Title
Positive Health Beliefs and Blood Pressure Reduction in the DESERVE Study.

Journal
Journal of the American Heart Association, 9(9)

Authors
Goldmann, Emily
Jacoby, Rachelle
Finfer, Erica
et al.

Publication Date
2020-05-05

DOI
10.1161/JAHA.119.014782

Peer reviewed

Journal of the American Heart Association

ORIGINAL RESEARCH

Positive Health Beliefs and Blood Pressure Reduction in the DESERVE Study

Emily Goldmann, PhD, MPH; Rachelle Jacoby, MPH; Erica Finfer, MPH; Noa Appleton, MPH; Nina S. Parikh, PhD, MPH; Eric T. Roberts, MPH; Bernadette Boden-Albala, DrPH, MPH

BACKGROUND: There is growing recognition that positive health beliefs may promote blood pressure (BP) reduction, which is critical to stroke prevention but remains a persistent challenge. Yet, studies that examine the association between positive health beliefs and BP among stroke survivors are lacking.

METHODS AND RESULTS: Data came from the DESERVE (Discharge Educational Strategies for Reduction of Vascular Events) study, a randomized controlled trial of a skills-based behavioral intervention to reduce vascular risk in a multiethnic cohort of 552 transient ischemic attack and mild/moderate stroke patients in New York City. The exposure was perception that people can protect themselves from having a stroke (ie, prevention self-efficacy) at baseline. The association between systolic BP (SBP) reduction at 12-month follow-up and self-efficacy was examined using linear regression adjusted for key confounders, overall and stratified by age, sex, race/ethnicity, and intervention trial arm. Approximately three quarters endorsed self-efficacy. These participants had, on average, 5.6 mm Hg greater SBP reduction compared with those who did not endorse it (95% CI, 0.5–10.7 mm Hg; *P*=0.032). Self-efficacy was significantly associated with greater SBP reduction, particularly among female versus male, younger versus older, and Hispanic versus non-Hispanic white patients. Sensitivity analysis adjusting for baseline SBP instead of elevated BP yielded no association between self-efficacy and SBP reduction, but showed sex differences in this association (women: β=5.3; 95% CI, −0.2 to 10.8; *P*=0.057; men: β=−3.3; 95% CI, −9.4 to 2.9; *P*=0.300; interaction *P*=0.064).

CONCLUSIONS: Self-efficacy was linked with greater SBP reduction among female stroke survivors. Targeted strategies to improve health beliefs after stroke may be important for risk factor management.

REGISTRATION: URL: https://www.clinicaltrials.gov; Unique identifier: NCT01836354.

Key Words: blood pressure ■ hypertension ■ self-efficacy ■ stroke

Elevated blood pressure (BP) is a well-established, modifiable risk factor for stroke and stroke recurrence, with higher BP strongly linked to increased stroke risk.[1,2] Hypertension control and BP reduction, through pharmacological and/or behavioral lifestyle approaches, is essential to primary[1] and secondary[3] stroke prevention but remains a persistent challenge for many. More than half of US adults with hypertension and more than one third of stroke survivors do not achieve BP control.[4–6] There are also significant disparities in hypertension control by race/ethnicity and sex, with a lower likelihood of BP control among non-Hispanic black, non-Hispanic Asian, and Hispanic adults compared with non-Hispanic white adults[4] and among older adult women compared with older adult men (the opposite is true for sex in younger populations).[7,8] Studies have also reported lower BP control among black versus white and female versus male stroke survivors.[6,9] Addressing these disparities may require further investigation, as well as targeted approaches to BP control.[7,8]

In addition to structural factors (eg, access to healthy food, quality health care, and opportunities for physical activity[10,11]), individual behaviors are important for

Correspondence to: Emily Goldmann, PhD, MPH, School of Global Public Health, New York University, 715 Broadway, 10th Floor, New York, NY 10031. E-mail: esg236@nyu.edu

For Sources of Funding and Disclosures, see page 11.

JAHA is available at: www.ahajournals.org/journal/jaha

CLINICAL PERSPECTIVE

What Is New?

- Self-efficacy may promote blood pressure reduction after stroke, particularly among female patients.

What Are the Clinical Implications?

- Assessment and promotion of positive health beliefs may be important components of risk factor management approaches to secondary stroke prevention.

Nonstandard Abbreviations and Acronyms

BP	Blood pressure
DESERVE	Discharge Educational Strategies for Reduction of Vascular Events
SBP	Systolic blood pressure
TIA	transient ischemic attack

addressing hypertension. In population-based studies of US adults with hypertension (BP ≥130/80 mm Hg or taking hypertensive medication), greater hypertension control has been associated with more healthcare visits,[5] greater continuity of care, having BP tested in the past year, and lifestyle behaviors, such as lower weight, reduced sodium intake, and greater physical activity.[12] Among hypertensive patients, adherence to prescribed antihypertensive medication regimens also plays a primary role in BP control.[13] Randomized controlled trials among hypertensive individuals (BP ≥140/85 mm Hg) have also linked lifestyle interventions, such as eating a healthier diet (eg, more fruits and vegetables and fewer fats and carbohydrates), increasing aerobic exercise, and restricting sodium and alcohol intake, to reduction in systolic BP (SBP).[14] More recently, among stroke and transient ischemic attack (TIA) patients, the large majority of whom had a history of hypertension, our study team reported a positive impact of a skills-based behavioral intervention targeting risk perception, patient-physician communication, and medication adherence on SBP reduction, particularly among Hispanic patients.[15]

There is growing recognition that positive well-being and positive health beliefs may also play a role in cardiovascular health.[16–29] For example, studies examining patients with cardiac conditions (eg, coronary artery disease and chronic angina) found that recovery expectations and optimism led to improved functional status and better clinical outcomes over time.[23,24] A large community-based prospective study also linked high emotional vitality to significantly lower hypertension risk.[18] There are several hypotheses offered to explain this relationship. Having positive health beliefs, such as higher levels of self-efficacy and confidence, motivation to take action, greater ability to cope and adjust to adversity, and accurate risk perception, may promote healthy behaviors (eg, diet, physical activity, sleep, and treatment adherence)[16,25,29–31] and result in better health outcomes. Greater psychosocial resources and better physiological functioning noted among those with positive psychological well-being may also explain this association.[21] In addition, positive emotions may buffer the impact of stress on health or reduce the stress itself.[21,22] Despite this evidence, studies that examine the association between positive health beliefs and BP are lacking.

To our knowledge, no study has assessed the association between positive health beliefs and BP reduction among stroke survivors, many of whom require BP control to improve stroke outcomes and reduce risk of stroke recurrence. Thus, this study examined the link between a positive health belief, self-efficacy, and SBP reduction 1 year following stroke in a multiethnic cohort of transient ischemic attack (TIA) and mild/moderate stroke patients. We hypothesized that having this positive health belief would be associated with greater mean SBP reduction at 1 year postdischarge compared with not having this positive health belief. Furthermore, given evidence that negative psychological characteristics (eg, depression) are associated with hypertension, and that this association might vary by age and sex,[26–28] as well as the lack of studies in diverse populations,[26] we also examined this association by age, sex, and race/ethnicity.

