Meditation and Cardiovascular Health in the US

Chayakrit Krittanawong, MD[a,b,c,*], Anirudh Kumar, MD[d], Zhen Wang, PhD[e,f], Bharat Narasimhan, MD[c], Hani Jneid, MD[a,b], Salim S. Virani, MD, PhD[a,b], and Glenn N. Levine, MD[a,b]

The 2017 American Heart Association Scientific Statement on meditation and cardiovascular risk suggested that meditation may be considered as an adjunct to guideline-directed cardiovascular risk-reduction interventions. Meditation could potentially increase physical and mental relaxation, leading to improved outcomes after a major cardiovascular event. We hypothesized that meditation is associated with lower cardiovascular risk in the US general population. Using data from the 2012 and 2017 National Health Interview Survey, we identified all patients with hypercholesterolemia, systemic hypertension (SH), diabetes mellitus (DM), stroke, and coronary artery disease (CAD), as well as those who reported that they meditate. Multivariable logistic regression analyses were performed to evaluate the association between meditation and risk of hypercholesterolemia, SH, DM, stroke, and CAD, adjusting for potential confounders. Of 61,267 the National Health Interview Survey participants, 5,851 (9.6%) participated in some form of meditation. After adjusting for age, gender, body mass index, race, marital status, cigarette smoking, sleeping duration, and depression, meditation was independently associated with a lower prevalence of hypercholesterolemia (odds ratio [OR] 0.65; 95% confidence interval [CI] 0.54 to 0.79; p = 0.001), SH (OR 0.86; 95% CI 0.75 to 0.99; p = 0.04), diabetes (OR 0.70; 95% CI 0.59 to 0.84; p = 0.0001), stroke (OR 0.76; 95% CI 0.58 to 0.99; p = 0.04), or CAD (OR 0.51; 95% CI 0.39 to 0.66; p <0.001), compared with those who did not meditate. In conclusion, using a large national database, we found that meditation is associated with a lower prevalence of cardiovascular risks factors and disease. **(Am J Cardiol 2020;131:23−26)**

Nonpharmacological lifestyle interventions are crucial for both primary and secondary cardiovascular disease (CVD) prevention. Meditation, a simple, cost-effective, and low-risk intervention, can result in decreased stress, greater mindfulness, and improved indices of psychological health, as well as long-term neurophysiologic and even neuroanatomic changes.[1−4] Numerous studies, including recent meta-analyses, have assessed the potential health benefits of meditation.[5−7] Although the data are far from definitive, there is the suggestion that meditation may have beneficial effects upon blood pressure, cholesterol level, smoking cessation, and overall cardiovascular risk.[3] The 2017 American Heart Association Scientific Statement on meditation and cardiovascular risk found that studies of meditation suggest a possible benefit on cardiovascular risk, although the overall quality and quantity of study data were limited. This statement concluded that meditation may be considered as an adjunct to guideline-directed cardiovascular risk reduction therapy by those interested in this method of lifestyle modification.[3] We thus aimed to utilize the National Health Interview Survey (NHIS) database to explore associations between meditation and cardiovascular risk.

Methods

The NHIS, an in-person household survey, has been one of the main primary surveys for monitoring the health of the US population.[8] The National Center for Health Statistics (NCHS) of the Centers for Disease Control and Prevention (CDC) has administered NHIS annually since 1957 by randomly selecting samples throughout the United States to assess a representative sample of the health of the civilian non-institutionalized US population. Any adult in the contacted household age 18 and older is eligible. The NHIS questionnaires include a set of basic health and demographic items. The NHIS's protocol and administration have been approved by the National Center for Health Statistics Research Ethics Review Board, and all NHIS participants provide informed consent.

