser*; Mayo*; Pacific Medical Center*; University of Colorado*; Valley Health Grand Rounds*; VBWG*; UCSF*; University of Utah*; Women's Health Congress*; WomenHeart*; New York University*; San Bernardino 18th Cardiology Symposium*; UCSC*; Northwestern*	None	None	NIH-CASE NIH grant review study section*; NHLBI Research Triangle Institute (RTA)†; Sanofi*; ACRWH (NIH advisory council)*	None
Richard J. Davidson	University of Wisconsin-Madison	None	None	None	None	None	Healthy Minds Innovations, Inc.*	None
Kenneth Jamerson	University of Michigan Health System	NIDDK*; Bayer*	None	None	None	None	None	None
Puja K. Mehta	Emory Medicine/ Cardiology	General Electric†; Gilead Sciences†	None	None	None	None	None	None
Erin D. Michos	Johns Hopkins University School of Medicine	None	None	None	None	None	None	None
Keith Norris	University of California, Los Angeles	None	None	None	None	None	None	None
Indranill Basu Ray	Texas Heart Institute/Baylor College of Medicine	None	None	None	None	None	None	None

Continued

Writing Group Disclosures Continued

Writing Group Member	Employment	Research Grant	Other Research Support	Speakers' Bureau/ Honoraria	Expert Witness	Ownership Interest	Consultant/ Advisory Board	Other
Karen L. Saban	Loyola University Chicago Marcella Niehoff School of Nursing	VA (PI for VA funded grant examining Mindfulness in Women Veterans)*	None	None	None	None	None	None
Tina Shah	Michael E. DeBakey VA Medical Center and Baylor College of Medicine	None	None	None	None	None	None	None
Sidney C. Smith, Jr	University of North Carolina	None	None	None	None	None	None	None
Richard Stein	New York University School of Medicine	None	None	None	Martin Clearwater and Bell-Defendant Law Firm*; Angel and Mccarthy-Defendant Law Firm*	None	None	None

This table represents the relationships of writing group members that may be perceived as actual or reasonably perceived conflicts of interest as reported on the Disclosure Questionnaire, which all members of the writing group are required to complete and submit. A relationship is considered to be "significant" if (a) the person receives $10 000 or more during any 12-month period, or 5% or more of the person's gross income; or (b) the person owns 5% or more of the voting stock or share of the entity, or owns $10 000 or more of the fair market value of the entity. A relationship is considered to be "modest" if it is less than "significant" under the preceding definition.

*Modest.

†Significant.

Reviewer Disclosures

Reviewer	Employment	Research Grant	Other Research Support	Speakers' Bureau/ Honoraria	Expert Witness	Ownership Interest	Consultant/ Advisory Board	Other
David S. Krantz	Uniformed Services University of the Health Sciences	None	None	None	None	None	None	None
Seth S. Martin	Johns Hopkins School of Medicine	None	Apple (Apple watches: in-kind support)*	None	None	None	None	None
Michael D. Shapiro	Oregon Health and Science University	None	None	None	None	None	None	None
Salim S. Virani	VA Medical Center Health Services/Baylor College of Medicine	None	None	None	None	None	None	None

This table represents the relationships of reviewers that may be perceived as actual or reasonably perceived conflicts of interest as reported on the Disclosure Questionnaire, which all reviewers are required to complete and submit. A relationship is considered to be "significant" if (a) the person receives $10 000 or more during any 12-month period, or 5% or more of the person's gross income; or (b) the person owns 5% or more of the voting stock or share of the entity, or owns $10 000 or more of the fair market value of the entity. A relationship is considered to be "modest" if it is less than "significant" under the preceding definition.

*Significant.

References

1. Centers for Disease Control and Prevention. Heart disease facts. 2016. Available at: http://www.cdc.gov/heartdisease/facts.htm. Accessed September 23, 2016.
2. Benjamin EJ, Blaha MJ, Chiuve SE, Cushman M, Das SR, Deo R, de Ferranti SD, Floyd J, Fornage M, Gillespie C, Isasi CR, Jimenez MC, Jordan LC, Judd SE, Lackland D, Lichtman JH, Lisabeth L, Liu S, Longenecker CT, Mackey RH, Matsushita K, Mozaffarian D, Mussolino ME, Nasir K, Neumar RW, Palaniappan L, Pandey DK, Thiagarajan RR, Reeves MJ, Ritchey M, Rodriguez CJ, Roth GA, Rosamond WD, Sasson C, Towfighi A, Tsao CW, Turner MB, Virani SS, Voeks JH, Willey JZ, Wilkins JT, Wu JHY, Alger HM, Wong SS, Muntner P; on behalf of the American Heart Association Statistics Committee and Stroke Statistics Subcommittee. Heart disease and stroke statistics—2017 update: a report from the American Heart Association [published correction appears in *Circulation*. 2017;135:e646]. *Circulation*. 2017;135:e146–e603. DOI: 10.1161/CIR.0000000000000485.