METHODS

The data that support the findings of this study are available from the principal investigator of the study, Dr Bernadette Boden-Albala (bbodenal@hs.uci.edu), on reasonable request.

Study Design, Setting, and Participants

The DESERVE (Discharge Educational Strategies for Reduction of Vascular Events) study was a randomized controlled trial conducted in a multiethnic cohort of TIA and mild/moderate stroke patients discharged from 4 New York City hospitals between August 2012 and May 2016 (ClinicalTrials.gov: NCT01836354; https://clinicaltrials.gov/ct2/show/NCT01836354). The goal of the trial was to assess the efficacy of a skill-based, culturally tailored behavioral intervention focused on medication adherence, patient-physician communication, and risk perception on SBP reduction between baseline (prehospital discharge) and 12-month follow-up. In addition, a questionnaire covering sociodemographic characteristics, psychosocial factors, health behaviors, and medical history was administered at baseline and at 6- and 12-month follow-up. Details of the study have been published previously.[15] All participants provided written informed consent. The study was approved by the Institutional Review Boards of all participating medical centers (New York University Langone Medical Center, Icahn School of Medicine at Mount Sinai, Columbia University Medical Center, and Bellevue Hospital Center).

Measures

The exposure of interest, participants' perception of their ability to protect themselves from having a stroke, was measured by asking whether they agreed or disagreed with the statement, "I can protect myself against having a stroke" at baseline (predischarge). In relation to stroke prevention, this positive health belief reflects, at least in part, the concept of self-efficacy, which includes the belief in one's ability to achieve a specific outcome[32] (referred to as "self-efficacy" going forward). The outcome of interest was SBP reduction (mm Hg) between baseline and 12-month follow-up. Baseline diastolic and systolic BP was measured at least 48 hours after stroke up to 3 times by trained research coordinators or research assistants using an automatic sphygmomanometer, following American Heart Association guidelines.[15] The 12-month follow-up BP measurements were recorded by research staff from the following sources: in-person measurement in the study office or in participants' homes, clinic visits where our study staff met with patients or abstracted chart records, and self-report by participants.[15] Reduction in SBP was calculated by subtracting participants' 12-month SBP from their baseline SBP.

Other variables examined in this study were measured at baseline and included sex (male/female), age (<65 versus ≥65 years), self-reported race/ethnicity (non-Hispanic white, non-Hispanic black, Hispanic, non-Hispanic other), education level (high school or less versus some college or more), marital status (married/cohabitating, divorced/widowed/separated, never married), nativity (born in the United States versus foreign born), number of chronic disease conditions, stroke severity at discharge, neurological disability, stroke/TIA history before current hospitalization (yes/no), Medicaid insurance coverage (yes/no), body mass index (underweight or normal weight <25, overweight 25 to <30, obese 30 or higher), participation in any moderate or vigorous physical activity in the past 30 days (yes/no), smoking status (current, former, never), trial arm (intervention versus usual care), and elevated BP at baseline. Depression symptoms were also assessed predischarge using the 20-item Center for Epidemiologic Studies–Depression scale (range, 0–60). Higher scores reflected greater symptom severity, and scores of ≥16 indicated probable depression.[33] Stroke severity was based on National Institutes of Health Stroke Scale (NIHSS) score measured at discharge, categorized as "missing" for those who did not have reported values (to maintain sample size), as "mild" for those with 0 to 4 symptoms, and as "moderate or higher" for those with ≥5 symptoms. Neurological disability was measured using the modified Rankin scale, categorized as "missing," 0 to 1 (no/mild), and 2 to 5 (moderate to severe). Elevated baseline BP was indicated for those with diastolic and systolic BP values that met criteria for prehypertension, stage 1 hypertension, or stage 2 hypertension, on the basis of 2017 guidelines.[34]

Statistical Analysis

The analytic sample included those who completed the self-efficacy question and had SBP measures at both baseline and 12-month follow-up (n=453). All variables were described using frequencies and percentages or means and SDs, as appropriate. The relationships between all study variables (including self-efficacy) and mean SBP reduction were assessed using *t* tests and ANOVA. The association between self-efficacy and all other variables was assessed using Pearson's χ^2 tests. The relation between SBP reduction and self-efficacy was further examined using unadjusted (model 1) and adjusted (models 2–4) linear regression. The β estimates, 95% CIs, and *P* values are reported. Covariates included in adjusted models were selected on the basis of their association with self-efficacy and SBP reduction in bivariable analysis (to identify potential confounders), conceptual importance, contribution to overall model fit when adding in each covariate one at a time to the model, and likelihood ratio tests. Elevated baseline BP was included in the adjusted model (model 3) because individuals with elevated BP would likely be strongly advised to reduce their BP through pharmacological and/or lifestyle approaches. As a sensitivity analysis, we adjusted for baseline SBP instead of elevated BP in an additional regression model also adjusted for other covariates (model 4). We also ran stratified adjusted regression models to further evaluate age-, sex-, and race/ethnic-specific associations between self-efficacy and SBP reduction. In addition, given the nature of the DESERVE study as a skills-based behavioral intervention, we examined trial arm as an effect modifier as an exploratory aim, to assess whether receiving the intervention may have amplified the impact of self-efficacy on SBP reduction. In a final set of regression models, interaction terms were added to adjusted models to test for statistical interaction between self-efficacy and age, sex, race/ethnicity, and intervention trial arm separately. Analyses were conducted using Stata/IC version 15.1 and SAS version 9.4 (Cary, NC), and statistical significance was determined where $P<0.05$.

RESULTS

Table 1 reports baseline characteristics of the DESERVE study participants included in the analytic sample, as well as the prevalence of self-efficacy and mean SBP reduction by these characteristics. More than three fourths of the sample agreed that they can protect themselves from having a stroke (77.5%). Mean SBP reduction in the sample was 6.3 mm Hg (SD, 24.1 mm Hg). The sample was evenly distributed by trial arm (intervention, 50.6%; usual care, 49.5%), sex (men, 49.1%; women, 50.9%), and the 3 largest race/ethnic groups (non-Hispanic white, 29.1%; non-Hispanic black, 32.2%; and Hispanic, 32.7%). Slightly less than half (45.7%) had a high school education or less, were aged ≥65 years (46.6%), and participated in moderate or vigorous physical activity in the past 30 days (48.4%), and more than half were born in the United States (58.0%). Approximately one third of the sample reported Medicaid insurance coverage (33.6%) and had a history of TIA/stroke (32.6%), most had mild strokes (68.7%), and the largest proportion had no/mild neurological disability (40.6%). The large majority had at least one chronic disease diagnosis, with 36.4% reporting ≥3 conditions. Approximately one fifth met criteria for probable depression (20.8%). A greater proportion of non-Hispanic white patients were older, male, educated with some college or more, married, born in the United States, and physically active, and a lower proportion of these patients were covered by Medicaid, current smokers, obese, and had more severe strokes than patients of other races/ethnicities. A greater proportion of male participants were non-Hispanic white, unmarried, physically active, and overweight versus obese compared with female participants (data not shown in tables).

