Psychosocial Factors and Hypertension
A Review of the Literature

Adolfo G. Cuevas, PhD[a], David R. Williams, PhD, MPH[b,c,*], Michelle A. Albert, MD, MPH[d]

KEYWORDS

• Hypertension • Psychosocial factors • Health disparities • Race/ethnicity • Review

KEY POINTS

- Hypertension is a leading cause of cardiovascular disease and stroke and this burden falls heavily on black people (African Americans).
- This article reviews recent research on psychosocial factors and hypertension and contextualizes the findings within a health disparities framework.
- This article reveals that psychosocial factors, such as socioeconomic status, stressors (including race-related stressors), and emotional states, may contribute to hypertension risks.
- Future research should investigate how psychosocial factors accumulate over the life course to contribute to hypertension disparities.
- Further research on psychosocial factors and hypertension can enhance the effectiveness of interventions to reduce hypertension risks in ethnic minority patients and communities.

INTRODUCTION

Hypertension is a pervasive problem in the United States, with approximately a third of Americans reporting being diagnosed with hypertension by their physicians or taking antihypertensive medicine.[1] Hypertension is an important risk factor for a variety of health conditions, such as cardiovascular disease, stroke, and kidney failure.[1] Nevertheless, this burden is unevenly distributed in society, with black people having the highest prevalence of hypertension compared with their white counterparts.[1] Despite improvements in increasing the awareness and treatment of hypertension, racial/ethnic differences in hypertension persist.

Growing evidence points to multiple psychological and social factors as contributors to the onset and trajectory of hypertension. Psychosocial factors that induce emotional stress can evoke a physiologic response meditated in part by activation of the sympathetic nervous system, inflammation, and the hypothalamic-pituitary-adrenal axis.[2,3] Repeated activation of this system can result in failing to return to resting blood pressure levels. Psychosocial factors, such as hostility and job strain, have been found to be associated with higher circulating levels of catecholamines, higher cortisol levels, and increased blood pressure over time.[4]

Prior reviews have identified several psychosocial indicators as potential risk factors for the onset

Disclosure Statement: The authors have nothing to disclose.
[a] Department of Social and Behavioral Sciences, Harvard T.H. Chan School of Public Health, Landmark Center, Room 428a, 401 Park Drive, Boston, MA 02215, USA; [b] Department of Social and Behavioral Sciences, Harvard T.H. Chan School of Public Health, 677 Huntington Avenue, 6th Floor, Boston, MA 02115, USA; [c] Department of African and African American Studies, Harvard University, 12 Quincy Street, Cambridge, MA 02138, USA; [d] Division of Cardiology, Department of Medicine, Center for the Study of Adversity and Cardiovascular Disease [NURTURE Center], University of California, San Francisco, 505 Parnassus Avenue, M1177, San Francisco, CA 94143, USA
* Corresponding author.
E-mail address: dwilliam@hsph.harvard.edu

Cardiol Clin 35 (2017) 223–230
http://dx.doi.org/10.1016/j.ccl.2016.12.004

and progression of hypertension.[2,5] This article provides an overview of recent findings related to major psychosocial factors and hypertension. Because of space constraints, emerging work about psychosocial factors (eg, personality, sleep quality[5]) cannot be fully discussed. Nevertheless, in presenting the major factors, this article highlights gaps in the extant literature that contribute to the limited understanding of the social determinants of the persistent racial/ethnic hypertension disparities and discusses directions for future research.

Socioeconomic Status

Socioeconomic status (SES) has long been identified as a risk factor for hypertension. A review by Spruill[2] suggests a complex interaction of social, psychological, and behavioral factors contributing to unequal distribution of diseases. Compared with their high-SES peers, individuals of low SES are more likely to lack sociopolitical power and economic resources, thereby resulting in occupancy of educational, occupational, residential, and recreational environments that are less health enhancing.[6] These factors lead to differential exposures to stressors (eg, unemployment, crime, and violence) and fewer resources (eg, recreation and physical activity) to cope with an accumulation of stressors that combine to contribute to greater risk of hypertension.[2] In a recent meta-analysis, multiple indicators of SES (ie, income, occupation, and education) were associated with an increased risk of hypertension.[7]

SES and race/ethnicity are closely intertwined.[2] Contemporary racial/ethnic categories simultaneously capture unmeasured confounding for biological factors associated with ancestral history and geographic origins; factors linked to current and earlier psychological, social, physical, and chemical environmental exposures; as well as biological adaptation to these exposures.[8] Racial/ethnic differences in SES are large and persistent, and likely contribute to racial/ethnic differences in hypertension. Recent national data reveal that black households earn 59 cents and Hispanics households 70 cents for every dollar of income that white households receive; moreover, black people have only 6 cents and Hispanics 7 cents for every dollar of wealth that white people have.[6]