The factors investigated in this study include the presence of hypercholesterolemia, systemic hypertension (SH), diabetes mellitus (DM), stroke, and coronary artery disease (CAD), defined based on the subject's response to survey questions, and compared between those who reported a meditation practice and those who did not. The primary outcomes were ascertained by an affirmative response to the question, "Have you ever been told by a doctor or health professional that your blood cholesterol level was high/you have hypertension/you have diabetes/you had a stroke/you had coronary heart disease?". We used the student's *t* test for continuous variables and Chi-squared

[a]The Michael E. DeBakey VA Medical Center, Houston, Texas; [b]Section of Cardiology, Baylor College of Medicine, Houston, Texas; [c]The Cardiovascular Institute, Icahn School of Medicine at Mount Sinai, Mount Sinai Heart, New York, New York; [d]Heart and Vascular Institute, Cleveland Clinic, Cleveland, Ohio; [e]Robert D. and Patricia E. Kern Center for the Science of Health Care Delivery, Mayo Clinic, Rochester, Minnesota; and [f]Division of Health Care Policy and Research, Department of Health Sciences Research, Mayo Clinic, Rochester, Minnesota, USA. Manuscript received May 12, 2020; revised manuscript received and accepted June 16, 2020.

See page 25 for disclosure information.

*Corresponding author: Tel: 713-798-4951. Twitter: @KrittanawongMD
E-mail address: Chayakrit.Krittanawong@bcm.edu (C. Krittanawong).

0002-9149/
https://doi.org/10.1016/j.amjcard.2020.06.043

test for categorical variables. Mean ± standard deviation was reported for continuous variables and frequency with percentages for categorical variables. We performed multivariable logistic regression analyses (Model 1) to assess the association between meditation and outcomes of interest (hypercholesterolemia, SH, DM, stroke, and CAD), adjusting for a priori selected candidate confounders, including age, gender, body mass index (BMI), race, marital status, cigarette smoking, alcohol consumption, moderate physical activities, exercise, sleep duration, and depression. We then conducted the backward stepwise elimination of the candidate variables, in which the criterion was set as $p > 0.20$. Significance was set by a 2-tailed α of 0.05. The findings were reported in the final model (Model 2) as odds ratios with 95% confidence intervals. All analyses were performed using R 3.4.0 and Stata version 14.2.

Results

Of 61,267 NHIS participants, 5,851 (9.6%) reported participation in meditation. Table 1 compares the baseline characteristics of those who reported practicing meditation those who reported no meditation practice. In univariate analysis, these meditation practitioners were younger, had a lower BMI, less likely to be cigarette smokers, exercise, sleep, more likely to be female, single or divorced, white, educated, and report a history of depression and less likely to have hypercholesterolemia, SH, DM, CAD, compared with non-meditators (all p-values <0.05). After adjusting for age, gender, BMI, race, marital status, cigarette smoking, sleeping duration, and depression, meditation practice was independently associated with a lower prevalence of hypercholesterolemia (odds ratio [OR] 0.65; 95% confidence interval [CI] 0.54 to 0.79; p = 0.001), SH (OR 0.86; 95% CI 0.75 to 0.99; p = 0.04), diabetes (OR 0.70; 95% CI 0.59 to 0.84; p = 0.0001), stroke (OR 0.76; 95% CI 0.58 to 0.99; p = 0.04), or CAD (OR 0.51; 95% CI 0.39 to 0.66; p <0.001), compared with those who did not meditate (Table 2; model 2).

Discussion

This is the first analysis using a large national database to explore associations between meditation practice and cardiovascular risk factors and disease. We found that in both univariate analysis and multivariate analysis, meditation practice was associated with a lower prevalence of hypercholesterolemia, SH, DM, and CAD.

To date, multiple studies have demonstrated the beneficial effects of meditation on cardiovascular risk. Several studies have found that meditation could lower serum lipid profiles, particularly serum cholesterol, in both healthy patients and those with comorbidities.[9–14] The scientific statement from the American Heart Association classified meditation as a class IIb, level of evidence B alternative approach to lowering blood pressure based on previous studies.[15] A recent meta-analysis of 19 clinical trials suggested that meditation could lower systolic blood pressure[16] and a recent randomized controlled trial showed that meditation had significantly lower ambulatory blood pressure monitoring values at 8 weeks follow up, but not at 20 weeks follow-up.[17] Evidence of the effects of meditation on diabetes is modest. Studies showed that meditation might reduce blood glucose and hemoglobin A1C in both type 2 diabetes and CAD patients.[18–20] However, data on meditation and CAD is very limited. Only few studies suggest a reproducible benefit of meditation on exercise duration and total possible workload in CAD patients,[21,22] but those findings rely on a purely subjective perception of participants.

