


Stress interventions and hypertension in Black women

Jolaade Kalinowski¹ , Kiran Kaur²,
 Valerie Newsome-Garcia³, Aisha Langford², Ayoola Kalejaiye⁴,
 Dorice Vieira², Chigozirim Izeogu², Judite Blanc²,
 Jacquelyn Taylor⁵, Olugbenga Ogedegbe²
 and Tanya Spruill²

Abstract

Hypertension is a risk factor for cardiovascular disease. Black women have high rates of hypertension compared to women of other racial or ethnic groups and are disproportionately affected by psychosocial stressors such as racial discrimination, gender discrimination, and caregiving stress. Evidence suggests that stress is associated with incident hypertension and hypertension risk. Stress management is associated with improvements in blood pressure outcomes. The purpose of this review is to synthesize evidence on effects of stress management interventions on blood pressure in Black women. A comprehensive search of scientific databases was conducted. Inclusion criteria included studies that were: (1) primary research that tested an intervention; (2) in the English language; (3) included African-American women; (4) incorporated stress in the intervention; (5) included blood pressure as an outcome; and (6) were US based. Eighteen studies met inclusion criteria. Ten (56%) studies tested meditation-based interventions, two (11%) tested coping and affirmation interventions, and six (33%) tested lifestyle modification interventions that included stress management content. Thirteen of the studies were randomized controlled trials. Reductions in blood pressure were observed in all of the meditation-based interventions, although the magnitude and statistical significance varied. Comprehensive lifestyle interventions were also efficacious for reducing blood pressure, although the relative contribution of stress management versus behavior modification could not be evaluated. Coping and affirmation interventions did not affect blood pressure. Most of the reviewed studies included small numbers of Black women and did not stratify results by race and gender, so effects remain unclear. This review highlights the urgent need for studies specifically focusing on Black women. Given the extensive disparities in cardiovascular disease morbidity and mortality, whether stress management can lower blood pressure and improve primary and secondary cardiovascular disease prevention among Black women is an important question for future research.

Keywords

behavioral health, disparities, hypertension, stress, women's health

Date received: 12 December 2020; revised: 1 March 2021; accepted: 24 March 2021

Introduction

Hypertension, affects more than 116 million adults in the United States and is a risk factor for cardiovascular disease (CVD), the leading cause of death.¹ Racial and ethnic minorities suffer disproportionately high rates of hypertension and hypertension-related morbidity and mortality.¹ More than 50% of African-American women have hypertension, compared to 39% of non-Hispanic white women and 38% of Hispanic women.¹ Only 26.5% of African-American women with hypertension have controlled blood pressure (BP),

¹Department of Human Development and Family Sciences, The University of Connecticut, Storrs, CT, USA

²Department of Population Health, School of Medicine, New York University, New York, NY, USA

³Morehouse School of Medicine, Atlanta, GA, USA

⁴Montefiore Medical Center, Bronx, NY, USA

⁵Columbia University School of Nursing, New York, NY, USA

Corresponding author:

Jolaade Kalinowski, Department of Human Development and Family Sciences, The University of Connecticut, Storrs, CT 06269, USA.
 Email: jolaade.kalinowski@uconn.edu



despite high levels of awareness and treatment.¹ Suggested lifestyle modifications include dietary changes, weight loss, and increasing physical activity,^{2,3} but modifications are challenging to adopt and maintain.⁴⁻⁶ Targeting other behaviors, such as stress, may have the potential to improve hypertension management and outcomes.

Psychosocial stressors (e.g. discrimination, financial stress, and caregiving) and perception of stress are associated with hypertension and CVD outcomes.⁷⁻¹¹ Adverse effects of stress on hypertension are hypothesized to involve psychological, behavioral, and pathophysiological mechanisms, including depression, diet, physical inactivity, sleep, and alterations in activity of the sympathetic and parasympathetic nervous systems.^{10,12-14} African Americans report higher exposure to stress and stressful life events compared to whites.^{15,16} African-American women face gender and race-related stressors,¹⁷ as well as unique stressors related to gendered racism,^{18,19} which contribute to hypertension disparities and poor health outcomes.^{20,21}

Maladaptive coping strategies may increase vulnerability to stress. For example, John Henryism, described as prolonged, high-effort, and active coping efforts, exacerbates physiological responses to stress and contributes to poor cardiovascular outcomes in African Americans.^{22,23} The "Superwoman Schema" posit that African-American women may feel obligated to be strong, to suppress emotions and vulnerability and to help others before themselves despite awareness of detrimental effects on their health.²⁴ Stress management augmented with other lifestyle interventions may be critical for hypertension management and prevention²⁵ as well as other CVD risk factors.²⁶ Meta-analyses suggest that stress management may be an effective tool for managing BP,²⁷ yet a few studies have assessed its effects on BP in African-American women. In this review, we summarize existing evidence on stress management interventions and BP and discuss priority topics for future research.

Methods

A medical librarian devised a comprehensive search strategy. Medical Subject Headings (MeSH), Embase's Emtree, and PsycINFO subject headings were identified along with relevant keywords. PubMed/Medline, Embase, PsycINFO, Web of Science Plus (which includes Biological Abstracts and BIOSIS Citation Index), AgeLine, and CINAHL databases were searched through October 2020. OpenGrey, OCLC's OAIster, and the New York Academy of Medicine Grey Literature databases were searched using various combinations of the following search terms: (hypertension OR high blood pressure OR hypertension OR elevated pressure OR blood pressure OR

blood pressure determination) AND (psychological stress OR mental stress OR life stress OR life stresses OR life stressors OR emotional stress OR nervous tension OR psychosocial stress OR coping OR perceived stress OR chronic stress OR stress management OR stress reduction) AND (early medical intervention OR early intervention education OR comparative effectiveness research OR health promotion OR intervention OR interventions OR trial OR trials OR outcomes) AND (women OR woman OR female OR females OR girls OR girl) AND (african americans OR african american OR blacks OR afro-americans OR afro-american OR Black American OR black americans OR Caribbean American OR Caribbean Americans OR ethnic groups OR minorities OR minority groups).

Inclusionary criteria included the following parameters: (1) primary research that conducted an intervention, (2) written in the English language, (3) included adults, specifically women and African Americans, (4) incorporated stress management in the intervention, (5) included BP as an outcome, and (6) were US based. Two authors separately reviewed article titles and abstracts to ascertain if they met the study's inclusionary criteria. They classified articles as I (included) or an E (excluded). A third author broke the tie for articles.

Results

Figure 1 summarizes the search process for identifying eligible. A total of 882 articles were identified and 755 remained after removal of duplicates. Ultimately, 18 studies were eligible. Sample sizes varied across studies. Samples ranged from N=20 to N=2478. Some studies had small samples of African Americans. For example, in Gilstrap et al., out of N=64 women, 2 were African American. Intervention duration varied substantially given the heterogeneity in study design and implementation across studies. Thirteen of the studies were randomized controlled trials (RCTs). One study was a quasi-experimental design and the remaining studies were non-RCTs. Intervention duration and follow-up ranged from 1 to 24 months.