3. Writing Committee, Smith SC Jr, Collins A, Ferrari R, Holmes DR Jr, Logstrup S, McGhie DV, Ralston J, Sacco RL, Stam H, Taubert K, Wood DA, Zoghbi WA. Our time: a call to save preventable death from cardiovascular disease (heart disease and stroke). *Glob Heart*. 2012;7:297–305.
4. World Health Organization. Global health observatory data repository. Cardiovascular diseases, deaths per 100,000. Data by country. 2016. Available at: http://apps.who.int/gho/data/node.main.A865CARDIOVASCULAR?lang=en. Accessed September 23, 2016.
5. World Heart Federation. Deaths due to cardiovascular disease. 2016. Available at: http://www.world-heart-federation.org/cardiovascular-health/global-facts-map/. Accessed September 23, 2016.
6. Fryer CD, Chen TC, Li X. Prevalence of uncontrolled risk factors for cardiovascular disease: United States, 1999–2010. 2012. NCHS Data Brief. No 102. Available at: http://www.cdc.gov/nchs/data/databriefs/db103.pdf. Accessed September 23, 2016.
7. National Center for Chronic Disease Prevention and Health Promotion. Centers for Disease Control and Prevention. National Diabetes Statistics Report, 201. 2014. Available at: http://www.cdc.gov/diabetes/pubs/statsreport14/national-diabetes-report-web.pdf. Accessed September 23, 2016.
8. Heidenreich PA, Trogdon JG, Khavjou OA, Butler J, Dracup K, Ezekowitz MD, Finkelstein EA, Hong Y, Johnston SC, Khera A, Lloyd-Jones DM, Nelson SA, Nichol G, Orenstein D, Wilson PW, Woo YJ; on behalf of the American Heart Association Advocacy Coordinating Committee; Stroke Council; Council on Cardiovascular Radiology and Intervention; Council on Clinical Cardiology; Council on Epidemiology and Prevention; Council on Arteriosclerosis; Thrombosis and Vascular Biology; Council on Cardiopulmonary; Critical Care; Perioperative and Resuscitation; Council on Cardiovascular Nursing; Council on the Kidney in Cardiovascular Disease; Council on Cardiovascular Surgery and Anesthesia, and Interdisciplinary Council on Quality of Care and Outcomes Research. Forecasting the future of cardiovascular disease in the United States: a policy statement from the American Heart Association. *Circulation*. 2011;123:933–944.
9. Use of complementary health approaches in the U.S. National Health Interview Survey. National Center for Complementary and Integrative Health. National Institute of Medicine. 2012. Available at: https://nccih.nih.gov/research/statistics/NHIS/2012/mind-body/meditation. Accessed September 23, 2016.
10. Prasad K, Sharma V, Lackore K, Jenkins SM, Prasad A, Sood A. Use of complementary therapies in cardiovascular disease. *Am J Cardiol*. 2013;111:339–345.
11. Saydah SH, Eberhardt MS. Use of complementary and alternative medicine among adults with chronic diseases: United States 2002. *J Altern Complement Med*. 2006;12:805–812.
12. Leung YW, Tamim H, Stewart DE, Arthur HM, Grace SL. The prevalence and correlates of mind-body therapy practices in patients with acute coronary syndrome. *Complement Ther Med*. 2008;16:254–261.
13. Yeh GY, Davis RB, Phillips RS. Use of complementary therapies in patients with cardiovascular disease. *Am J Cardiol*. 2006;98:673–680.
14. Thompson PD, Buchner D, Piña IL, Balady GJ, Williams MA, Marcus BH, Berra K, Blair SN, Costa F, Franklin B, Fletcher GF, Gordon NF, Pate RR, Rodriguez BL, Yancey AK, Wenger NK. Exercise and physical activity in the prevention and treatment of atherosclerotic cardiovascular disease: a statement from the Council on Clinical Cardiology (Subcommittee on Exercise, Rehabilitation, and Prevention) and the Council on Nutrition, Physical Activity, and Metabolism (Subcommittee on Physical Activity). *Circulation*. 2003;107:3109–3116.
15. Shiroma EJ, Lee IM. Physical activity and cardiovascular health: lessons learned from epidemiological studies across age, gender, and race/ethnicity. *Circulation*. 2010;122:743–752.
16. Gawler I, Bedson P. *Meditation. An In-Depth Guide*. New York, NY: Jeremy P. Tarcher/Penguin; 2011.
17. Meditation. National Center for Complementary and Integrative Health. National Institute of Health. 2016. Available at: https://nccih.nih.gov/health/meditation?nav=govd. Accessed February 26, 2017.
18. Ricard M, Lutz A, Davidson RJ. Mind of the meditator. *Sci Am*. 2014;311:38–45.
19. Goyal M, Singh S, Sibinga EM, Gould NF, Rowland-Seymour A, Sharma R, Berger Z, Sleicher D, Maron DD, Shihab HM, Ranasinghe PD, Linn S, Saha S, Bass EB, Haythornthwaite JA. Meditation programs for psychological stress and well-being: a systematic review and meta-analysis. *JAMA Intern Med*. 2014;174:357–368.
20. Pantuso T. *Meditation Types and Clinical Use*. Chicago, IL: AHC Media; 2015.
21. Rakel D. *Integrative Medicine*. 3rd ed. Philadelphia, PA: Saunders; 2012.
22. Eisler M. 11 meditation styles and techniques explained. 2015. Available at: https://mindfulminutes.com/meditation-styles-techniques-explained/. Accessed February 26, 2017.