Table 1
Baseline characteristics of participants with vs without meditation

Variables	Meditation		p-value
	No (n = 55,416)	Yes (n = 5,851)	
Age (years)	49.63 ± 18.53	49.25 ± 17.14	0.14
Men	51.80%	45.15%	<0.0001
Exercise (in minutes each time)	57.00 ± 50.53	53.46 ± 43.00	0.0001
Light or moderate activity (in minutes each time)	48.05 ± 52.58	45.25 ± 48.10	0.0008
Sleep per night (hours)	7.13 ± 1.42	7.00 ± 1.39	<0.0001
Cigarette smoker	15.79%	13.14%	<0.0001
Arthritis	25.14%	32.08%	<0.0001
Alcohol consumption (days per week)	1.46 ± 2.06	1.52 ± 2.02	0.07
Race: White	76.96%	81.37%	<0.0001
Overweight	34.79%	31.50%	<0.0001
Obese	29.93%	28.52%	0.03
Married	42.46%	38.32%	0.0001
Divorced	13.87%	17.45%	<0.0001
Coronary artery disease	5.42%	4.16%	<0.0001
Stroke	3.44%	3.62%	0.45
Chronic obstructive pulmonary disease	3.68%	3.94%	0.32
Diabetes mellitus	10.61%	9.31%	<0.0001
Hypercholesterolemia	71.76%	65.67%	<0.0001
Systemic hypertension	85.87%	83.45%	0.0008
Depression	15.76%	44.97%	<0.0001

Table 2
Association between meditation and systemic hypertension, diabetes mellitus, stroke, and coronary artery disease

	OR [95% CI]	p Value
Systemic hypertension		
Unadjusted	0.82 (0.71-0.94)	0.006
Model 1	0.93 (0.72-1.23)	0.63
Model 2	0.86 (0.75-0.99)	0.04
Diabetes mellitus		
Unadjusted	0.69 (0.57-0.83)	<0.001
Model 1	0.72 (0.51-1.00)	0.06
Model 2	0.70 (0.59-0.84)	0.0001
Hypercholesterolemia		
Unadjusted	0.74 (0.67-0.83)	<0.001
Model 1	0.61 (0.46-0.84)	0.001
Model 2	0.65 (0.54-0.79)	<0.001
Stroke		
Unadjusted	1.02 (0.87-1.18)	0.76
Model 1	0.82 (0.48-1.31)	0.43
Model 2	0.76 (0.58-0.99)	0.04
Coronary artery disease		
Unadjusted	0.74 (0.64-0.85)	<0.001
Model 1	0.54 (0.25-1.01)	0.38
Model 2	0.51 (0.39-0.66)	<0.001

Model 1 (full model)—Multivariable adjusted for age, gender, BMI, race, marital status, cigarette smoking, alcohol consumption, moderate physical activities, exercise, sleeping duration, and depression.

Model 2 (final model)—Multivariable adjusted for age, gender, BMI, race, marital status, cigarette smoking, sleeping duration, and depression.

There are certain limitations of this study. First, this study is the simple dualistic categorization of either meditation practitioner or non-practitioner. There are numerous types of meditation, including samatha (calming and concentration) meditation, vipassana (insight) meditation, mindful meditation, Vedic (mantra-based) meditation, and metta (loving-kindness) meditation, and it is possible that some types may have differing degrees of benefit on assessed parameters of cardiovascular risk. In fact, in addition to meditation, studies have shown an association between other similar therapies and cardiovascular risk. Heat therapy, such as sauna baths, has been shown to be associated with a reduced risk of hypertension,[23] improvement in endothelial function,[24] reduction in inflammation,[24] improvement in parasympathetic activity and a decrease in sympathetic activity,[25] promotion of cardiovascular health and as an adjunct to exercise training in cardiac rehabilitation.[26,27] Second, intensity and duration of meditation practice is not captured in the NHIS survey. It is possible that those who practice for longer durations, more frequently, and for more years are more likely to derive greater benefit than those who practice for only a few minutes and only occasionally or have only recently taken up a meditation practice. Third, importantly, is the inherent limitation of reverse causation in observational studies. For example, individuals may have started meditation to cope with depression because individuals who meditate had higher prevalence of depression than those who meditate compared to those who don't. Fourth, there might be variables as confounders or in the causal pathway between meditation and cardiovascular risk. Several studies showed meditation had the indirect effects of exercise capacity, suggesting a causal pathway.[21,28,29] Moreover, meditation may share a causal pathway with alcohol. Meditation practice, for example, may reduce anxiety and stress, leading to a reduction in the likelihood of future alcohol consumption.[30] Fifth, mediation, physical activity/exercise and the primary outcomes (SH, DM, stroke, and CAD) were self-reported and defined based on the subject's response to survey questions. Last, additional confounders include the fact that some mind-body interventions include both mental and physical processes, and that some may practice meditation as part of a more comprehensive life-style modification process, such as comprehensive programs that involve meditation, exercise, and nutritional counseling.