The prevalence of self-efficacy was significantly higher among men versus women (81.5% versus 73.5%; P=0.041) and among those with less stroke-related disability compared with those with greater stroke disability (83.7% versus 67.8%; P=0.006). Mean SBP reduction was significantly greater among those with self-efficacy versus those without (7.8 versus 1.2 mm Hg; P=0.015). Mean SBP reduction was also significantly greater among men than women (9.2 versus 3.6 mm Hg; P=0.012), those with predischarge elevated BP versus not (9.9 versus −13.8 mm Hg; $P<0.001$), and those who participated in any physical activity in the past 30 days versus not (11.1 versus 2.4 mm Hg; $P<0.001$). Mean baseline SBP was significantly higher among those with self-efficacy versus those without (141.3 versus 135.2 mm Hg; P=0.007), and baseline SBP was significantly and positively associated with mean SBP reduction (Pearson correlation coefficient, r=0.687; $P<0.001$; data not shown in tables).

Table 2 reports results from linear regression analysis. In the unadjusted model (model 1), mean SBP reduction was 6.6 mm Hg greater among those with self-efficacy compared to those without (95% CI, 1.3–11.9 mm Hg; P=0.015, R^2=0.013). After adjusting for age, sex, race/ethnicity, marital status, number of chronic disease conditions, past month physical activity, and trial arm (model 2), this association remained the same (β=6.6 mm Hg; 95% CI, 1.2–12.0 mm Hg; P=0.018, R^2=0.076). In a fully adjusted model that also controlled for baseline elevated BP (model 3), the association was slightly attenuated but remained strong and significant (β=5.6 mm Hg; 95% CI, 0.5–10.7 mm Hg; P=0.032, R^2=0.187). Likelihood ratio tests suggested that each model was an improvement on the previous model in terms of model fit (all $P<0.001$).

Figure 1 highlights results from fully adjusted models overall and by race/ethnicity, age, sex, and intervention trial arm. For all subgroups, mean SBP reduction was greater among those with self-efficacy compared with those without. In stratified models, self-efficacy was significantly associated with greater mean SBP reduction among female (β=9.8 mm Hg; 95% CI, 2.3–17.2 mm Hg; P=0.010) and younger (β=7.2 mm Hg; 95% CI, 0.2–14.3 mm Hg; P=0.045) patients, but mean difference in SBP reduction was not statistically significant among other age, race/ethnicity, and sex subgroups, although the effect size was particularly large for Hispanic patients (β=10.3 mm Hg; 95% CI, −0.1 to 20.6 mm Hg; P=0.052) compared with other race/ethnic groups. Self-efficacy was not associated with SBP reduction among those in the intervention trial arm (β=4.3 mm Hg; 95% CI, −3.2 to 11.7 mm Hg; P=0.259) but was associated with SBP reduction in the usual care arm (β=7.2 mm Hg; 95% CI, 0.0–14.3 mm Hg; P=0.049). Interactions between self-efficacy and age (P=0.727), sex (P=0.104), race/ethnicity (P=0.547), and intervention trial arm (P=0.889) were not significant (data not shown in tables).

Sensitivity analysis, where we adjusted for baseline SBP instead of elevated baseline BP (Table 2, model 4), yielded no association between self-efficacy and mean SBP reduction (β=1.8 mm Hg; 95% CI, −2.2 to 5.8; P=0.381, R^2=0.509). In stratified models (Figure 2), the association between self-efficacy and mean SBP

Table 1. Baseline (Predischarge) Characteristics of DESERVE Study Participants, Self-efficacy, and Mean SBP Reduction by These Characteristics

		Self-efficacy		SBP Reduction, mm Hg	
Variable	N (%)	N (%)	*P* Value	Mean (SD)	*P* Value
All participants	453 (100.0)	351 (77.5)		6.3 (24.1)	
Self-efficacy					0.015
No	102 (22.5)	…		1.2 (25.4)	
Yes	351 (77.5)	…		7.8 (23.5)	
Trial arm			0.439		0.099
Usual care	229 (49.5)	174 (76.0)		4.5 (23.6)	
Intervention	224 (50.6)	177 (79.0)		8.2 (24.5)	
Age, y			0.143		0.557
<65	242 (53.4)	194 (80.2)		5.7 (23.5)	
65	211 (46.6)	157 (74.4)		7.0 (24.8)	
Sex			0.041		0.012
Women	230 (50.9)	169 (73.5)		3.6 (24.3)	
Men	222 (49.1)	181 (81.5)		9.2 (23.6)	
Race/ethnicity			0.424		0.418
Non-Hispanic white	131 (29.1)	106 (80.9)		8.4 (21.6)	
Non-Hispanic black	145 (32.2)	108 (74.5)		7.0 (25.5)	
Hispanic	147 (32.7)	117 (79.6)		3.7 (25.3)	
Other	27 (6.0)	19 (70.4)		5.3 (20.8)	
Educational attainment			0.385		0.201
High school education or less	205 (45.7)	156 (76.1)		4.7 (24.3)	
Some college or more	244 (54.3)	194 (79.5)		7.6 (24.0)	
Marital status			0.279		0.142
Married or living with partner	211 (47.2)	169 (80.1)		8.0 (24.6)	
Divorced, separated, or widowed	155 (34.7)	114 (73.6)		3.2 (23.9)	
Never married	81 (18.1)	65 (80.3)		8.0 (23.4)	
Medicaid insurance coverage			0.584		0.930
No	300 (66.4)	230 (76.7)		6.3 (23.0)	
Yes	152 (33.6)	120 (79.0)		6.5 (26.2)	
Nativity			0.818		0.550
Born in the United States	261 (58.0)	204 (78.2)		6.8 (24.5)	
Foreign born	189 (42.0)	146 (77.3)		5.5 (23.7)	
Stroke severity at discharge (NIHSS)			0.136		0.808
0–4 (Mild)	311 (68.7)	249 (80.1)		6.5 (24.2)	
5 (Moderate)	46 (10.2)	32 (69.6)		7.8 (22.6)	
Missing	96 (21.2)	70 (72.9)		5.1 (24.7)	
Modified Rankin score			0.006		0.786
0–1	184 (40.6)	154 (83.7)		6.4 (23.6)	
2–5	115 (25.4)	78 (67.8)		5.1 (24.3)	
Missing	154 (34.0)	119 (77.3)		7.1 (24.6)	
History of stroke or TIA			0.354		0.087
No	288 (67.5)	227 (78.8)		7.6 (24.7)	
Yes	139 (32.6)	104 (74.8)		3.4 (22.0)	
No. of chronic disease conditions*			0.483		0.256
0	49 (10.8)	41 (83.7)		7.3 (27.9)	
1	123 (27.2)	97 (78.9)		4.8 (22.6)	