23. Wallace B. The Buddhist tradition of Samatha. *J Conscious Stud*. 1999;6:175–187.
24. Types of meditation: extensive list of techniques. 2016. Available at: http://mentalhealthdaily.com/2015/03/24/types-of-meditation-extensive-list-of-techniques/. Accessed February 26, 2017.
25. Maharishi Foundation USA. What is TM? 2017. Available at: https://www.tm.org/transcendental-meditation. Accessed February 26, 2017.
26. ZEN-BUDDHISM.NET. Zen Buddhism. 2017. Available at: http://www.zen-buddhism.net/practice/zen-meditation.html. Accessed February 26, 2017.
27. Mitchell M. Dr. Herbert Benson's Relaxation Response. 2017. Available at: https://www.psychologytoday.com/blog/heart-and-soul-healing/201303/dr-herbert-benson-s-relaxation-response. Accessed February 26, 2017.
28. Nazari J, Hebert M. Raja Yogis. 2017. Available at: http://www.rajayogis.net/content/raja-yoga. Accessed February 26, 2017.
29. Lutz A, Slagter HA, Dunne JD, Davidson RJ. Attention regulation and monitoring in meditation. *Trends Cogn Sci*. 2008;12:163–169.
30. Davidson RJ, Lutz A. Buddha's brain: neuroplasticity and meditation. *IEEE Signal Process Mag*. 2008;25:176–174.
31. Brewer JA, Worhunsky PD, Gray JR, Tang YY, Weber J, Kober H. Meditation experience is associated with differences in default mode network activity and connectivity. *Proc Natl Acad Sci USA*. 2011;108:20254–20259.
32. Weng HY, Fox AS, Shackman AJ, Stodola DE, Caldwell JZ, Olson MC, Rogers GM, Davidson RJ. Compassion training alters altruism and neural responses to suffering. *Psychol Sci*. 2013;24:1171–1180.
33. Klimecki OM, Leiberg S, Ricard M, Singer T. Differential pattern of functional brain plasticity after compassion and empathy training. *Soc Cogn Affect Neurosci*. 2014;9:873–879.
34. Davidson RJ, Kabat-Zinn J, Schumacher J, Rosenkranz M, Muller D, Santorelli SF, Urbanowski F, Harrington A, Bonus K, Sheridan JF. Alterations in brain and immune function produced by mindfulness meditation. *Psychosom Med*. 2003;65:564–570.
35. Lutz A, Greischar LL, Rawlings NB, Ricard M, Davidson RJ. Long-term meditators self-induce high-amplitude gamma synchrony during mental practice. *Proc Natl Acad Sci USA*. 2004;101:16369–16373.
36. Vestergaard-Poulsen P, van Beek M, Skewes J, Bjarkam CR, Stubberup M, Bertelsen J, Roepstorff A. Long-term meditation is associated with increased gray matter density in the brain stem. *Neuroreport*. 2009;20:170–174.
37. Tang YY, Holzel BK, Posner MI. The neuroscience of mindfulness meditation. *Nat Rev Neurosci*. 2015;16:213–225.
38. Fox KC, Nijeboer S, Dixon ML, Floman JL, Ellamil M, Rumak SP, Sedlmeier P, Christoff K. Is meditation associated with altered brain structure? A systematic review and meta-analysis of morphometric neuroimaging in meditation practitioners. *Neurosci Biobehav Rev*. 2014;43:48–73.
39. Carlson LE, Doll R, Stephen J, Faris P, Tamagawa R, Drysdale E, Speca M. Randomized controlled trial of mindfulness-based cancer recovery versus supportive expressive group therapy for distressed survivors of breast cancer. *J Clin Oncol*. 2013;31:3119–3126.
40. Tang YY, Ma Y, Wang J, Fan Y, Feng S, Lu Q, Yu Q, Sui D, Rothbart MK, Fan M, Posner MI. Short-term meditation training improves attention and self-regulation. *Proc Natl Acad Sci USA*. 2007;104:17152–17156.
41. Black DS, O'Reilly GA, Olmstead R, Breen EC, Irwin MR. Mindfulness meditation and improvement in sleep quality and daytime impairment among older adults with sleep disturbances: a randomized clinical trial. *JAMA Intern Med*. 2015;175:494–501.
42. Klatt MD, Buckworth J, Malarkey WB. Effects of low-dose mindfulness-based stress reduction (MBSR-ld) on working adults. *Health Educ Behav*. 2009;36:601–614.
43. Pace TW, Negi LT, Adame DD, Cole SP, Sivilli TI, Brown TD, Issa MJ, Raison CL. Effect of compassion meditation on neuroendocrine, innate immune and behavioral responses to psychosocial stress. *Psychoneuroendocrinology*. 2009;34:87–98.
44. Cash E, Salmon P, Weissbecker I, Rebholz WN, Bayley-Veloso R, Zimmaro LA, Floyd A, Dedert E, Sephton SE. Mindfulness meditation alleviates fibromyalgia symptoms in women: results of a randomized clinical trial. *Ann Behav Med*. 2015;49:319–330.
45. Speca M, Carlson LE, Goodey E, Angen M. A randomized, wait-list controlled clinical trial: the effect of a mindfulness meditation-based stress reduction program on mood and symptoms of stress in cancer outpatients. *Psychosom Med*. 2000;62:613–622.
46. Goyal M, Singh SS, Sibinga EM, Gould NF, Rowland-Seymour A, Sharma R, Berger Z, Sleicher D, Maron DD, Shihab HM, Ranasinghe PD, Linn S, Saha S, Bass EB, Haythornthwaite JA. Meditation programs for psychological stress and well-being. Comparitive Effectiveness Review No. 124. Rockville, MD: Agency for Healthcare Research and Quality; 2014.