Measures of stress

There was variability in regard to how stress was measured. Half of studies examined stress in their outcomes. Of the studies that did examine stress, nine (50%) utilized the perceived stress scale (PSS), developed by Cohen and colleagues, which examines stress levels in the last month. In regard to the remaining nine studies, stress was either not captured or captured by other tools. In two studies, stress was captured using single-item measures.^{28,29} In Ward et al., stress was measured by a single-item question from

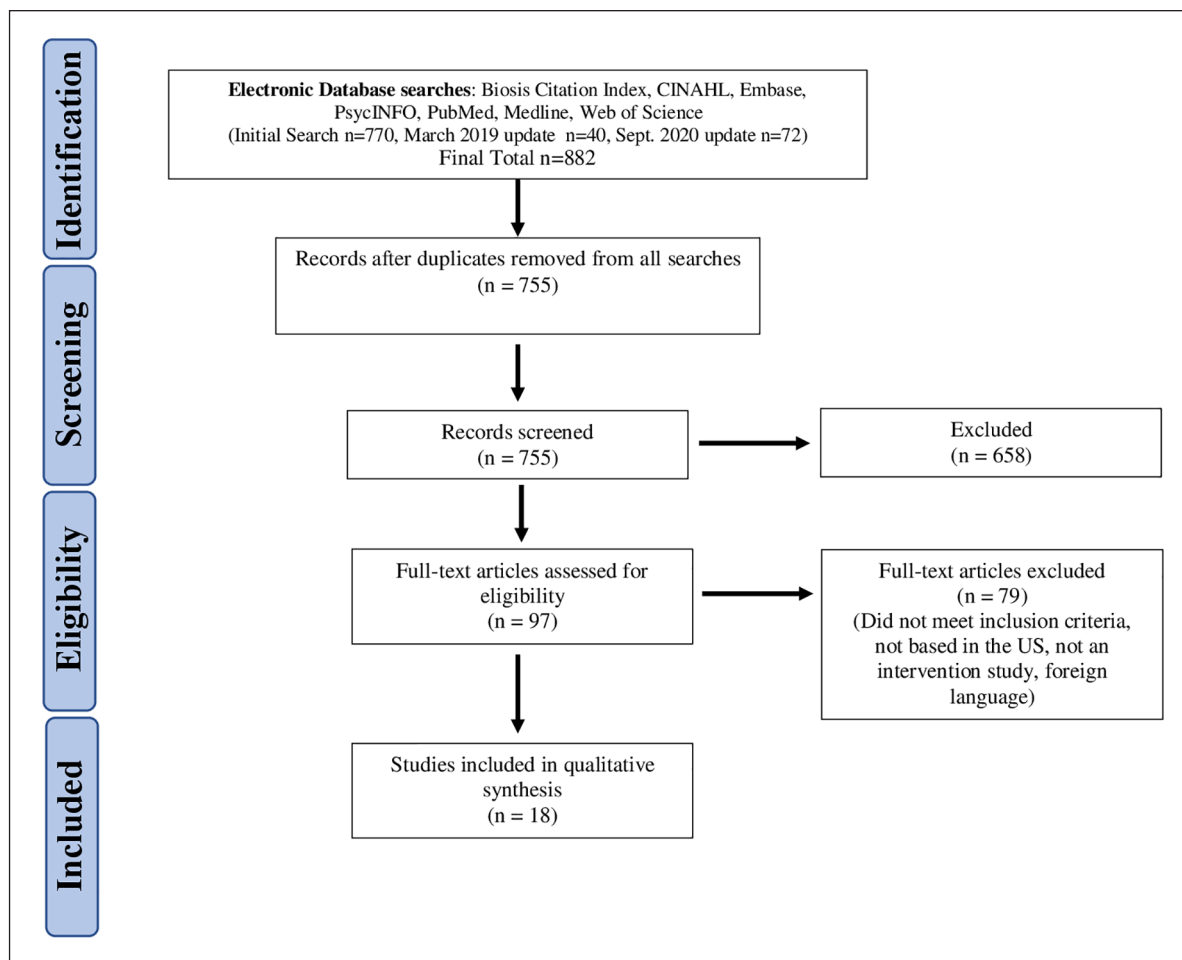


Figure 1. PRISMA flow diagram.

the Society for Behavioral Medicine's Common Data Elements examining past week distress on a scale of 0 to 10 (0=no distress and 10=extreme distress); whereas, in Thomas et al., stress was captured by a single-item question examining current levels of perceived stress rated from 1 (lowest) to 7 (the highest). Schneider 1995 utilized the National Survey of Black Americans subscale to measure self-efficacy, stress impact, and social support. They did not report on these measures. Tucker et al. utilized the strain questionnaire, which included questions about behavioral and health-related stress in the past week. Five studies did not report measuring stress. There was variability in when/how often stress was measured. For example, in Palta et al., stress was measured at baseline, but stress data were not reported at follow-up.

Overview of interventions

Study settings varied with one study being a workplace intervention at a childcare center,²⁹ nine studies at community-based settings, one church-based study, five studies at major academic medical centers, and one study at a senior center and one ambulatory care center. Studies were distributed over three categories: meditation and mindfulness-based interventions, lifestyle modification interventions, and affirmation and coping interventions. Ten studies (56%) included meditation, two studies (11%) included coping and affirmations, and approximately six (33%) included comprehensive lifestyle modifications (e.g. weight management, physical activity, and medication adherence). Study characteristics are presented in Table 1.

Table 1. Summary of Interventions.

Authors	Research design	Participants	Intervention	Control	Follow-up assessment	Findings
Adams et al. ²⁵	RCT	Adults with prehypertension (n = 64); 45.3% female, 48.4% African American	Tension Tamer: smartphone app that offers breathing awareness meditation (BAM). BAM practiced two times per day over 6 months for either <ul style="list-style-type: none"> ○ 5 min (n = 23) ○ 10 min (n = 19) ○ 15 min (n = 22) 	N/A	1, 3, 6 months	<ul style="list-style-type: none"> • Significant decreases in SBP and DBP during all follow-up months. • Higher TT dose → greater reduction in SBP (3 and 6 months). 3-month follow-up: <ul style="list-style-type: none"> • Significant differences between: <ul style="list-style-type: none"> ○ 5- and 15-min dosages. ○ 10- and 15-min dosages (p = 0.027). 6-month follow-up: <ul style="list-style-type: none"> • Significant differences between: <ul style="list-style-type: none"> ○ 5- and 15-min dosages (p = 0.018). Baseline BP (12.5 ± 8.79 ± 3 mm Hg): <ul style="list-style-type: none"> • -6 ± 12/3 ± 3 mm Hg (p ≤ 0.001). • 952 subjects (38.4%) normalized BP (p ≤ 0.001). 6-month follow-up: <ul style="list-style-type: none"> • Participants with baseline SBP 120–139 (n = 2082) • -7 ± 12 mm Hg (p ≤ 0.001). • Participants with baseline DBP 80–89 (n = 1504) • -6 ± 13 mm Hg (p ≤ 0.001). No differences in BP control between control and intervention group. <p>Those with higher perceived stress or depressive symptoms were less likely to have controlled BP.</p> TM group: <ul style="list-style-type: none"> • Stress reduction associated with reduced carotid atherosclerosis in AA with HTN • Within group changes: <ul style="list-style-type: none"> ○ SBP -7.77 ± 10.34 mm Hg (p = 0.0003). ○ DBP -3.5 ± 7.6 mm Hg (p = 0.02). ○ Pulse pressure -4.26 ± 9.02 mm Hg (p = 0.02). Health education group: <ul style="list-style-type: none"> • Within group changes: <ul style="list-style-type: none"> ○ SBP -6.74 ± 12.8 mm Hg (p = 0.01). ○ DBP -5.9 ± 8.6 mm Hg (p = 0.001). ○ Pulse pressure -4.26 ± 9.02 mm Hg (p = 0.02). No significant between-group differences in BP. <p>TM group:</p> <ul style="list-style-type: none"> • SBP -5.6 ± 9.6 (p < 0.01). Enhanced health education group: <ul style="list-style-type: none"> • SBP -10.0 ± 10.9 (p < 0.001). • DBP -5.6 ± 7.1 (p < 0.001). <ul style="list-style-type: none"> • Greater number of dietary changes (reduced intake of calories, carbohydrates, and fats) No significant between-group differences in BP.
Bavikati et al. ³⁰	Non-RCT	Adult patients with prehypertension (n = 2478); 73% female, 18% AA	Behavioral lifestyle changes; I-on-1 behavioral counseling to manage pre-HTN over 6 months (n = 2478)	N/A	6 months	<ul style="list-style-type: none"> • Received a workbook on HTN knowledge (n = 87) Health Education program to reducing cardiovascular risk factors (n = 29; 65.52% female)
Boutin-Foster et al. ³¹	RCT	African-American adults with uncontrolled hypertension (n = 238); 68.8% female	Motivational interviewing-based counseling for medication adherence. Bi-monthly phone calls.	Received a workbook on HTN knowledge (n = 87)	12 months	<ul style="list-style-type: none"> • Transcendental meditation (TM) practiced daily for 20 min, individually (n = 31; 70.97% female)
Castillo-Richmond et al. ⁴¹	RCT	African-American adults with high normal BP, stage I/II hypertension (n = 138 enrolled; 60 participated); 68.3% female	Transcendental meditation (TM) practiced daily for 20 min, individually (n = 31; 70.97% female)	Health Education program to reducing cardiovascular risk factors (n = 29; 65.52% female)	1 week, 2, 3, 4, 5, and 6 months	<ul style="list-style-type: none"> • Transcendental Meditation (TM) practiced daily for 20 min (n = 24; 54.2% female)
Duraimani et al. ³²	RCT	African-American adults with stage I hypertension (n = 48); 54.2% female	Transcendental Meditation (TM) practiced daily for 20 min (n = 24; 54.2% female)	Enhanced health education; reinforcement for lifestyle changes (n = 24; 54.2% female)	4 months	<ul style="list-style-type: none"> • Transcendental Meditation (TM) practiced daily for 20 min (n = 24; 54.2% female)