These limitations and confounders may contribute to the positive and negative findings in this analysis. Nonetheless, accepting these caveats, this utilization of a national database provides data that adds to the growing body of research on the potential benefits of meditation, including lower prevalence of hypercholesterolemia in those who engage in some form of meditative practice.

In conclusion, using an extensive national database, we found that meditation is associated with a lower prevalence of cardiovascular risk.

Credit Author Statement

Chayakrit Krittanawong: Conceptualization, Methodology, Software, Analysis, Writing- Original draft preparation
Anirudh Kumar: Writing, Editing, Conceptualization
Zhen Wang: Methodology, Software, Analysis, Validation
Bharat Narasimhan: Methodology, Software, Analysis
Hani Jneid: Writing- Reviewing and Editing
Salim S. Virani: Writing- Reviewing and Editing
Glenn N Levine: Reviewing, Editing and Supervision

Disclosures

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

1. Goyal M, Singh S, Sibinga E, 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.
2. Chen KW, Berger CC, Manheimer E, Forde D, Magidson J, Dachman L, Lejuez CW. Meditative therapies for reducing anxiety: a systematic review and meta-analysis of randomized controlled trials. *Depress Anxiety* 2012;29:545–562.
3. 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. 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.
4. Goyal M, Singh S, Sibinga EMS, 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. Comparative Effectiveness Reviews*. Rockville, MD: The Agency for Healthcare Research and Quality; 2014.