47. Momeni J, Omidi A, Raygan F, Akbari H. The effects of mindfulness-based stress reduction on cardiac patients' blood pressure, perceived stress, and anger: a single-blind randomized controlled trial. *J Am Soc Hypertens*. 2016;10:763–771.
48. de Fatima Rosas MM, Kozasa EH, Miranda RD, Monezi Andrade AL, Perrotti TC, Leite JR. Decrease in blood pressure and improved psychological aspects through meditation training in hypertensive older adults: a randomized control study. *Geriatr Gerontol Int*. 2015;15:1158–1164.
49. Lipschitz DL, Kuhn R, Kinney AY, Donaldson GW, Nakamura Y. Reduction in salivary alpha-amylase levels following a mind-body intervention in cancer survivors—an exploratory study. *Psychoneuroendocrinology*. 2013;38:1521–1531.
50. Rosenkranz MA, Davidson RJ, Maccoon DG, Sheridan JF, Kalin NH, Lutz A. A comparison of mindfulness-based stress reduction and an active control in modulation of neurogenic inflammation. *Brain Behav Immun*. 2013;27:174–184.
51. Epel ES, Puterman E, Lin J, Blackburn EH, Lum PY, Beckmann ND, Zhu J, Lee E, Gilbert A, Rissman RA, Tanzi RE, Schadt EE. Meditation and vacation effects have an impact on disease-associated molecular phenotypes. *Transl Psychiatry*. 2016;6:e880.
52. Jacobs TL, Epel ES, Lin J, Blackburn EH, Wolkowitz OM, Bridwell DA, Zanesco AP, Aichele SR, Sahdra BK, MacLean KA, King BG, Shaver PR, Rosenberg EL, Ferrer E, Wallace BA, Saron CD. Intensive meditation training, immune cell telomerase activity, and psychological mediators. *Psychoneuroendocrinology*. 2011;36:664–681.
53. Carlson LE, Speca M, Faris P, Patel KD. One year pre-post intervention follow-up of psychological, immune, endocrine and blood pressure outcomes of mindfulness-based stress reduction (MBSR) in breast and prostate cancer outpatients. *Brain Behav Immun*. 2007;21:1038–1049.
54. Malarkey WB, Jarjoura D, Klatt M. Workplace based mindfulness practice and inflammation: a randomized trial. *Brain Behav Immun*. 2013;27:145–154.
55. Witek-Janusek L, Albuquerque K, Chroniak KR, Chroniak C, Durazo-Arvizu R, Mathews HL. Effect of mindfulness based stress reduction on immune function, quality of life and coping in women newly diagnosed with early stage breast cancer. *Brain Behav Immun*. 2008;22:969–981.
56. Jensen CG, Vangkilde S, Frokjaer V, Hasselbalch SG. Mindfulness training affects attention—or is it attentional effort? *J Exp Psychol Gen*. 2012;141:106–123.
57. Creswell JD, Irwin MR, Burklund LJ, Lieberman MD, Arevalo JM, Ma J, Breen EC, Cole SW. Mindfulness-based stress reduction training reduces loneliness and pro-inflammatory gene expression in older adults: a small randomized controlled trial. *Brain Behav Immun*. 2012;26:1095–1101.
58. Qu S, Olafsrud SM, Meza-Zepeda LA, Saatcioglu F. Rapid gene expression changes in peripheral blood lymphocytes upon practice of a comprehensive yoga program. *PLoS One*. 2013;8:e61910.
59. Bower JE, Irwin MR. Mind-body therapies and control of inflammatory biology: a descriptive review. *Brain Behav Immun*. 2016;51:1–11.
60. Manikonda JP, Störk S, Tögel S, Lobmüller A, Grünberg I, Bedel S, Schardt F, Angermann CE, Jahns R, Voelker W. Contemplative meditation reduces ambulatory blood pressure and stress-induced hypertension: a randomized pilot trial. *J Hum Hypertens*. 2008;22:138–140.
61. Hughes JW, Fresco DM, Myerscough R, van Dulmen MH, Carlson LE, Josephson R. Randomized controlled trial of mindfulness-based stress reduction for prehypertension. *Psychosom Med*. 2013;75:721–728.
62. Gregoski MJ, Barnes VA, Tingen MS, Harshfield GA, Treiber FA. Breathing awareness meditation and LifeSkills Training programs influence upon ambulatory blood pressure and sodium excretion among African American adolescents. *J Adolesc Health*. 2011;48:59–64.
63. Blom K, Baker B, How M, Dai M, Irvine J, Abbey S, Abramson BL, Myers MG, Kiss A, Perkins NJ, Tobe SW. Hypertension analysis of stress reduction using mindfulness meditation and yoga: results from the HARMONY randomized controlled trial. *Am J Hypertens*. 2014;27:122–129.
64. Palta P, Page G, Piferi RL, Gill JM, Hayat MJ, Connolly AB, Szanton SL. Evaluation of a mindfulness-based intervention program to decrease blood pressure in low-income African-American older adults. *J Urban Health*. 2012;89:308–316.
65. Chung SC, Brooks MM, Rai M, Balk JL, Rai S. Effect of Sahaja yoga meditation on quality of life, anxiety, and blood pressure control. *J Altern Complement Med*. 2012;18:589–596.
66. Yeh GY, Wang C, Wayne PM, Phillips RS. The effect of tai chi exercise on blood pressure: a systematic review. *Prev Cardiol*. 2008;11:82–89.
67. Xiong X, Wang P, Li X, Zhang Y. Qigong for hypertension: a systematic review. *Medicine (Baltimore)*. 2015;94:e352.
68. Dhameja K, Singh S, Mustafa MD, Singh KP, Banerjee BD, Agarwal M, Ahmed RS. Therapeutic effect of yoga in patients with hypertension with reference to GST gene polymorphism. *J Altern Complement Med*. 2013;19:243–249.