(Continued)

Table 1. (Continued)

Authors	Research design	Participants	Intervention	Control	Follow-up assessment	Findings
Dusek et al. ³³	RCT	Participants 55 years or older, with SBP of 140–159 mm Hg/DBP of <90 mm Hg. (n = 122); 54.9% female, 8.19% African American	Stress management program (relaxation response training) for 8 weeks; participants asked to follow the 20-min audio guide daily (n = 61; 49% female)	Lifestyle modification received 1 h of written and oral instruction of the impact of stress on health (n = 61)	2 months	<p>Relaxation Response Training:</p> <ul style="list-style-type: none"> • SBP -9.4 ± 11.4 ($p < 0.0001$). • DBP -1.5 ± 6.2 ($p = 0.05$). • Higher proportion of patients eliminated ≥ 1 antihypertensive medication. <p>Control group:</p> <ul style="list-style-type: none"> • SBP -8.8 ± 13 ($p < 0.0001$). • DBP -2.4 ± 6.9 ($p = 0.05$). <p>No significant between-group differences in BP. Stress management training and lifestyle modification resulted in SBP reduction in elderly patients with systolic hypertension.</p> <p>Full-group outcomes:</p> <ul style="list-style-type: none"> • Reductions in depression ($b = 11.50$, $p < 0.01$). • Reductions in systolic blood pressure ($b = -1.68$, $p = 0.03$). • Changes in diastolic blood pressure ($b = 0.09$, $p = 0.85$). <p>Hypertensive subgroup (n = 24):</p> <ul style="list-style-type: none"> • Decrease in SBP ($b = -4.04$, $p < 0.01$). • No significant decrease in DBP ($n = 0.04$, $p = 0.95$). <p>Lower life satisfaction (LLS):</p> <ul style="list-style-type: none"> • associated with higher DBP at 6 months (0.52, $p < 0.01$). • not associated with increased SBP. <p>Active coping</p> <ul style="list-style-type: none"> • SBP $+1.64$ ($p < 0.05$) at 18 months, $+2.11$ ($p < 0.01$) at 24 months. • DBP $+0.93$ ($p < 0.05$) at 24 months. <p>The church-based intervention had no effect on the association between LLS in relation to BP.</p> <p>% women with hypertensive BP:</p> <ul style="list-style-type: none"> • baseline (37.5%) to year 1 (16.3%) ($p = 0.02$). • year 1 (16.3%) to year 2 (9.3%) ($p < 0.01$). <p>1-year follow-up:</p> <ul style="list-style-type: none"> • decrease in prevalence of metabolic syndrome (62.7% at BL, 34.9% at 1 year). <p>ELDRSHINE BL BP: $148.5 \pm 17.5/78 \pm 9.5$ mm Hg. Follow-up BP: $137.4 \pm 16.1/74.3/11$ mm Hg. Social support group BL BPL $144.5 \pm 27.7/67.3 \pm 13.4$ mm Hg. Follow-up BP: $140.3 \pm 15.8/70.3 \pm 9.1$ mm Hg. Between group: • ELDRSHINE had a greater decrease in BP over time compared to the social support group ($p = 0.020$). • Intervention group SBP: 21.92 mm Hg lower than control ($p = 0.020$). • Intervention group DBP: 16.70 mm Hg lower than control ($p = 0.003$). </p>
Emmert-Aronson et al. ³⁵	Non-RCT	Participants with behaviorally mediated clinical concerns (n = 49); 63.35 female, 24.5% African American	Open-Source Wellness (OSW) Program consisting of meditation, nutrition counseling, coaching, and physical activity sessions (n = 49)	N/A	1, 2, 3, 4 months	
Mendez et al. ³⁶	Quasi-experimental design	African Americans over 45 years from six churches (n = 89); 68.6% female	Faith-based intervention on nutrition, physical activity, and stress reduction (n = 29; 62.1% female)	CVD educational materials and an individual session with a nutritionist (n = 57; 71.9% female)	6, 18, 24 months	
Gilstrap et al. ³⁷	Non-RCT	Minority women with at least two risk factors for CVD (n = 64); 3.1% African American	The Health Awareness and Primary Prevention in Your neighborhood Heart Study (HAPPY) included stress reduction and individualized exercise and dietary plans	N/A	1, 2 years	
Palta et al. ⁴²	RCT	African-American adults ≥ 62 years at a low-income senior residence facility (n = 20); 95% female	ELDRSHINE incorporated mindfulness-based stress reduction (MBSR) that was delivered once per week for 90 min, over 8 weeks (n = 12)	Social support group that met once per week for 90 min, over 8 weeks (n = 8)	8 weeks	

(Continued)

Table 1. (Continued)