(*Continued*)

Table 1. Continued

Variable	N (%)	Self-efficacy		SBP Reduction, mm Hg	
		N (%)	*P* Value	Mean (SD)	*P* Value
2	116 (25.6)	91 (78.5)		10.0 (25.2)	
3	165 (36.4)	122 (73.9)		4.6 (23.1)	
Probable depression			0.661		0.281
No	184 (40.6)	140 (76.1)		5.7 (24.1)	
Yes	94 (20.8)	76 (80.9)		3.7 (24.1)	
Missing	175 (38.6)	135 (77.1)		8.4 (24.0)	
Predischarge elevated blood pressure†			0.441		<0.001
No	69 (15.2)	51 (73.9)		−13.8 (18.3)	
Yes	384 (84.8)	300 (78.1)		9.9 (23.2)	
Any moderate/vigorous physical activity in past 30 d			0.266		<0.001
No	230 (51.6)	173 (75.2)		2.4 (24.6)	
Yes	216 (48.4)	172 (79.6)		11.1 (22.8)	
Smoking status			0.576		0.195
Current	65 (14.4)	53 (81.5)		4.7 (26.0)	
Former	128 (28.3)	96 (75.0)		9.6 (22.6)	
Never	259 (57.3)	202 (78.0)		5.1 (24.3)	
Body mass index			0.078		0.533
Underweight or normal weight	124 (27.4)	94 (75.8)		5.6 (23.1)	
Overweight	166 (36.6)	138 (83.1)		8.0 (25.2)	
Obese	163 (36.0)	119 (73.0)		5.2 (23.8)	

DESERVE indicates Discharge Educational Strategies for Reduction of Vascular Events; NIHSS, National Institutes of Health Stroke Scale; SBP, systolic blood pressure; and TIA, transient ischemic attack.

*Includes hypertension, heart disease, weak/failing kidneys, cancer, psychiatric disorder, diabetes mellitus, and stroke.

†Prehypertension, stage 1 hypertension, and stage 2 hypertension.

reduction was also attenuated for all subgroups, with the strongest association noted among female participants (β=5.3 mm Hg; 95% CI, −0.2 to 10.8 mm Hg; *P*=0.057) and the weakest association among male participants (β=−3.3 mm Hg; 95% CI, −9.4 to 2.9; *P*=0.300; interaction term for self-efficacy by sex, *P*=0.064).

DISCUSSION

This study is, to our knowledge, the first to evaluate the link between a positive health belief, specifically, self-efficacy in relation to stroke prevention, and BP reduction among stroke survivors. We found that self-efficacy was common, endorsed by three quarters of respondents, in a multiethnic cohort of TIA and mild/moderate stroke survivors in New York City. This specific measure of positive health beliefs has not been used in previous studies, reducing our ability to compare our findings with the existing literature. However, other measures of self-efficacy have been associated with better functioning, mood, and quality of life among stroke survivors.[32] Conceptualized in the Health Belief Model, self-efficacy is considered a key component to underlying health behavior change and essential for effective self-management of chronic disease,[35–37] which for many stroke survivors includes BP reduction and/or control.[3] Promoting self-efficacy, confidence, and motivation is paramount in disease management strategies and self-care activities (healthful behaviors and medication compliance) and may likely reduce risk and result in better outcomes among stroke patients.[38,39]

The association between self-efficacy and BP reduction noted in this study is consistent with previous studies that have linked positive psychological states to better health outcomes in the context of cardiovascular disease and stroke, largely through improved health behaviors.[16,29] For example, Ostir et al (2001)[19] reported an inverse relationship between positive affect and stroke incidence among older adults with no history of stroke. A study using data from the Whitehall II cohort found that positive well-being, characterized by emotional vitality and optimism, was associated with lower risk of coronary heart disease.[40] Studies using data from the Heart and Soul Study reported that positive affect was associated with being physically active, being adherent to medication, and having good sleep quality among patients with coronary heart disease,[25] as well as with decreased risk of all-cause

Table 2. Association Between SBP Reduction (mm Hg) From Baseline to 1-Year Follow-Up and Self-Efficacy

Variable	Model 1: Unadjusted				Model 2: Adjusted				Model 3: Adjusted				Model 4: Adjusted			
	β	95% CI		*P* Value	β	95% CI		*P* Value	β	95% CI		*P* Value	β	95% CI		*P* Value
Self-efficacy																
No	Reference				Reference				Reference				Reference			
Yes	6.6	1.3	11.9	0.015	6.6	1.2	12.0	0.018	5.6	0.5	10.7	0.032	1.8	−2.2	5.8	0.381
Age, y																
Less than 65 years	Reference				Reference				Reference				Reference			
65 years of olders	1.3	−3.1	5.8	0.557	3.3	−1.5	8.1	0.178	1.9	−2.7	6.4	0.416	−0.1	−3.6	3.5	0.970
Sex																
Women	Reference				Reference				Reference				Reference			
Men	5.7	1.2	10.1	0.012	4.1	−0.8	8.9	0.098	2.2	−2.4	6.8	0.346	−0.5	−4.1	3.1	0.789
Race/ethnicity																
Non-Hispanic white	Reference				Reference				Reference				Reference			
Non-Hispanic black	−1.4	−7.1	4.3	0.624	1.4	−4.8	7.5	0.666	0.1	−5.7	5.9	0.975	−2.8	−7.3	1.7	0.222
Hispanic	−4.7	−10.4	1.0	0.106	−1.5	−7.5	4.5	0.627	−1.3	−6.9	4.4	0.661	−1.9	−6.3	2.5	0.399
Non-Hispanic other	−3.1	−13.1	6.9	0.543	−2.1	−12.4	8.1	0.682	−1.6	−11.3	8.0	0.738	0.3	−7.1	7.8	0.928
Marital status																
Married or living with partner	Reference				Reference				Reference				Reference			
Divorced, separated, or widowed	−4.7	−9.8	0.3	0.065	−2.7	−8.1	2.8	0.338	−3.3	−8.4	1.8	0.205	−3.8	−7.7	0.2	0.063
Never married	0.1	−6.1	6.3	0.982	1.2	−5.3	7.7	0.726	−0.3	−6.4	5.8	0.928	−2.3	−7.0	2.5	0.345
Educational attainment																
High school or less	Reference															
Some college or more	2.9	−1.6	7.4	0.201												
Medicaid insurance coverage																
No	Reference															
Yes	0.2	−4.5	4.9	0.930												
Born in the United States																
No	Reference															
Yes	1.4	−3.2	5.9	0.550												
No. of chronic disease diagnoses*																
0	Reference				Reference				Reference				Reference			
1	−2.4	−10.4	5.6	0.551	−0.6	−8.7	7.5	0.885	−3.1	−10.8	4.6	0.425	−4.6	−10.5	1.4	0.132
2	2.7	−5.4	10.8	0.511	3.7	−4.5	11.9	0.376	2.8	−4.9	10.6	0.471	−1.2	−7.2	4.8	0.696
3	−2.7	−10.4	5.0	0.493	−1.1	−9.0	6.9	0.793	−3.4	−10.9	4.0	0.365	−5.5	−11.3	0.3	0.061