69. Hagins M, States R, Selfe T, Innes K. Effectiveness of yoga for hypertension: systematic review and meta-analysis. *Evid Based Complement Alternat Med*. 2013;2013:649836.
70. Schneider RH, Grim CE, Rainforth MV, Kotchen T, Nidich SI, Gaylord-King C, Salerno JW, Kotchen JM, Alexander CN. Stress reduction in the secondary prevention of cardiovascular disease: randomized, controlled trial of transcendental meditation and health education in Blacks. *Circ Cardiovasc Qual Outcomes*. 2012;5:750–758.
71. Nidich SI, Rainforth MV, Haaga DA, Hagelin J, Salerno JW, Travis F, Tanner M, Gaylord-King C, Grosswald S, Schneider RH. A randomized controlled trial on effects of the Transcendental Meditation program on blood pressure, psychological distress, and coping in young adults. *Am J Hypertens*. 2009;22:1326–1331.
72. Bai Z, Chang J, Chen C, Li P, Yang K, Chi I. Investigating the effect of transcendental meditation on blood pressure: a systematic review and meta-analysis. *J Hum Hypertens*. 2015;29:653–662.
73. Anderson JW, Liu C, Kryscio RJ. Blood pressure response to transcendental meditation: a meta-analysis. *Am J Hypertens*. 2008;21:310–316.
74. Rainforth MV, Schneider RH, Nidich SI, Gaylord-King C, Salerno JW, Anderson JW. Stress reduction programs in patients with elevated blood pressure: a systematic review and meta-analysis. *Curr Hypertens Rep*. 2007;9:520–528.
75. Ospina MB, Bond K, Karkhaneh M, Tjosvold L, Vandermeer B, Liang Y. *Meditation Practices for Health: State of the Research*. Rockville, MD: Agency for Healthcare Research and Quality Evidence Report/Technology Assessment Number 155; 2007.
76. Urushidani S, Kuriyama A. Transcendental meditation and blood pressure. *J Hum Hypertens*. 2016;30:354.
77. Brook RD, Appel LJ, Rubenfire M, Ogedegbe G, Bisognano JD, Elliott WJ, Fuchs FD, Hughes JW, Lackland DT, Staffileno BA, Townsend RR, Rajagopalan S; on behalf of the American Heart Association Professional Education Committee of the Council for High Blood Pressure Research, Council on Cardiovascular and Stroke Nursing, Council on Epidemiology and Prevention, and Council on Nutrition, Physical Activity and Metabolism. Beyond medications and diet: alternative approaches to lowering blood pressure: a scientific statement from the American Heart Association. *Hypertension*. 2013;61:1360–1383.
78. Xiong GL, Doraiswamy PM. Does meditation enhance cognition and brain plasticity? *Ann N Y Acad Sci*. 2009;1172:63–69.
79. Park J, Lyles RH, Bauer-Wu S. Mindfulness meditation lowers muscle sympathetic nerve activity and blood pressure in African-American males with chronic kidney disease. *Am J Physiol Regul Integr Comp Physiol*. 2014;307:R93–R101.
80. Ospina MB, Bond K, Karkhaneh M, Buscemi N, Dryden DM, Barnes V, Carlson LE, Dusek JA, Shannahoff-Khalsa D. Clinical trials of meditation practices in health care: characteristics and quality. *J Altern Complement Med*. 2008;14:1199–1213.
81. United States. Public Health Service. Office of the Surgeon General, United States. Department of Health and Human Services. *The Health Consequences of Smoking: 50 Years of Progress: A Report of the Surgeon General*. Rockville, MD: US Department of Health and Human Services; 2014.
82. Jha P, Ramasundarahettige C, Landsman V, Rostron B, Thun M, Anderson RN, McAfee T, Peto R. 21st-century hazards of smoking and benefits of cessation in the United States. *N Engl J Med*. 2013;368:341–350.
83. Quitting smoking among adults—United States, 2001–2010. *MMWR Morb Mortal Wkly Rep*. 2011;60:1513–1519.
84. Davis JM, Fleming MF, Bonus KA, Baker TB. A pilot study on mindfulness based stress reduction for smokers. *BMC Complement Altern Med*. 2007;7:2.
85. Davis JM, Mills DM, Stankevitz KA, Manley AR, Majeskie MR, Smith SS. Pilot randomized trial on mindfulness training for smokers in young adult binge drinkers. *BMC Complement Altern Med*. 2013;13:215.
86. Davis JM, Goldberg SB, Anderson MC, Manley AR, Smith SS, Baker TB. Randomized trial on mindfulness training for smokers targeted to a disadvantaged population. *Subst Use Misuse*. 2014;49:571–585.
87. Davis JM, Manley AR, Goldberg SB, Smith SS, Jorenby DE. Randomized trial comparing mindfulness training for smokers to a matched control. *J Subst Abuse Treat*. 2014;47:213–221.
88. Brewer JA, Mallik S, Babuscio TA, Nich C, Johnson HE, Deleone CM, Minnix-Cotton CA, Byrne SA, Kober H, Weinstein AJ, Carroll KM, Rounsaville B. Mindfulness training for smoking cessation: results from a randomized controlled trial. *Drug Alcohol Depend*. 2011;119:72–80.
89. Davis JM, Manley AR, Goldberg SB, Stankevitz KA, Smith SS. Mindfulness training for smokers via web-based video instruction with phone support: a prospective observational study. *BMC Complement Altern Med*. 2015;15:95.