Authors	Research design	Participants	Intervention	Control	Follow-up assessment	Findings
Schneider et al. ⁴⁴	RCT	African-American adults (≥ 55 years) with mild hypertension (n = 127); 57% female. Initial BP criteria: DBP: 90–109 mmHg. SBP: ≤ 189 mmHg	Two active stress-reductive interventions that included practicing transcendental meditation (TM) (n = 36; 50% female) or progressive muscle relaxation (PMR) (n = 37; 54% female) for 20 min individually, two times per day. In addition, monthly group sessions for 1.5 h per week.	Education control (EC) received materials on non-pharmacological treatment of hypertension and attended group sessions for 30 min to 1 h (n = 38; 68.4% female)	3 months	Compared to control, TM reduced SBP by 10.7 ± 2.9 mmHg ($p < 0.0003$) and DBP by 6.4 ± 1.6 mmHg ($p < 0.00005$). PMR lowered SBP by 4.7 ± 2.9 mmHg ($p = 0.54$) and DBP by 3.3 ± 1.6 mmHg ($p < 0.02$). The reductions for participants in the TM group were greater than in the PMR group for both SBP (-6.0 ± 3 mmHg; $p = 0.02$) and DBP (-3.1 ± 1.6 mmHg; $p = 0.03$).
Schneider et al. ⁴⁰	RCT	African Americans with coronary heart disease (n = 201); 42.5% female	Transcendental Meditation (TM) group received in-depth training on techniques for personal practice twice daily for 20 min (n = 99; 41.8% female)	Health Education (HE) group received CVD education and were instructed to spend 20 min/day on lifestyle modifications to improve heart health (n = 102; 43.2% female)	Randomized subjects were observed for a maximum of 9.3 years and a mean of 5.4 ± 2.4 years. 52 primary end point events.	The TM group exhibited improvements in blood pressure, as well as psychosocial distress indicators. There were significant net differences in SBP (-4.9 mmHg; 95% CI, -9.3 to 1.5 mmHg; $p = 0.01$) in the TM group vs the health education group. No significant changes to DBP, BMI, physical activity, alcohol use, smoking, or diet.
Schneider et al. ⁴³	RCT	African American with SBP of 140–179 mmHg or diastolic BP of 90 to 109 mmHg; (n = 150); 52.7% female.	Transcendental Meditation (TM) group received in-depth training on techniques for personal practice twice daily for 20 min (n = 54; 46.3% female); Progressive Muscle Relaxation (PMR), which included instruction on relaxing muscle groups for relaxation for 15–20 min daily (n = 52; 55.8% female)	Health Education (HE) focused on lifestyle modifications for cardiovascular risk and asked to spend 20 min twice a day on lifestyle modifications (n = 44; 56.8% female)	3, 6, 9, 12 months	The TM group showed greater reductions in systolic BP in comparison to the PMR or HE groups $-3.1/-5.7$ mmHg compared to -0.05 mmHg (PMR) -2.9 (HE) mmHg. SBP decrease: TM (-3.12 ± 1.52 ; $p = 0.02$). PMR and HE were not significant. TM decreased SBP more than PMR ($p = 0.12$) and HE ($p = 0.17$). DBP decrease (all $p < 0.01$): TM (-5.67 ± 0.89). PMR (-2.90 ± 0.89). HE (-2.59 ± 1.00). TM decreased DBP more than PMR ($p = 0.01$) and HE ($p = 0.01$). TM group decreased use of antiHTN medication, compared to increases in PMR ($p = 0.015$) and HE ($p = 0.006$). Women in the TM group showed greater decreases in SBP and DBP than both PMR ($p = 0.01$) and HE ($p = 0.03$; $p = 0.02$) groups. SBP change in women: TM (-7.32). PMR (0.68). HE (-0.72). DBP change in women: TM (-6.85). PMR (-2.72). HE (-3.0).

(Continued)

Table 1. (Continued)

Authors	Research design	Participants	Intervention	Control	Follow-up assessment	Findings
Schneider et al. ³⁸	RCT	African Americans ages 20–75 years with SBP of 120–179 or DBP of 80–109 (n = 85); 64.7% female	Transcendental Meditation (TM) group received in-depth training on techniques for personal practice twice daily for 20 min (n = 41; 70.73% female)	Health education received behavioral instructions for CVD risk factor prevention (n = 44; 59% female)	6 months	<p>TM Group:</p> <ul style="list-style-type: none"> Decrease in SBP (–5.978 (1.661); p = 0.003). Decrease in DBP (–3.258 (1.270); p = 0.028). Perceived stress scores (0.42 (0.017); p = 0.004). <p>Health Education Group:</p> <ul style="list-style-type: none"> Decrease in SBP (–7.497 (1.582); p = 0.00). Decrease in DBP (–6.629 (1.210); p = 0.00). Perceived stress scores (0.049 (0.017); p = 0.028). <p>No significant between-group differences were seen. Specific values for blood pressure were not reported (only classifications for normal, pre-hypertensive, and hypertensive). Stress was considered an outcome and was measured by one-single item on a 7-point scale.</p> <p>PTSC participants reported lower stress levels after the intervention, at 12-week posttest (mean = 2.99 ± 1.44) than at pretest (mean = 3.96 ± 1.66) (p < 0.000). Stress levels were also significantly lower at 6-month follow-up (mean = 3.18 ± 1.54) than at pretest (3.79 ± 1.59) (p < 0.0000).</p> <p>No significance levels were reported for the BP classification categories:</p> <p>Pretest BP readings: Hypertensive—39.1%. Pre-hypertensive—35.7%. Normal—25.1%. 12-week follow-up: Hypertensive—29.8%. Pre-hypertensive—42.4%. Normal—27.8%.</p> <p>PTSC women reported significantly lower levels of stress at 12-week (mean = 2.99 ± 1.50) and 6-month (mean = 3.09 ± 1.51) posttest than they did at pretest (p < 0.05). Comparison group reported no significant stress level changes.</p> <p>No significance levels were reported for the BP classification categories: A lower proportion of PTSC women were classified in the hypertensive category at 12-week (40.7%) and 6-month (34.3%) posttest than at baseline (45.7%).</p>
Thomas et al. ²⁸ —study 1 evaluation	Non-RCT	African-American women recruited from community settings (n = 656)	Prime Time Sister Circles (PTSC) participants received intervention weekly for 2h, over 3 months. Intervention incorporated cognitive behavioral strategies and tools were provided to improve stress management, nutrition and exercise (n = 656).	N/A	3, 6 months	
Thomas et al. ²⁸ —study 2	Pre/post quasi-experimental design	African-American women recruited from community settings (n = 266)	Prime Time Sister Circles (PTSC) participants received intervention weekly for 2h, over 3 months. Intervention incorporated cognitive behavioral strategies and tools were provided to improve stress management, nutrition, and exercise (n = 211).	Received a copy of text written by the PI on health and wellness but did not receive the PTSC curriculum, facilitator, or expert consultants (n = 55)	3, 6 months	

(Continued)

Table 1. (Continued)

Authors	Research design	Participants	Intervention	Control	Follow-up assessment	Findings
Tucker et al. ⁷²	RCT	Adults who reported having type 2 diabetes (n = 130); 74.6% female, 70% African American	The health promotion program implemented a workshop series (2, 6-hour workshops, 2 weeks apart) that emphasized lifestyle modifications (i.e. healthy eating and physical activity behaviors) (n = 64; 73.4% female, 67.2% African American)	Wait-list control (n = 66; 75.8% female, 72.7% African American)	2 months	Participants in the intervention group exhibited significantly lower stress scores, and lower glucose and diastolic blood pressure levels. There were significant group differences at posttest in change for DBP (F(1,77) = 4.75, p < 0.05) and physical stress (F(1,82) = 4.25, p < 0.05) among participants in the intervention group compared to those in the control group.
Vaccarino et al. ⁴⁵	RCT	African Americans with metabolic syndrome risk factors aged 30–65 years (n = 68); 79% female	Consciously resting meditation (CRM), a sound-based meditation. Participants were instructed to practice for 20 min daily, twice a day (n = 33); 75% female.	21 group meetings over a 1-year period led by a trained health educator, received health education (HE) for prevention of CVD through lifestyle modifications. Participants instructed to undertake a 20-min twice a day home practice session applying recommendations (n = 35); 83% female	6, 12 months	In the CRM group, changes between baseline and 12 months were significant for DBP (−6.2 mm Hg, 95% CI, −11.7 to −0.8 mm Hg, p = 0.026). No significant between-group differences. Perceived stress scores were reduced slightly more in the HE group as compared to CRM (p = 0.022).
Ward et al. ^{73,74}	Cluster— RCT	Participants from 56 child care centers (n = 56 centers; 553 staff); 96.7% female, 51.6% African American	The Healthy Lifestyles intervention delivered content on physical activity, stress management and other lifestyle modifications over three 8-week health campaigns over 6 months (n = 28 centers; n = 250 staff); 98.8% female, 49.8% African American	Healthy Finances program focused on personal financial management (n = 28 centers; n = 303 staff); 95% female, 53.2% African American	6, 18 months	Elevated BP ($\geq 140/90$ mm Hg) was observed among 26.5% of the sample during baseline. At 6-month, perceived level of stress decreased within the Health Lifestyle (−1.2, 95% CI, −1.6 to −0.7, p < 0.001) and Health Finance group (−0.7, 95% CI, −1.1 to −0.3, p < 0.01). As compared to baseline, at 6 months, a decrease in mean arterial pressure was observed within both the Healthy Lifestyle (−1.8, 95% CI, −3.5 to −0.1, p = 0.05) and Health Finance (−3.6, 95% CI, −5.1 to −2.2, p < 0.001) groups. There was no significant between-group difference.