(*Continued*)

Table 2. Continued

Variable	Model 1: Unadjusted				Model 2: Adjusted				Model 3: Adjusted				Model 4: Adjusted			
	β	95% CI		*P* Value	β	95% CI		*P* Value	β	95% CI		*P* Value	β	95% CI		*P* Value
Probable depression																
No	Reference															
Yes	−2.0	−8.0	4.0	0.518												
Missing	2.7	−2.3	7.7	0.285												
Any moderate or vigorous exercise in past 30 d																
No	Reference				Reference				Reference				Reference			
Yes	8.7	4.3	13.1	<0.001	7.4	2.8	12.0	0.002	6.3	1.9	10.6	0.005	4.7	1.3	8.1	0.007
Smoking status																
Current	Reference															
Former	4.8	−2.4	12.1	0.187												
Never	0.4	−6.2	6.9	0.909												
Body mass index																
Underweight or normal weight	Reference															
Overweight	2.4	−3.2	8.0	0.399												
Obese	−0.4	−6.0	5.3	0.900												
Stroke severity at discharge (NIHSS)																
0–4 (Mild)	Reference															
5 (Moderate)	1.3	−6.2	8.8	0.738												
Missing	−1.4	−6.9	4.1	0.622												
Modified Rankin score																
0–1	Reference															
2–5	−1.3	−7.0	4.3	0.641												
Missing	0.7	−4.5	5.9	0.787												
Trial arm																
Usual care	Reference				Reference				Reference				Reference			
Intervention	3.7	−0.7	8.2	0.099	3.2	−1.3	7.8	0.164	2.5	−1.8	6.8	0.248	2.2	−1.1	5.5	0.187
Elevated baseline blood pressure																
No	Reference								Reference							
Yes	23.7	17.9	29.5	<0.001					23.1	17.1	29.1	<0.001				
Baseline SBP													0.7	0.7	0.8	<.0001
R^2					0.076				0.187				0.509			

NIHSS indicates National Institutes of Health Stroke Scale; and SBP, systolic blood pressure.
*Includes hypertension, heart disease, weak/failing kidneys, cancer, psychiatric disorder, diabetes mellitus, stroke.

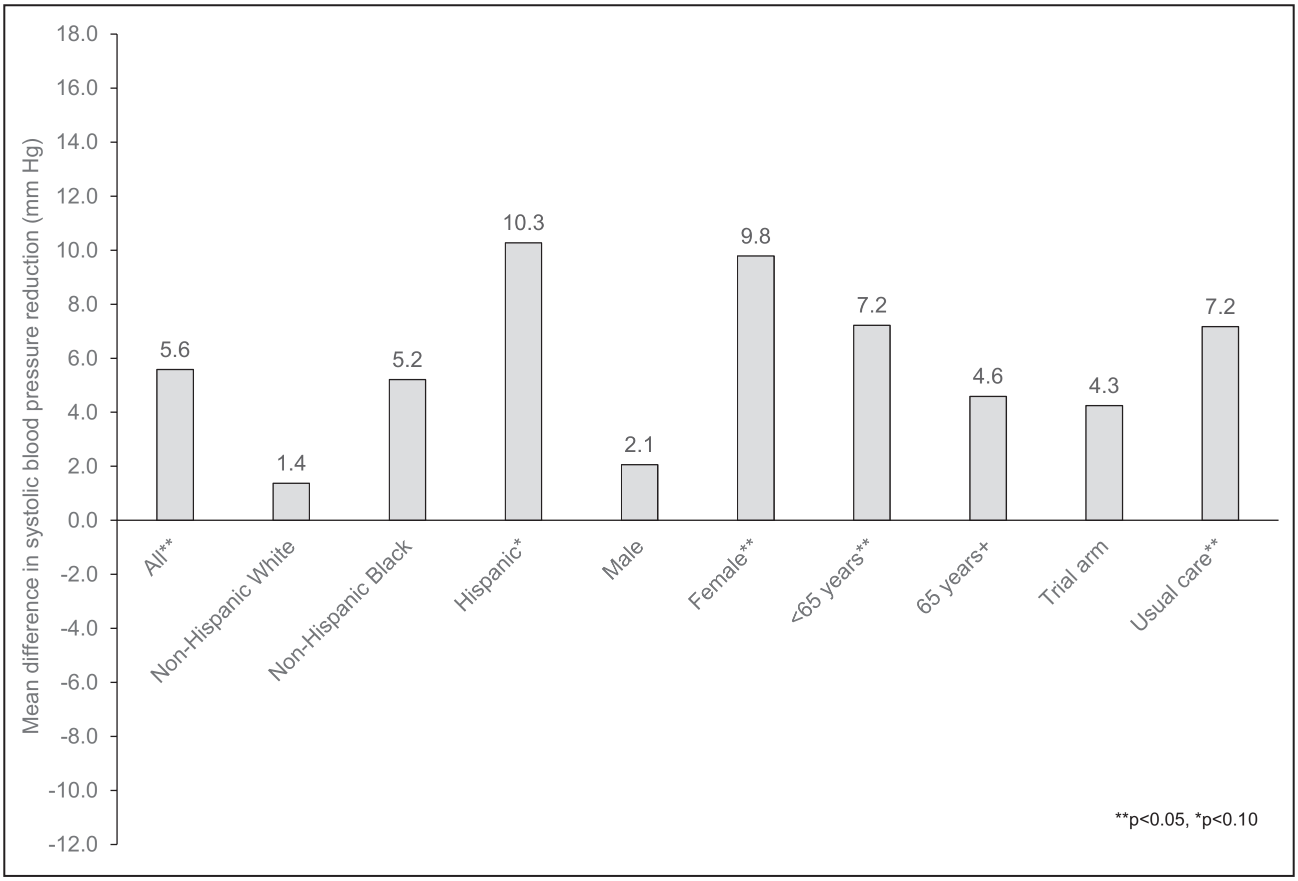

Figure 1. Adjusted mean difference in systolic blood pressure reduction (mm Hg) between those with self-efficacy vs. those without, overall and by race/ethnicity, sex, age, and intervention trial arm.

mortality (explained in large part by greater physical activity).[41] In addition, psychologically based interventions that incorporate positive health belief promotion have been shown to effectively promote positive health behaviors.[16] In terms of BP specifically, an analysis of Whitehall II data linked high emotional vitality with lower risk of incident hypertension, an association only slightly weakened after adjusting for positive health behaviors, such as smoking, alcohol consumption, physical activity, and diet.[18] In addition to health behaviors, positive psychological well-being may also be linked to BP through biological/physiological processes regulated by the immune system, hypothalamic-pituitary-adrenal axis, and sympathetic nervous system.[16,29] Of note, probable depression was not associated with self-efficacy or with SBP reduction in this sample, suggesting that it likely did not play a mediating role in this relationship. Because much of the literature on this topic in the context of stroke focuses on other psychological states (eg, optimism and emotional vitality) instead of self-efficacy, additional studies of this patient population are needed to confirm our findings.