90. Tang YY, Tang R, Posner MI. Brief meditation training induces smoking reduction. *Proc Natl Acad Sci USA*. 2013;110:13971–13975.

91. Oikonomou MT, Arvanitis M, Sokolove RL. Mindfulness training for smoking cessation: a meta-analysis of randomized-controlled trials. *J Health Psychol*. 2016 April 4. pii: 1359105316637667. [Epub ahead of print]

92. Haaga DA, Grosswald S, Gaylord-King C, Rainforth M, Tanner M, Travis F, Nidich S, Schneider RH. Effects of the transcendental meditation program on substance use among university students. *Cardiol Res Pract*. 2011;2011:537101.

93. Grundy SM, Cleeman JI, Daniels SR, Donato KA, Eckel RH, Franklin BA, Gordon DJ, Krauss RM, Savage PJ, Smith SC Jr, Spertus JA, Costa F. Diagnosis and management of the metabolic syndrome: an American Heart Association/National Heart, Lung, and Blood Institute scientific statement. *Circulation*. 2005;112:2735–2752.

94. Isomaa B, Almgren P, Tuomi T, Forsén B, Lahti K, Nissén M, Taskinen MR, Groop L. Cardiovascular morbidity and mortality associated with the metabolic syndrome. *Diabetes Care*. 2001;24:683–689.