RCT: randomized controlled trial; SBP: systolic blood pressure; DBP: diastolic blood pressure; TT: Tension Tamer; CVD: cardiovascular disease; HAPPY: Health Awareness and Primary Prevention in Your; CI: confidence interval; BMI: body mass index; AA: African American; HTN: hypertension; PI: principal investigator; BL: baseline; BLBP: baseline blood pressure.

Meditation and mindfulness-based interventions. The most frequently studied meditation-based intervention was Transcendental Meditation (TM), a meditation program that encourages a state of relaxation,³⁹ which was in 6 (33%) of the 18 interventions. It is worth noting four (44%) of the nine studies on meditations were completed by Schneider and colleagues and largely assessed the effects of TM on BP and other cardiovascular outcomes.^{38,40,43,44} Consciously resting meditation (CRM), a sound-based meditation program was used as an intervention modality in 1 (5%) study.⁴⁵ Mindfulness-Based Stress Reduction (MBSR)⁴⁶ was utilized in one (5%) of the studies,⁴² and Relaxation Response (RR), a relaxation technique resulting in an altered state of consciousness,³⁴ was used in another study (5%) of the studies.³³

Three meditation interventions reported no statistically significant differences between intervention and control arms.^{32,38,41} Duraimani et al.³² examined TM versus extensive health education (EHE), both delivered over 16 weeks. African-American adults with stage I hypertension in both TM and enhanced health education (HE) control group demonstrated decreases in systolic blood pressure (SBP), but there was no statistical difference between the groups. Results also exhibited greater reductions in diastolic blood pressure (DBP) for participants in the enhanced HE group compared to the TM group ($p=0.04$). Similarly, Castillo-Richmond et al.⁴¹ explored TM and its effects on carotid atherosclerosis. While both the TM group and HE control group had significant reductions in SBP and DBP, there were no significant differences in BP reduction between arms. The study was underpowered to detect statistically significant differences between study arms. In Schneider et al.,³⁸ they found within group decreases in SBP and DBP, but no statistical differences between arms.

Other studies included that utilized TM techniques reported positive results in regard to efficacy in lowering BP.^{40,43,44} Schneider et al.,⁴³ examined effects of TM, Progressive Muscle Relaxation (PMR), and HE on BP and reported that African-American women in the TM group, compared to PMR and HE, exhibited the greatest improvements in BP and psychosocial distress. African-American women within the TM group exhibited lower BP decreased use of antihypertensive medications, and adoption of other behavioral modifications.

Dusek et al.³³ tested a stress management program that included training on breathing and RR training for adults over the age of 55 years. SBP statistically decreased in both RR and control groups. There were no between-group differences. Results showed that a higher proportion of patients were able to eliminate at least one antihypertensive medication maintaining BP control.³³

One study utilized a meditation mobile app to provide mindfulness training.²⁵ In Adams et al.,²⁵ researchers assessed the effects of a mindfulness smartphone app, Tension Tamer (TT) on BP. Their sample was 48.4% African American and

45.3% female. Participants were randomized to specific groups, to practice breathing awareness meditation through TT for either 5, 10, or 15min twice daily. The researchers noted significant decreases in SBP and DBP at 1, 3, and 6 months.²⁵ A higher TT dose resulted in significantly greater reductions in SBP at months 3 and 6. During the 3-month follow-up, significant differences were seen between the 5- and 15-min conditions, and 10- and 15-min conditions. During the 6-month follow-up, significant differences were seen in the 5- and 15-min conditions. Participants assigned to the 15-min condition demonstrated the greatest reduction in SBP over time. During the 1-month follow-up, there was a significant association between adherence and SBP changes.

A study that focused specifically on older African Americans with hypertension, (≥ 62 years old, 95% female), and found an 8-week MBSR to be efficacious in reducing BP. Participants in MBSR arm exhibited 21.92-mmHg lower SBP levels compared to the social support group ($p=0.020$). Similarly, the intervention arm also exhibited 16.70-mmHg lower DBP compared to the control arm ($p=0.003$).⁴²

Lifestyle modification interventions

Of the 18 articles, 6 (33%) included interventions that incorporated stress management as part of a comprehensive lifestyle modification. Studies varied in regard to the patient populations served and study design. For example, one of the studies included focused on patients with type 2 diabetes and one study was a workplace intervention. Of the six lifestyle interventions, three were RCTs.

In a non-RCT, Thomas et al.²⁸ evaluated the effectiveness of a culturally tailored lifestyle intervention, Prime Time Sister Circles (PTSC), on stress management, physical activity, and nutrition for African-American women. PTSC was found to be efficacious in lowering stress by participants reporting significantly lower stress levels at 3-month and 6-month follow-ups. Women reported incorporating skills such as deep breathing and meditation more often than at baseline. They also reported engaging in more physical activity and higher levels of healthy eating patterns. At 3 months, a lower percentage of women fell within the hypertensive BP category (29.8%) and a higher percentage of women were classified as having normal BP (27.8%) compared to baseline (39.1% hypertensive and 25.1% normal). The same pattern was seen when Thomas et al. incorporated PTSC into a quasi-experimental design with women reporting higher levels of exercise, higher levels of healthy eating, and a lower proportion of PTSC women classified as hypertensive.²⁸ Gilstrap et al. (also a non-RCT) examined the effects of the Health Awareness and Primary Prevention in Your neighborhood (HAPPY) program on cardiovascular risk. The program incorporated lifestyle modification education on stress reduction, smoking cessation, and implementation of individualized

exercise and dietary plans. The percentage of women with hypertension decreased from baseline to 1-year follow-up as well as 1-year to 2-year follow-up. Participants showed significant decreases in stress and BP by the 2-year follow-up. Just 3.1% of the sample was comprised of African-American women.³⁷

Lifestyle modifications incorporating stress management was also efficacious in managing BP in women with type 2 diabetes. Tucker et al. implemented a tailored community-based health promotion program to adults with type 2 diabetes and examined the effects of lifestyle behavior modifications on body mass index (BMI), BP, stress levels, and blood glucose levels. Sessions were delivered in a workshop format with counseling on stress management, nutrition, food preparation, and physical activity. Participants in the intervention group, consisting of 67.2% African Americans and 73.4% female, exhibited significantly lower stress scores and DBP.

In a cluster-RCT, Ward et al. tested the efficacy of a workplace-based intervention, Health Lifestyles, with content focusing on physical activity, stress management, and other behavioral lifestyle modifications. The control group received the Healthy Finances program which focused solely on managing personal finances. At 6 months, stress and mean arterial pressure decreased significantly within both groups. However, no statistically significant differences were reported between groups.

Bavikati et al. led a non-RCT, community-based comprehensive lifestyle modification program that included physical activity, stress management, nutrition counseling, as well as one-on-one behavioral counseling for adults with prehypertension. Their study reported significant improvements in BP, and also reported reductions in BP were higher in women than in men. They also found that BP changes varied by those reporting a BMI of <30 versus individuals reporting a BMI of >30.³⁰

Using a non-randomized, uncontrolled-single arm design, Emmert-Aronson et al. implemented a "behavioral pharmacy" approach that engaged multiple social determinants of health to engage patients at a federally qualified health center (FHQC) with conditions that can be managed through behavioral intervention.³⁵ The "behavioral pharmacy" approach was rooted in four components: physical activity, nutrition, social support, and stress reduction. This study's approach incorporated comprehensive lifestyle changes while also including a meditation aspect for the stress reduction component. Their findings showed statistically significant decreases in SBP and improvements in other cardiovascular risk factors such as BMI and physical activity. Among individuals with depression, there were statistically significant reductions in depression and SBP at the conclusion of the program. They did not report findings on stress specifically.³⁵

Affirmation and coping interventions. Two articles (11%) were classified as affirmation and coping interventions.