5. Breedvelt JF, Amanvermez Y, Harrer M, Karyotaki E, Gilbody S, Bockting CLH, Cuijpers P, Ebert DD. The effects of meditation, yoga, and mindfulness on depression, anxiety, and stress in tertiary education students: a meta-analysis. *Front Psychiatry* 2019;10. 193-193.
6. Rusch HL, Rosario M, Levison LM, Olivera A, Livingston WS, Wu T, Gill JM. The effect of mindfulness meditation on sleep quality: a systematic review and meta-analysis of randomized controlled trials. *Ann N Y Acad Sci* 2019;1445:5–16.
7. Djernis D, Lerstrup I, Poulsen D, Stigsdotter U, Dahlgaard J, O'Toole M. A systematic review and meta-analysis of nature-based mindfulness: effects of moving mindfulness training into an outdoor natural setting. *Int J Environ Res Public Health* 2019;16:3202.
8. Centers for Disease Control and Prevention. Surveys and data collection. Available at: http://www.cdc.gov/nchs/surveys.htm#tabs-1139715-1. Accessed June 6, 2020.
9. Schneider RH, Nidich SI, Salerno JW, Sharma HM, Robinson CE, Nidich RJ, Alexander CN. Lower lipid peroxide levels in practitioners of the Transcendental Meditation program. *Psychosom Med* 1998;60:38–41.
10. Mahajan AS, Reddy KS, Sachdeva U. Lipid profile of coronary risk subjects following yogic lifestyle intervention. *Indian Heart J* 1999;51:37–40.
11. Singh S, Kyizom T, Singh KP, Tandon OP, Madhu SV. Influence of pranayamas and yoga-asanas on serum insulin, blood glucose and lipid profile in type 2 diabetes. *Indian J Clin Biochem* 2008;23:365–368.
12. Kim D, Moon Y, Kim H, Jung J, Park H, Suh H, Kim Y, Song D. Effect of Zen Meditation on serum nitric oxide activity and lipid peroxidation. *Prog Neuropsychopharmacol Biol Psychiatry* 2005;29:327–331.
13. Bijlani RL, Vempati RP, Yadav RK, Ray RB, Gupta V, Sharma R, Mehta N, Mahapatra SC. A brief but comprehensive lifestyle education program based on yoga reduces risk factors for cardiovascular disease and diabetes mellitus. *J Altern Complement Med* 2005;11:267–274.
14. Cooper MJ, Aygen MM. A relaxation technique in the management of hypercholesterolemia. *J Human Stress* 1979;5:24–27.
15. Brook RD, Appel LJ, Rubenfire M, Ogedegbe G, Bisognano JD, Elliott WJ, Fuchs FD, Hughes JW, Lackland DT, Staffileno BA, Townsend RR, Rajagopalan S. 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 beyond medications and diet: alternative approaches to lowering blood pressure: a scientific statement from the american heart association. *Hypertension* 2013;61:1360–1383.
16. Shi L, Zhang D, Wang L, Zhuang J, Cook R, Chen L. Meditation and blood pressure: a meta-analysis of randomized clinical trials. *J Hypertens* 2017;35:696–706.
17. Márquez PHP, Feliu-Soler A, Solé-Villa MJ, Matas-Pericas L, Filella-Agullo D, Ruiz-Herrerias M, Soler-Ribaudi J, Coll AR, Arroyo-Díaz JA. Benefits of mindfulness meditation in reducing blood pressure and stress in patients with arterial hypertension. *J Hum Hypertens* 2019;33:237–247.
18. Kian AA, Vahdani B, Noorbala AA, Nejatisafa A, Arbabi M, Zenoozian S, Nakhjavani M. The impact of mindfulness-based stress reduction on emotional wellbeing and glycemic control of patients with type 2 diabetes mellitus. *J Diabetes Res* 2018:1986820.
19. Rosenzweig S, Reibel DK, Greeson JM, Edman JS, Jasser SA, McMearty KD, Goldstein BJ. Mindfulness-based stress reduction is associated with improved glycemic control in type 2 diabetes mellitus: a pilot study. *Altern Ther Health Med* 2007;13:36–38.
20. Sinha SS, Jain AK, Tyagi S, Gupta SK, Mahajan AS. Effect of 6 months of meditation on blood sugar, glycosylated hemoglobin, and insulin levels in patients of coronary artery disease. *Int J Yoga* 2018;11:122–128.
21. 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.
22. 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.
23. Zaccardi F, Laukkanen T, Willeit P, Kunutsor SK, Kauhanen J, Laukkanen JA. Sauna bathing and incident hypertension: a prospective cohort study. *Am J Hypertens* 2017;30:1120–1125.
24. Laukkanen JA, Laukkanen T, Kunutsor SK. Cardiovascular and other health benefits of sauna bathing: a review of the evidence. *Mayo Clin Proc* 2018;93:1111–1121.
25. Laukkanen T, Lipponen J, Kunutsor SK, Zaccardi F, Araújo CGS, Mäkikallio TH, Khan HK, Willeit P, Lee E, Poikonen S, Tarvainen M, Laukkanen JA. Recovery from sauna bathing favorably modulates cardiac autonomic nervous system. *Complement Ther Med* 2019;45:190–197.
26. Pal GK, Ganesh V, Karthik S, Nanda N, Pal P. The effects of short-term relaxation therapy on indices of heart rate variability and blood pressure in young adults. *Am J Health Promot* 2014;29:23–28.
27. Van Dixhoorn JJ, Duivenvoorden HJ. Effect of relaxation therapy on cardiac events after myocardial infarction: a 5-year follow-up study. *J Cardiopulm Rehabil* 1999;19:178–185.
28. Goldstein E, Topitzes J, Brown RL, Barrett B. Mediational pathways of meditation and exercise on mental health and perceived stress: a randomized controlled trial. *J Health Psychol* 2018. 1359105318772608.
29. Edwards MK, Loprinzi PD. Experimental effects of acute exercise and meditation on parameters of cognitive function. *J Clin Med* 2018;7:125.
30. Carey KB, Carey MP. Reasons for drinking among psychiatric outpatients: relationship to drinking patterns. *Psychol Addict Behav* 1995;9:251–257.