Self-efficacy was no longer associated with mean SBP reduction in an adjusted model controlling for baseline SBP, and the association was also attenuated across subgroups in stratified analysis. Although self-efficacy was not associated with elevated baseline BP, mean baseline SBP was significantly higher among those with self-efficacy versus those without; thus, those with greater self-efficacy had greater opportunity to reduce their BP over time. Adjusting for baseline values in change analysis is a topic of some debate, with some arguing that controlling for baseline values in observational studies of change can lead to bias.[42] The current study's findings highlight this methodological issue and, thus, it should be a continued focus of future study.

Nevertheless, there was some evidence of sex differences in the association between having positive health beliefs and vascular risk reduction, a finding that was robust to sensitivity analysis. Self-efficacy was linked to a >5–mm Hg SBP reduction among women, but had a negative (nonsignificant) association with SBP reduction among men. In fact, on average, female patients who did not feel they could protect themselves from having a stroke demonstrated slightly *increased* mean SBP at 1 year postdischarge, whereas those who felt they could protect themselves had clinically significant mean SBP reduction. Previous studies

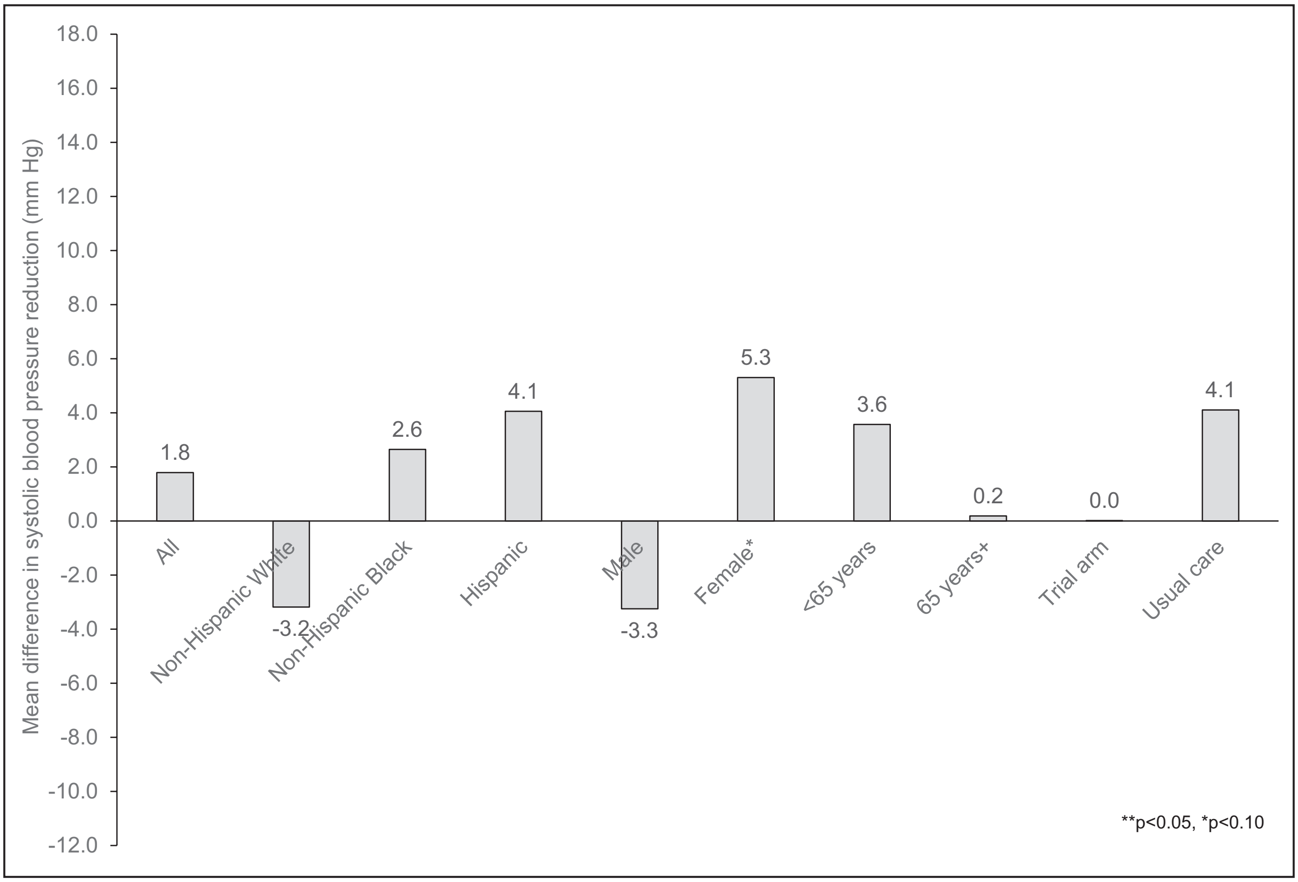

Figure 2. Sensitivity analysis.
Adjusted mean difference in systolic blood pressure reduction (mm Hg) between those with self-efficacy vs. those without, overall and by race/ethnicity, sex, age, and intervention trial arm.

have noted that the association between positive psychological well-being and cardiovascular disease outcomes is fairly similar by age and sex[25]; however, use of different exposure and outcome variables limits our ability to compare findings. Evidence suggests that older women are less likely to achieve BP control compared with older men because of differences in biological processes and lower access to health care.[7] Greater self-efficacy and optimism may reduce the impact of these factors on BP control for women in particular, providing the confidence and motivation to achieve positive health outcomes, despite sex-related barriers. Additional research on the interrelation between sex, health beliefs, and vascular risk reduction in stroke survivors could shed light on the mechanisms driving these relationships.

Also of note was the stronger association between self-efficacy and SBP reduction among participants in the usual care versus intervention trial arm, although these associations were also attenuated in sensitivity analysis. It is possible that the intervention, which aimed to promote self-efficacy, albeit indirectly, was successful in improving this health belief among those who did not endorse it at baseline, thereby reducing the impact of self-efficacy on SBP reduction at follow-up among those who received the intervention.