One study was performed in ambulatory care practices tested self-affirmation and positive effect on BP control in African-American adults with uncontrolled hypertension.³¹ The results showed that individuals with greater stress or depressive symptoms at baseline were less likely to have controlled BP at 12-month follow-up. Multivariate analysis showed that females had 2.95 times greater odds of achieving the outcome BP of 140/90 mm Hg ($p=0.10$). There was no difference in BP control between the intervention and control groups. The authors suggested that the intervention and control arm were not distinctive enough and that there could have been possible contamination given that the same research staff delivered both interventions.

One study (5%) was a faith-based intervention and categorized as a coping/affirmation intervention. Mendez et al. (2018) examined a church-based intervention for older African-American adults (>45 years old), Health for Hearts United (HHU), which centered around awareness building, clinical learning, and efficacy development.³⁶ HHU included individual and group sessions that incorporated stress management by introducing active coping skills. Lower life satisfaction (LLS) was found to be significantly associated with higher DBP at 6-month follow-up but had no associations with SBP. Active coping was adversely associated with BP, resulting in higher levels of SBP ($p<0.01$) and DBP ($p<0.05$) at 24 months. They reported that the coping intervention resulted in improvements in anthropometric measures related to CVD risk. Authors proposed that perhaps some elements of John Henryism may help to understand how participants were engaging in active coping.

Discussion

We reviewed 18 studies that were interventions incorporated stress management for BP control in Black women. Notably, meditation-based interventions statistically significant results varied. Lifestyle interventions were also efficacious as reducing BP. This review also demonstrates that more studies are needed to ascertain the true effects of stress on BP because so a few studies focused on African-American women or stratified by both race and gender. A number of studies examining stress management and hypertension were not included because they did not include stratifications by race and/or gender.⁴⁷⁻⁴⁹

The mixed findings relating to the affirmation/coping interventions included warrant further exploration. In Boutin-Foster et al., the authors suggested that a possible explanation for the negative trial may have been that affirmation and self-affect may not have been as effective mediators in comparison to patient education.

In the only coping intervention, Mendez et al. reported unexpected results showing that coping did not have an effect on the association between LLS and BP and an adverse relationship between coping and BP. This introduces critical questions regarding coping and their

effects on BP among African Americans. Perhaps it is important to differentiate between high-effort coping and the presence of stress as particularly detrimental combinations for BP. For example, James et al.²² hypothesized a construct within the John Henryism framework suggesting that high-effort coping alone may not necessarily be as detrimental as in the presence of high stress combined with high-effort coping.²² A study examining the John Henryism hypothesis in the Jackson Heart Study (JHS) found that socioeconomic status may potentially exacerbate the effects of high-effort coping on hypertension in men.⁵⁰ These findings raise further research questions about what characteristics and populations may be particularly susceptible to the effects of John Henryism.

The relative success reported by the studies that included stress management in the lifestyle interventions may be promising—especially given the strong relationships between health behaviors and both stress and BP. Stress can inhibit adoption of positive health behaviors and lifestyle factors that can reduce risk for hypertension. For example, Gaston et al.⁵¹ explored a behavioral health intervention for mid-life African-American women and found that 14.5% of women noted stress as a barrier preventing them from adhering to a regular exercise regimen. Kang et al.⁵² found that among African-American women who reported high-stress levels, there was lower adherence to behavioral lifestyle modifications. In the JHS study, stress was associated with lower adoption of Life's Simple 7, the American Heart Association (AHA) recommended lifestyle modifications for optimal heart health.⁵³ The finding that the “behavioral pharmacy” approach evaluated by Emmert-Aronson et al. may be helpful in patients with depression is critical, given that African Americans have increased the risk for severe depression,⁵⁴ depression is a major risk factor for CVD,⁵⁵ and individuals with depression may be more susceptible to the detrimental effects of stress.⁵⁶

The utility of mobile health applications (mHealth) has been increasingly recognized as potentially efficacious tools in public health. However, there are limited studies evaluating mHealth stress management interventions, particularly as they may pertain to BP control, and even less so on if they are acceptable, feasible or efficacious in African-American women. At the time of this review, only one published study examining an mHealth stress management intervention on BP outcomes was available.²⁵ The results demonstrated the potential in App-delivered mindfulness training as an mHealth modality for stress management. A systematic review on the effects of mHealth interventions on secondary CVD prevention noted that mHealth patients exhibited increased medication adherence and adherence to recommended non-pharmacological therapies for managing BP.⁵⁷ Another review that showed promising results for mHealth interventions and other risk factors for CVD and BP such as smoking and glycemic control.⁵⁸ Research suggests that mHealth interventions may be complementary

when combined with other intervention components such as home BP monitoring.⁵⁹ This is especially promising for BP control in Black women given their high rates of mobile phone ownership and use of mobile phones for Internet access.⁶⁰ Despite these encouragements, the utility of mHealth mindfulness-based interventions among Black women remains largely untested.

The meditation interventions included in this review demonstrated some positive results in terms of reducing BP, although some were statistically insignificant when comparing intervention versus control arms. There has been an increase of mindfulness-based interventions in modalities for stress management in scientific research in recent years. There is a growing body of evidence about the benefit of meditation practices as complementary approaches to pharmacotherapy for BP control. It has been shown to improve physical and mental health outcomes among individuals with coronary heart disease, prehypertension, anxiety, and depression.^{47,61–64} Despite the promising benefit of mindfulness-based interventions such as mindfulness-based cognitive therapy (MBCT), there are barriers associated with traditional in-person delivery of MBCT. Other studies have tested adaptations to MBCT, such as phone adaptation.⁶⁵ Limited evidence exists on how these may be efficacious in BP control in African Americans.

A notable challenge in stress and behavioral health research is the complexities in measuring stress in general, specifically in African-American women. There is no gold standard on how to measure stress, and a variety of validated tools have been used. Most commonly used in research is the PSS, developed by Cohen et al.⁶⁶ The PSS was originally developed as a 14-item tool by Cohen et al.,⁶⁶ and evaluated as a 10-item tool.⁶⁷ Other measures of stress include the strain questionnaire, which measures behavioral, cognitive, and health-related stressors. Other previously utilized measures of stress include the Weekly Stress Inventory (WSI), an 87-item measure of stressful events occurring in the past week.⁶⁸ The Stress Overload Scale (SOS) has been used notably among African-American women in prior research,⁶⁹ which includes measurements of personal vulnerability and stressful event loads.⁷⁰ Future research should address challenges in measuring stress within the African-American community, particularly among women. Some research suggests that African-American women may underreport stress due to cultural and societal norms that may facilitate maladaptive coping and difficulty acknowledging stress.⁷¹ More research is needed on assessments of stress in this population and whether or not currently available tools may not perform ideally in this population to capture stress levels accurately.

Conclusion

This review utilized rigorous search strategies to obtain published studies of stress management and samples that included African-American women. However, there are

some limitations that should be considered. Because so a few studies focused specifically on African-American women, so even when positive effects were found, it is not possible to draw conclusions about effects in this population. Also, some studies did not have adequately powered sample sizes, thereby inhibiting ability to detect differences between study arms.^{32,40} Many studies had active control arms, which may have made it difficult to ascertain the true efficacy of the intervention. In addition, some studies did not include a control group, were not RCTs, and/or were underpowered. These methodological limitations hinder our ability to make causal inferences or establish generalizability. As previously mentioned, there was substantial variability in stress measures, limiting our ability to aggregate the data and conduct a meta-analysis.