95. Reilly MP, Rader DJ. The metabolic syndrome: more than the sum of its parts? *Circulation*. 2003;108:1546–1551.

96. Paul-Labrador M, Polk D, Dwyer JH, Velasquez I, Nidich S, Rainforth M, Schneider R, Merz CN. Effects of a randomized controlled trial of transcendental meditation on components of the metabolic syndrome in subjects with coronary heart disease. *Arch Intern Med*. 2006;166:1218–1224.

97. Khatri D, Mathur KC, Gahlot S, Jain S, Agrawal RP. Effects of yoga and meditation on clinical and biochemical parameters of metabolic syndrome. *Diabetes Res Clin Pract*. 2007;78:e9–e10.

98. Bhasin MK, Dusek JA, Chang BH, Joseph MG, Denninger JW, Fricchione GL, Benson H, Libermann TA. Relaxation response induces temporal transcriptome changes in energy metabolism, insulin secretion and inflammatory pathways. *PLoS One*. 2013;8:e62817.

99. Cai D, Liu T. Inflammatory cause of metabolic syndrome via brain stress and NF-kappaB. *Aging (Albany NY)*. 2012;4:98–115.

100. Hotamisligil GS. Inflammation and metabolic disorders. *Nature*. 2006;444:860–867.

101. Anderson J, Taylor AG. The metabolic syndrome and mind-body therapies: a systematic review. *J Nutr Metab*. 2011;2011:276419.

102. Castillo-Richmond A, Schneider RH, Alexander CN, Cook R, Myers H, Nidich S, Haney C, Rainforth M, Salerno J. Effects of stress reduction on carotid atherosclerosis in hypertensive African Americans. *Stroke*. 2000;31:568–573.

103. Fields JZ, Walton KG, Schneider RH, Nidich S, Pomerantz R, Suchdev P, Castillo-Richmond A, Payne K, Clark ET, Rainforth M. Effect of a multimodality natural medicine program on carotid atherosclerosis in older subjects: a pilot trial of Maharishi Vedic Medicine. *Am J Cardiol*. 2002;89:952–958.

104. Ornish D, Brown SE, Scherwitz LW, Billings JH, Armstrong WT, Ports TA, McLanahan SM, Kirkeeide RL, Brand RJ, Gould KL. Can lifestyle changes reverse coronary heart disease? The Lifestyle Heart Trial. *Lancet*. 1990;336:129–133.

105. Ornish D, Scherwitz LW, Billings JH, Brown SE, Gould KL, Merritt TA, Sparler S, Armstrong WT, Ports TA, Kirkeeide RL, Hogeboom C, Brand RJ. Intensive lifestyle changes for reversal of coronary heart disease. *JAMA*. 1998;280:2001–2007.

106. Gupta SK, Sawhney RC, Rai L, Chavan VD, Dani S, Arora RC, Selvamurthy W, Chopra HK, Nanda NC. Regression of coronary atherosclerosis through healthy lifestyle in coronary artery disease patients—Mount Abu Open Heart Trial. *Indian Heart J*. 2011;63:461–469.

107. Zhang Y, Li N, Sun J, Su Q. Effects of combined traditional Chinese exercises on blood pressure and arterial function of adult female hypertensive patients. *Res Sports Med*. 2013;21:98–109.

108. Sivasankaran S, Pollard-Quintner S, Sachdeva R, Pugeda J, Hoq SM, Zarich SW. The effect of a six-week program of yoga and meditation on brachial artery reactivity: do psychosocial interventions affect vascular tone? *Clin Cardiol*. 2006;29:393–398.

109. Vaccarino V, Kondwani KA, Kelley ME, Murrah NV, Boyd L, Ahmed Y, Meng YX, Gibbons GH, Hooper WC, De Staercke C, Quyyumi AA. Effect of meditation on endothelial function in Black Americans with metabolic syndrome: a randomized trial. *Psychosom Med*. 2013;75:591–599.

110. Zamarra JW, Schneider RH, Besseghini I, Robinson DK, Salerno JW. Usefulness of the transcendental meditation program in the treatment of patients with coronary artery disease. *Am J Cardiol*. 1996;77:867–870.

111. Ornish D, Scherwitz LW, Doody RS, Kesten D, McLanahan SM, Brown SE, DePuey E, Sonnemaker R, Haynes C, Lester J, McAllister GK, Hall RJ, Burdine JA, Gotto AM Jr. Effects of stress management training and dietary changes in treating ischemic heart disease. *JAMA*. 1983;249:54–59.

112. Hartley L, Mavrodaris A, Flowers N, Ernst E, Rees K. Transcendental meditation for the primary prevention of cardiovascular disease. *Cochrane Database Syst Rev*. 2014;(12):CD010359.

113. Hartley L, Flowers N, Lee MS, Ernst E, Rees K. Tai chi for primary prevention of cardiovascular disease. *Cochrane Database Syst Rev*. 2014;(4):CD010366.