This study contributes to the literature by examining how health beliefs may improve vascular risk in a multiethnic cohort of TIA and stroke patients. The longitudinal nature of the study allowed for assessment of how a health belief might influence future outcomes and limits temporal ambiguity. We also adjusted for both baseline hypertension status and SBP level, which are likely important drivers of SBP reduction; those with elevated BP may be particularly motivated to reduce BP and may be prescribed more aggressive treatment strategies to do so. However, results should be interpreted in the context of several limitations. First, the health belief of interest was measured at baseline (prehospital discharge) only, limiting our ability to also examine how change in health beliefs postdischarge may contribute to SBP reduction. Second, this health belief was not measured using a previously validated instrument. However, the goal of the study was to specifically evaluate how perception of one's ability to prevent stroke impacts health outcomes among stroke survivors, which precluded use of instruments that do not directly measure this construct. Those who agreed that they can protect themselves from stroke had significantly higher prevalence of endorsing the phrase, "If I follow my physician's advice I will be less likely to have a stroke" than those who did not, which speaks to this measure's convergent validity somewhat. Other measures that potentially capture similar constructs, such as the Expectations for Coping Scale, may be useful in future studies.[23] Third, although relatively small, there was some attrition over the 1-year follow-up period and missing information for the exposure and outcome of interest (17.9% of the full DESERVE study cohort at baseline, n=552). However, there were no significant differences in baseline characteristics between those in the full DESERVE study cohort and those included in this study's analytic sample (data not shown), with the exception of number of chronic disease conditions; the prevalence of having 1 chronic disease was lower, and the prevalence of having ≥3 chronic diseases was higher, in the analytic sample versus the full cohort (P=0.030). In addition, the prevalence of self-efficacy was similar among those who died before follow-up and those who did not, which suggests that selection bias may be minimal. Our findings may not be generalizable to those who have experienced more severe strokes or reside in different geographic areas. Finally, adjusted regression model R^2 values were relatively small, meaning that they do not explain a large proportion of the variance in SBP reduction (50%–92% unexplained, depending on the model). This suggests that additional factors not evaluated in the current study could play an important role in predicting SBP reduction and require further examination.

This study addresses a particularly important area of inquiry, given the existence of well-established approaches to primary and secondary stroke prevention and the fact that many stroke survivors fail to achieve BP control. Targeted strategies to improve health beliefs after stroke may be important components to include in risk factor management among stroke survivors. Indeed, a similar suggestion has been made for other types of cardiovascular disease management[16] and in the main DESERVE study,[15] and interventions that include psychosocial skills training, specifically cognitive behavioral approaches, have successfully improved cardiovascular disease outcomes.[43,44] However, it is important to recognize and address the structural issues that contribute to unequal access to quality health care, healthy food, and opportunities for physical activity that may, ultimately, impede one's ability to manage risk factors after stroke, despite positive beliefs and best efforts. Future studies that examine both the impact of other health beliefs, behaviors, and outcomes within the context of stroke and how they may be effectively incorporated into and evaluated in stroke prevention trials with diverse patient cohorts, as well as the impact of policies to address structural barriers on stroke prevention, are warranted.

ARTICLE INFORMATION

Received February 20, 2020; accepted April 9, 2020.

Affiliations

From the Departments of Epidemiology (E.G., R.J., E.F., E.T.R.) and Social and Behavioral Sciences (N.S.P.), School of Global Public Health, New York University, New York, NY; Department of Population Health, New York University Langone Health, New York, NY (N.A.); and Program in Public Health, Susan and Henry Samueli College of Health Sciences, University of California, Irvine, CA (B.B.-A.).

Sources of Funding

Research reported in this publication was supported by the National Institute of Neurological Disorders and Stroke of the National Institutes of Health under award P50NS049060. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

Disclosures

None.

REFERENCES

1. Meschia JF, Bushnell C, Boden-Albala B, Braun LT, Bravata DM, Chaturvedi S, Creager MA, Eckel RH, Elkind MS, Fornage M, et al. Guidelines for the primary prevention of stroke: a statement for healthcare professionals from the American Heart Association/American Stroke Association. *Stroke*. 2014;45:3754–3832.
2. Boan AD, Lackland DT, Ovbiagele B. Lowering of blood pressure for recurrent stroke prevention. *Stroke*. 2014;45:2506–2513.
3. Kernan WN, Ovbiagele B, Black HR, Bravata DM, Chimowitz MI, Ezekowitz MD, Fang MC, Fisher M, Furie KL, Heck DV, et al. Guidelines for the prevention of stroke in patients with stroke and transient ischemic attack: a guideline for healthcare professionals from the American Heart Association/American Stroke Association. *Stroke*. 2014;45:2160–2236.
4. Fryar CD, Ostchega Y, Hales CM, Zhang G, Kruszon-Moran D. Hypertension prevalence and control among adults: United States, 2015–2016. *NCHS Data Brief*. 2017;1–8. Available at: https://www.cdc.gov/nchs/data/databriefs/db289.pdf.
5. Ostchega Y, Zhang G, Hughes JP, Nwankwo T. Factors associated with hypertension control in US adults using 2017 ACC/AHA guidelines: National Health and Nutrition Examination Survey 1999-2016. *Am J Hypertens*. 2018;31:886–894.
6. Sonawane K, Zhu Y, Balkrishnan R, Suk R, Sharrief A, Deshmukh AA, Aguilar D. Antihypertensive drug use and blood pressure control among stroke survivors in the United States: NHANES 2003-2014. *J Clin Hypertens*. 2019;21:766–773.
7. Lopez-Ruiz A, Sartori-Valinotti J, Yanes LL, Iliescu R, Reckelhoff JF. Sex differences in control of blood pressure: role of oxidative stress in hypertension in females. *Am J Physiol Heart Circul Physiol*. 2008;295:H466–H474.
8. Abramson BL, Srivaratharajah K, Davis LL, Parapid B. Women and hypertension: beyond the 2017 guideline for prevention, detection, evaluation, and management of high blood pressure in adults. 2018. https://www.acc.org/latest-in-cardiology/articles/2018/07/27/09/02/women-and-hypertension. Accessed January 21, 2020.
9. Towfighi A, Markovic D, Ovbiagele B. Consistency of blood pressure control after ischemic stroke: prevalence and prognosis. *Stroke*. 2014;45:1313–1317.
10. Kelli HM, Hammadah M, Ahmed H, Ko YA, Topel M, Samman-Tahhan A, Awad M, Patel K, Mohammed K, Sperling LS, et al. Association between living in food deserts and cardiovascular risk. *Circ Cardiovasc Qual Outcomes*. 2017;10:1–22.