This synopsis on stress management interventions and BP among African-American women highlights the need for efficacious interventions to reduce BP and cardiovascular risk. Increasing randomized clinical trials on stress management in African-American women is critical. There have been several adaptations and novel innovations of stress management programs, yet little is known about their efficacy in African-American women. Future research should examine if and how such adaptations can be effective tools for stress management in African-American women.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The authors disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: Preparation of this article was supported in part by the National Institutes of Health grant T32HL129953 - Mentoring URM Scientists in Behavioral and Cardiovascular Health to Increase Academic Workforce Diversity and American Heart Association grant 19POST34380633.

ORCID iD

Jolaade Kalinowski  <https://orcid.org/0000-0003-1637-0455>

References

1. Virani SS, Alonso A, Benjamin EJ, et al. Heart disease and stroke statistics-2020 update: a report From the American Heart Association. *Circulation* 2020; 141: e139–e596.
2. Chobanian AV, Bakris GL, Black HR, et al. Seventh report of the joint national committee on prevention, detection, evaluation, and treatment of high blood pressure. *Hypertension* 2003; 42: 1206–1252.
3. Appel LJ, Champagne CM, Harsha DW, et al. Effects of comprehensive lifestyle modification on blood pressure control: main results of the PREMIER clinical trial. *JAMA* 2003; 289: 2083–2093.
4. Carnethon MR, Pu J, Howard G, et al. Cardiovascular health in African Americans: a scientific statement from the American Heart Association. *Circulation* 2017; 136: e393–e423.
5. Greenlund KJ, Daviglus ML and Croft JB. Differences in healthy lifestyle characteristics between adults with prehypertension and normal blood pressure. *J Hypertens* 2009; 27(5): 955–962.
6. King DE, Mainous AG 3rd, Carnemolla M, et al. Adherence to healthy lifestyle habits in US adults, 1988–2006. *Am J Med* 2009; 122(6): 528–534.
7. Spruill TM. Chronic psychosocial stress and hypertension. *Curr Hypertens Rep* 2010; 12: 10–16.
8. Richardson S, Shaffer JA, Falzon L, et al. Meta-analysis of perceived stress and its association with incident coronary heart disease. *Am J Cardiol* 2012; 110: 1711–1716.
9. Arnold SV, Smolderen KG, Buchanan DM, et al. Perceived stress in myocardial infarction: long-term mortality and health status outcomes. *J Am Coll Cardiol* 2012; 60: 1756–1763.
10. Albert MA, Slopen N and Williams DR. Cumulative psychological stress and cardiovascular disease risk: a focused review with consideration of Black-White disparities. *Curr Cardiovasc Risk Rep* 2013; 7: 318–325.
11. Spruill TM, Butler MJ, Thomas SJ, et al. Association between high perceived stress over time and incident hypertension in Black adults: findings from the Jackson Heart Study. *J Am Heart Assoc* 2019; 8: e012139.
12. Rod NH, Gronbaek M, Schnohr P, et al. Perceived stress as a risk factor for changes in health behaviour and cardiac risk profile: a longitudinal study. *J Intern Med* 2009; 266(5): 467–475.
13. Clark A, Lange T, Hallqvist J, et al. Sleep impairment and prognosis of acute myocardial infarction: a prospective cohort study. *Sleep* 2014; 37: 851–858.
14. Rozanski A, Blumenthal JA, Davidson KW, et al. The epidemiology, pathophysiology, and management of psychosocial risk factors in cardiac practice: the emerging field of behavioral cardiology. *J Am Coll Cardiol* 2005; 45: 637–651.
15. Sternthal MJ, Slopen N and Williams DR. Racial disparities in health: how much does stress really matter. *Du Bois Rev* 2011; 8(1): 95–113.
16. Burroughs Pena MS, Mbassa RS, Slopen NB, et al. Cumulative psychosocial stress and ideal cardiovascular health in older women. *Circulation* 2019; 139: 2012–2021.
17. Shorter-Gooden K. Multiple resistance strategies: how African American women cope with racism and sexism. *J Black Psychol* 2004; 30: 406–425.
18. Lewis JA and Neville HA. Construction and initial validation of the Gendered Racial Microaggressions Scale for Black women. *J Couns Psychol* 2015; 62(2): 289–302.
19. Lewis JA, Williams MG, Peppers EJ, et al. Applying intersectionality to explore the relations between gendered racism and health among Black women. *J Couns Psychol* 2017; 64(5): 475–486.
20. Lewis TT, Kravitz HM, Janssen I, et al. Self-reported experiences of discrimination and visceral fat in middle-aged African-American and Caucasian women. *Am J Epidemiol* 2011; 173: 1223–1231.
21. Lewis TT, Everson-Rose SA, Powell LH, et al. Chronic exposure to everyday discrimination and coronary artery

- calcification in African-American women: the SWAN Heart Study. *Psychosom Med* 2006; 68(3): 362–368.
22. James SA, Hartnett SA and Kalsbeek WD. John Henryism and blood pressure differences among black men. *J Behav Med* 1983; 6: 259–278.
 23. Merritt MM, Bennett GG, Williams RB, et al. Low educational attainment, John Henryism, and cardiovascular reactivity to and recovery from personally relevant stress. *Psychosom Med* 2004; 66(1): 49–55.
 24. Woods-Giscombé CL. Superwoman schema: African American women's views on stress, strength, and health. *Qual Health Res* 2010; 20(5): 668–683.
 25. Adams ZW, Sieverdes JC, Brunner-Jackson B, et al. Meditation smartphone application effects on prehypertensive adults' blood pressure: dose-response feasibility trial. *Health Psychol* 2018; 37(9): 850–860.
 26. Cox TL, Krukowski R, Love SJ, et al. Stress management-augmented behavioral weight loss intervention for African American women: a pilot, randomized controlled trial. *Health Educ Behav* 2013; 40(1): 78–87.
 27. Rainforth MV, Schneider RH, Nidich SI, et al. Stress reduction programs in patients with elevated blood pressure: a systematic review and meta-analysis. *Curr Hypertens Rep* 2007; 9(6): 520–528.
 28. Thomas VG, Gaston MH, Porter GK, et al. Prime Time Sister Circles® II: evaluating a culturally relevant intervention to decrease psychological and physical risk factors for chronic disease in mid-life African American women. *J Natl Med Assoc* 2016; 108(1): 6–18.
 29. Ward DS, Vaughn AE, Hales D, et al. Workplace health and safety intervention for child care staff: rationale, design, and baseline results from the CARE cluster randomized control trial. *Contemp Clin Trials* 2018; 68: 116–126.
 30. Bavikati VV, Sperling LS, Salmon RD, et al. Effect of comprehensive therapeutic lifestyle changes on prehypertension. *Am J Cardiol* 2008; 102: 1677–1680.
 31. Boutin-Foster C, Offidani E, Kanna B, et al. Results from the trial using motivational interviewing, positive affect, and self-affirmation in African Americans with hypertension (TRIUMPH). *Ethn Dis* 2016; 26: 51–60.
 32. Duraïmani S, Schneider RH, Randall OS, et al. Effects of lifestyle modification on telomerase gene expression in hypertensive patients: a pilot trial of stress reduction and health education programs in African Americans. *PLoS ONE* 2015; 10(11): e0142689.
 33. Dusek JA, Hibberd PL, Buczynski B, et al. Stress management versus lifestyle modification on systolic hypertension and medication elimination: a randomized trial. *J Altern Complement Med* 2008; 14(2): 129–138.
 34. Benson H, Beary JF and Carol MP. The relaxation response. *Psychiatry* 1974; 37: 37–46.
 35. Emmert-Aronson B, Grill KB, Trivedi Z, et al. Group Medical Visits 2.0: The Open Source Wellness behavioral pharmacy model. *J Altern Complement Med* 2019; 25(10): 1026–1034.
 36. Mendez YP, Ralston PA, Wickrama KK, et al. Lower life satisfaction, active coping and cardiovascular disease risk factors in older African Americans: outcomes of a longitudinal church-based intervention. *J Behav Med* 2018; 41(3): 344–356.
 37. Gilstrap LG, Malhotra R, Peltier-Saxe D, et al. Community-based primary prevention programs decrease the rate of metabolic syndrome among socioeconomically disadvantaged women. *J Womens Health* 2013; 22(4): 322–329.
 38. Schneider RH, Myers HF, Marwaha K, et al. Stress reduction in the prevention of left ventricular hypertrophy: a randomized controlled trial of transcendental meditation and health education in hypertensive African Americans. *Ethn Dis* 2019; 29(4): 577–586.
 39. Yunesian M, Aslani A, Vash JH, et al. Effects of transcendental meditation on mental health: a before-after study. *Clin Pract Epidemiol Ment Health* 2008; 4: 25.
 40. Schneider RH, Grim CE, Rainforth MV, et al. 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(6): 750–758.
 41. Castillo-Richmond A, Schneider RH, Alexander CN, et al. Effects of stress reduction on carotid atherosclerosis in hypertensive African Americans. *Stroke* 2000; 31(3): 568–573.
 42. Palta P, Page G, Piferi R, et al. Evaluation of a mindfulness-based intervention program to decrease blood pressure in low-income African-American older adults. *J Urban Health* 2012; 89(2): 308–316.
 43. Schneider RH, Alexander CN, Staggers F, et al. A randomized controlled trial of stress reduction in African Americans treated for hypertension for over one year. *Am J Hypertens* 2005; 18(1): 88–98.
 44. Schneider RH, Staggers F, Alexander CN, et al. A randomized controlled trial of stress reduction for hypertension in older African Americans. *Hypertension* 1995; 26: 820–827.
 45. Vaccarino V, Kondwani KA, Kelley ME, et al. Effect of meditation on endothelial function in Black Americans with metabolic syndrome: a randomized trial. *Psychosom Med* 2013; 75(6): 591–599.
 46. Kabat-Zinn J. Some reflections on the origins of MBSR, skillful means, and the trouble with maps. *Contemp Buddhism* 2011; 12: 281–306.
 47. Hughes JW, Fresco DM, Myerscough R, et al. Randomized controlled trial of mindfulness-based stress reduction for prehypertension. *Psychosom Med* 2013; 75(8): 721–728.
 48. Patel C, Marmot M, Terry D, et al. Trial of relaxation in reducing coronary risk: four year follow up. *Br Med J* 1985; 290: 1103–1106.
 49. Blom K, Baker B, How M, et al. Hypertension analysis of stress reduction using mindfulness meditation and yoga: results from the harmony randomized controlled trial. *Am J Hypertens* 2014; 27(1): 122–129.
 50. Subramanyam MA, James SA, Diez-Roux AV, et al. Socioeconomic status, John Henryism and blood pressure among African-Americans in the Jackson Heart Study. *Soc Sci Med* 2013; 93: 139–146.
 51. Gaston MH, Porter GK and Thomas VG. Prime Time Sister Circles: evaluating a gender-specific, culturally relevant health intervention to decrease major risk factors in mid-life African-American women. *J Natl Med Assoc* 2007; 99(4): 428–438.
 52. Kang AW, Dulin A, Nadimpalli S, et al. Stress, adherence, and blood pressure control: a baseline examination of Black women with hypertension participating in the SisterTalk II intervention. *Prev Med Rep* 2018; 12: 25–32.