114. Hartley L, Lee MS, Kwong JS, Flowers N, Todkill D, Ernst E, Rees K. Qigong for the primary prevention of cardiovascular disease. *Cochrane Database Syst Rev*. 2015;(6):CD010390.

115. Hartley L, Dyakova M, Holmes J, Clarke A, Lee MS, Ernst E, Rees K. Yoga for the primary prevention of cardiovascular disease. *Cochrane Database Syst Rev*. 2014;(5):CD010072.

116. Alexander CN, Langer EJ, Newman RI, Chandler HM, Davies JL. Transcendental meditation, mindfulness, and longevity: an experimental study with the elderly. *J Pers Soc Psychol*. 1989;57:950–964.

117. Barnes J, Schneider RH, Alexander CN, Rainforth M, Staggers F, Salerno J. Impact of transcendental meditation on mortality in older African Americans with hypertension—eight-year follow-up. *J Soc Behav Pers*. 2005;17:201–216.

118. Shepherd J, Cobbe SM, Ford I, Isles CG, Lorimer AR, MacFarlane PW, McKillop JH, Packard CJ. Prevention of coronary heart disease with pravastatin in men with hypercholesterolemia. West of Scotland Coronary Prevention Study Group. *N Engl J Med*. 1995;333:1301–1307.

119. Major outcomes in high-risk hypertensive patients randomized to angiotensin-converting enzyme inhibitor or calcium channel blocker vs diuretic: the Antihypertensive and Lipid-Lowering Treatment to Prevent Heart Attack Trial (ALLHAT). *JAMA*. 2002;288:2981–2997.

120. Wright JT Jr, Williamson JD, Whelton PK, Snyder JK, Sink KM, Rocco MV, Reboussin DM, Rahman M, Oparil S, Lewis CE, Kimmel PL, Johnson KC, Goff DC Jr, Fine LJ, Cutler JA, Cushman WC, Cheung AK, Ambrosius WT. A randomized trial of intensive versus standard blood-pressure control. *N Engl J Med*. 2015;373:2103–2116.

121. DuBroff R, Lad V, Murray-Krezan C. A prospective trial of ayurveda for coronary heart disease: a pilot study. *Altern Ther Health Med*. 2015;21:52–62.

122. Parswani MJ, Sharma MP, Iyengar S. Mindfulness-based stress reduction program in coronary heart disease: a randomized control trial. *Int J Yoga*. 2013;6:111–117.

123. Nehra DK, Sharma NR, Kumar P, Nehra S. Efficacy of mindfulness-based stress reduction (MBSR) program in reducing perceived stress and health complaints in patients with coronary heart disease. *Dysphrenia*. 2014;5:19-25.

124. Delui MH, Yari M, Khouyinezhad G, Amini M, Bayazi MH. Comparison of cardiac rehabilitation programs combined with relaxation and meditation techniques on reduction of depression and anxiety of cardiovascular patients. *Open Cardiovasc Med J*. 2013;7:99–103.

125. Tacón AM, McComb J, Caldera Y, Randolph P. Mindfulness meditation, anxiety reduction, and heart disease: a pilot study. *Fam Community Health*. 2003;26:25–33.

126. Robert McComb JJ, Tacon A, Randolph P, Caldera Y. A pilot study to examine the effects of a mindfulness-based stress-reduction and relaxation program on levels of stress hormones, physical functioning, and submaximal exercise responses. *J Altern Complement Med*. 2004;10:819–827.

127. Sullivan MJ, Wood L, Terry J, Brantley J, Charles A, McGee V, Johnson D, Krucoff MW, Rosenberg B, Bosworth HB, Adams K, Cuffe MS. The Support, Education, and Research in Chronic Heart Failure Study (SEARCH): a mindfulness-based psychoeducational intervention improves depression and clinical symptoms in patients with chronic heart failure. *Am Heart J*. 2009;157:84–90.

128. Younge JO, Gotink RA, Baena CP, Roos-Hesselink JW, Hunink MG. Mind-body practices for patients with cardiac disease: a systematic review and meta-analysis. *Eur J Prev Cardiol*. 2015;22:1385–1398.

129. Olex S, Newberg A, Figueredo VM. Meditation: should a cardiologist care? *Int J Cardiol*. 2013;168:1805–1810.

130. Husten L. Archives decides at last minute not to publish scheduled paper. Cardiobrief. Available at: http://cardiobrief.org/2011/06/27/archivesdecidesatlastminutenottopublishascheduledpaper/. Accessed June 27, 2011.

131. Kinra S, Ebrahim S, Pocock SJ, Chaturvedi N, Roberts IG, Acharya AK, Hughes AD. Development and evaluation of a yoga-based cardiac rehabilitation programme (Yoga-CaRe) for secondary prevention of myocardial infarction. 2017. Available at: http://gtr.rcuk.ac.uk/projects?ref=MR/J000175/1. Accessed February 12, 2017.