11. Suarez JJ, Isakova T, Anderson CA, Boulware LE, Wolf M, Scialla JJ. Food access, chronic kidney disease, and hypertension in the U.S. *Am J Prev Med*. 2015;49:912–920.
12. He J, Muntner P, Chen J, Roccella EJ, Streiffer RH, Whelton PK. Factors associated with hypertension control in the general population of the United States. *Arch Intern Med*. 2002;162:1051–1058.
13. Schroeder K, Fahey T, Ebrahim S. Interventions for improving adherence to treatment in patients with high blood pressure in ambulatory settings. *Cochrane Database Syst Rev*. 2004;2:CD004804.
14. Dickinson HO, Mason JM, Nicolson DJ, Campbell F, Beyer FR, Cook JV, Williams B, Ford GA. Lifestyle interventions to reduce raised blood pressure: a systematic review of randomized controlled trials. *J Hypertens*. 2006;24:215–233.
15. Boden-Albala B, Goldmann E, Parikh NS, Carman H, Roberts ET, Lord AS, Torrico V, Appleton N, Birkemeier J, Parides M, Quarles L. Efficacy of a discharge educational strategy vs standard discharge care on reduction of vascular risk in patients with stroke and transient ischemic attack: the DESERVE randomized clinical trial. *JAMA Neurol*. 2019;76:20–27.
16. Sin NL. The protective role of positive well-being in cardiovascular disease: review of current evidence, mechanisms, and clinical implications. *Curr Cardiol Rep*. 2016;18:106.
17. Yanek LR, Kral BG, Moy TF, Vaidya D, Lazo M, Becker LC, Becker DM. Effect of positive well-being on incidence of symptomatic coronary artery disease. *Am J Cardiol*. 2013;112:1120–1125.
18. Trudel-Fitzgerald C, Boehm JK, Kivimaki M, Kubzansky LD. Taking the tension out of hypertension: a prospective study of psychological well being and hypertension. *J Hypertens*. 2014;32:1222–1228.
19. Ostir GV, Markides KS, Peek MK, Goodwin JS. The association between emotional well-being and the incidence of stroke in older adults. *Psychosom Med*. 2001;63:210–215.
20. Lambiase MJ, Kubzansky LD, Thurston RC. Positive psychological health and stroke risk: the benefits of emotional vitality. *Health Psychol*. 2015;34:1043–1046.
21. Pressman SD, Jenkins BN, Moskowitz JT. Positive affect and health: what do we know and where next should we go? *Annu Rev Psychol*. 2019;70:627–650.
22. Chida Y, Steptoe A. Positive psychological well-being and mortality: a quantitative review of prospective observational studies. *Psychosom Med*. 2008;70:741–756.
23. Barefoot JC, Brummett BH, Williams RB, Siegler IC, Helms MJ, Boyle SH, Clapp-Channing NE, Mark DB. Recovery expectations and long-term prognosis of patients with coronary heart disease. *Arch Int Med*. 2011;171:929–935.
24. Fanaroff AC,Prather K, Brucker A, Wojdyla D, Davidson-Ray L, Mark DB, Williams RB, Barefoot J, Weisz G, Ben-Yehuda O, et al. Relationship between optimism and outcomes in patients with chronic angina pectoris. *Am J Cardiol*. 2019;123:1399–1405.
25. Sin NL, Moskowitz JT, Whooley MA. Positive affect and health behaviors across 5 years in patients with coronary heart disease: the Heart and Soul Study. *Psychosom Med*. 2015;77:1058–1066.
26. Trudel-Fitzgerald C, Gilsanz P, Mittleman MA, Kubzansky LD. Dysregulated blood pressure: can regulating emotions help? *Curr Hypertens Rep*. 2015;17:92.
27. Stein DJ, Aguilar-Gaxiola S, Alonso J, Bruffaerts R, de Jonge P, Liu Z, Miguel Caldas-de-Almeida J, O'Neill S, Viana MC, Al-Hamzawi AO, et al. Associations between mental disorders and subsequent onset of hypertension. *Gen Hosp Psychiatry*. 2014;36:142–149.
28. Shah MT, Zonderman AB, Waldstein SR. Sex and age differences in the relation of depressive symptoms with blood pressure. *Am J Hypertens*. 2013;26:1413–1420.
29. Boehm JK, Kubzansky LD. The heart's content: the association between positive psychological well-being and cardiovascular health. *Psychol Bullet J*. 2012;138:655–691.
30. Kreuter MW, Strecher VJ. Changing inaccurate perceptions of health risk: results from a randomized trial. *Health Psychol*. 1995;14:56–63.
31. Boden-Albala B, Carman H, Moran M, Doyle M, Paik MC. Perception of recurrent stroke risk among black, white and Hispanic ischemic stroke and transient ischemic attack survivors: the SWIFT study. *Neuroepidemiology*. 2011;37:83–87.
32. Korpershoek C, van der Bijl J, Hafsteinsdottir TB. Self-efficacy and its influence on recovery of patients with stroke: a systematic review. *J Adv Nurs*. 2011;67:1876–1894.
33. Lewinsohn PM, Seeley JR, Roberts RE, Allen NB. Center for Epidemiological Studies-Depression Scale (CES-D) as a screening instrument for depression among community-residing older adults. *Psychol Aging*. 1997;12:277–287.
34. Whelton PK, Carey RM, Aronow WS, Casey DE Jr, Collins KJ, Dennison Himmelfarb C, DePalma SM, Gidding S, Jamerson KA, Jones DW, et al. 2017 ACC/AHA/AAPA/ABC/ACPM/AGS/APHA/ASH/ASPC/NMA/PCNA Guideline for the prevention, detection, evaluation, and management of high blood pressure in adults: a report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. *Hypertension*. 2018;71:e13–e115.
35. Jones F, Partridge C, Reid F. The Stroke Self-efficacy Questionnaire: measuring individual confidence in functional performance after stroke. *J Clin Nurs*. 2008;17:244–252.
36. Jones F, Riazi A. Self-efficacy and self-management after stroke: a systematic review. *Disabil Rehabil*. 2011;33:797–810.
37. Jones CL, Jensen JD, Scherr CL, Brown NR, Christy K, Weaver J. The health belief model as an explanatory framework in communication research: exploring parallel, serial, and moderated mediation. *Health Commun*. 2015;30:566–576.
38. Lorig KR, Holman HR. Self-management education: history, definition, outcomes, and mechanisms. *Ann Behav Med*. 2003;26:1–7.
39. Sol BGM, van der Graaf Y, van der Bifl JJ, Goessens BGN, Visseren FLJ. Self-efficacy in patients with clinical manifestations of vascular diseases. *Patient Educ Couns*. 2006;61:443–448.
40. Boehm JK, Peterson C, Kivimaki M, Kubzansky L. A prospective study of positive psychological well-being and coronary heart disease. *Health Psychol*. 2011;30:259–267.
41. Hoen PW, Denollet J, de Jonge P, Whooley MA. Positive affect and survival in patients with stable coronary heart disease: findings from the Heart and Soul Study. *J Clin Psychiatry*. 2013;74:716–722.
42. Glymour MM, Weuve J, Berkman LF, Kawachi I, Robins JM. When is baseline adjustment useful in analysis of change? An example with education and cognitive change. *Am J Epidemiol*. 2005;162:267–278.
43. Bishop GD, Kaur D, Tan VL, Chua YL, Liew SM, Mak KH. Effects of a psychosocial skills training workshop on psychophysiological and psychosocial risk in patients undergoing coronary artery bypass grafting. *Am Heart J*. 2005;150:602–609.
44. Gulliksson M, Burell G, Vessby B, Lundin L, Toss H, Svärdsudd K. Randomized controlled trial of cognitive behavioral therapy vs standard treatment to prevent recurrent cardiovascular events in patients with coronary heart disease: secondary Prevention in Uppsala Primary Health Care project (SUPRIM). *Arch Intern Med*. 2011;17:134–140.