53. Brewer LC, Redmond N, Slusser JP, et al. Stress and achievement of cardiovascular health metrics: the American Heart Association Life's Simple 7 in Blacks of the Jackson Heart Study. *J Am Heart Assoc* 2018; 7: e008855.
54. Williams DR, Gonzalez HM, Neighbors H, et al. Prevalence and distribution of major depressive disorder in African Americans, Caribbean blacks, and non-Hispanic whites—results from the National Survey of American Life. *Arch Gen Psychiatry* 2007; 64(3): 305–315.
55. Pickering TG. Mental stress as a causal factor in the development of hypertension and cardiovascular disease. *Curr Hypertens Rep* 2001; 3(3): 249–254.
56. Burg MM and Abrams D. Depression in chronic medical illness: the case of coronary heart disease. *J Clin Psychol* 2001; 57(11): 1323–1337.
57. Gandhi S, Hong L, Sun K, et al. Effect of mobile health interventions on the secondary prevention of cardiovascular disease: systematic review and meta-analysis. *Can J Cardiol* 2016; 32: S278.
58. Widmer RJ, Collins NM, Collins CS, et al. Digital health interventions for the prevention of cardiovascular disease: a systematic review and metaanalysis. *Mayo Clinic Proc* 2015; 90: 469–480.
59. Xiong S, Berkhouse H, Schooler M, et al. Effectiveness of mHealth interventions in improving medication adherence among people with hypertension: a systematic review. *Curr Hypertens Rep* 2018; 20: 86.
60. Zickuhr K and Smith A. *Digital differences*. Washington, DC: Pew Research Center, 2012.
61. Abbott RA, Whear R, Rodgers LR, et al. Effectiveness of mindfulness-based stress reduction and mindfulness based cognitive therapy in vascular disease: a systematic review and meta-analysis of randomised controlled trials. *J Psychosom Res* 2014; 76(5): 341–351.
62. Ray IB, Menezes AR, Malur P, et al. Meditation and coronary heart disease: a review of the current clinical evidence. *Ochsner J* 2014; 14(4): 696–703.
63. Gotink RA, Chu P, Busschbach JJ, et al. Standardised mindfulness-based interventions in healthcare: an overview of systematic reviews and meta-analyses of RCTs. *PLoS ONE* 2015; 10: e0124344.
64. Hofmann SG, Sawyer AT, Witt AA, et al. The effect of mindfulness-based therapy on anxiety and depression: a meta-analytic review. *J Consult Clin Psychol* 2010; 78(2): 169–183.
65. Spruill TM, Reynolds HR, Dickson VV, et al. Telephone-based mindfulness training to reduce stress in women with myocardial infarction: rationale and design of a multicenter randomized controlled trial. *Am Heart J* 2018; 202: 61–67.
66. Cohen S, Kamarck T and Mermelstein R. A global measure of perceived stress. *J Health Soc Behav* 1983; 24: 385–396.
67. Cole SR. Assessment of differential item functioning in the Perceived Stress Scale-10. *J Epidemiol Community Health* 1999; 53(5): 319–320.
68. Payne TJ, Wyatt SB, Mosley TH, et al. Sociocultural methods in the Jackson Heart Study: conceptual descriptive overview. *Ethn Dis* 2005; 15: S38–S48.
69. Crusto CA, Barcelona de Mendoza V, Connell CM, et al. The intergenerational impact of genetic and psychological factors on blood pressure study (InterGEN): design and methods for recruitment and psychological measures. *Nurs Res* 2016; 65(4): 331–338.
70. Amir Khan JH. Stress overload: a new approach to the assessment of stress. *Am J Community Psychol* 2012; 49(1–2): 55–71.
71. Brown KM, Hui Q, Huang Y, et al. Association between stress and coping with DNA methylation of blood pressure-related genes among African American women. *Chronic Stress* 2019; 3: 2470547019879088.
72. Tucker CM, Lopez MT, Campbell K, et al. The effects of a culturally sensitive, empowerment-focused, community based health promotion program on health outcomes of adults with type 2 diabetes. *J Health Care Poor Underserved* 2014; 25(1): 292.
73. Ward DS, Vaughn AE, Hales D, et al. Workplace health and safety intervention for child care staff: rationale, design, and baseline results from the CARE cluster randomized control trial. *Contemp Clin Trials* 2018; 68: 116–126.
74. Linnan LA, Vaughn AE, Smith FT, et al. Results of caring and reaching for health (CARE): a cluster-randomized controlled trial assessing a worksite wellness intervention for child care staff. *Int J Behav Nutr Phys Act* 2020; 17: 1–15.