In addition, because of the persistence of a residual association between race and hypertension after controlling for modifiable risk factors and SES, other unmeasured explanatory factors likely contribute to hypertension disparities.[9] Research suggests that a life-course perspective provides insight into the prolonged impact that early SES can have on blood pressure. Although most studies taking a life-course perspective are cross-sectional studies, they suggest that the accumulation of stress caused by SES positioning likely promotes health-damaging effects later in life. For instance, low childhood SES and childhood adversity are associated with higher risk of hypertension.[10,11] Slopen and colleagues[12] found that a positive neighborhood context may modify the relationship between childhood adversity and cumulative biological risk in adulthood. Importantly, because evidence suggests that racial/ethnic minorities have higher cumulative stress than white people,[13] further research is needed to examine the extent to which race/ethnicity may moderate the association between the accumulation of stressors over the life course and hypertension.

Race-Related/Ethnicity-Related Stress

Discrimination

Growing attention is paid to the ways in which race-related/ethnicity-related aspects of social experience may adversely affect health, such as discrimination.[9] Discrimination can erode an individual's health through negative psychological and physiologic responses and untoward health maintenance and behaviors.[14] Nevertheless, the literature on discrimination and hypertension is riddled with inconsistent findings, partly caused by measurement issues and the shortage of longitudinal studies.[9,15] For example, research from the Jackson Heart Study found that lifetime discrimination and the burden of discrimination were each modestly associated with increased hypertension prevalence.[16] However, no association was observed between hypertension and a measure of current everyday discrimination. It is plausible that reports of current exposure to minor instances of discrimination might be related to short-term measured blood pressure change, whereas lifetime measures might more aptly capture the cumulative effect of discriminatory exposure on blood pressure risk over time.[16] Not surprisingly, chronic discrimination is more consistently associated with ambulatory blood pressure than with resting clinic blood pressure.[17]

Pathways through which discrimination might affect hypertension risk are multiple. Although prior research indicates that black people are more likely than white people to have a blunted blood pressure decline during sleep, emerging studies reveal that exposure to discrimination contributes to the increased levels of blood pressure and lack of blood pressure decrease among black people at night.[14] Sleep disturbances are also

related to hypertension risk. Moreover, a recent review indicates that discrimination is positively associated with reported sleep difficulties, insomnia, and fatigue, thereby influencing hypertension risk.[18] In other research, threat of exposure to discrimination versus actual exposure also affects hypertension risk, possibly via heightened vigilance.[19] Experiences of discrimination have also been associated with lower levels of adherence and follow-up for multiple health conditions, and, if this pattern is also true of hypertension, it could contribute to greater severity and poorer course of hypertension.[14] In light of these points, future studies should consider the multiple dimensions of discrimination and conditions that adversely affect blood pressure.[17]

Goal-striving stress

There are other, more novel race-related risk factors that may also play a role. Goal-striving stress is a measure of thwarted aspirations. It is typically operationalized as the discrepancy between aspirations and achievement, weighted by the subjective probability of success and the level of disappointment experienced if goals are not reached.[20] Analyses of a large national sample revealed that higher levels of goal-striving stress were associated with the prevalence of self-reported hypertension among white Americans, African Americans, and Caribbean black people, and race/ethnicity did not moderate the relationship between goal-striving stress and hypertension.[20] Longitudinal research is needed to enhance the understanding of the timing of the development of goal-striving stress and how exposure and response to it may influence the onset and course of hypertension disparities. Relatedly, John Henryism, an active predisposition to succeed against all odds, is associated with high blood pressure among persons who lack the resources to facilitate success.[21] Research is needed to better understand the conditions under which psychological risk factors and coping mechanisms such as goal-striving stress and John Henryism can affect the development and course of hypertension and the behavioral and biological mechanisms through which these processes occur.[21]

Internalized racism

Self-stereotyping (or internalized racism) has been identified as another mechanism by which racism might adversely affect health. Limited research indicates a positive association between internalized racism and multiple health outcomes, including overweight/obesity and blood pressure.[14] Other data show that internalized racism interacts with discrimination to predict increased risk of hypertension,[22] such that, in a sample of 91 African American men, increased hypertension risk was only evident for African American men who scored high both on discrimination and anti-black bias.

Stereotype threat is a term describing the activation of negative stereotypes in members of a stigmatized group that creates reactions, anxieties, and expectations that adversely affect psychological functioning and health.[23] For example, in the work by Blascovich and colleagues,[24] physiologic arousal triggered by stereotype threat is associated with greater increases in blood pressure among African Americans than in European American students. Stereotype threat is also purported to trigger increases in anxiety and impairment of decision-making and self-regulation processes in a manner that increases aggressive behavior and overeating.[25] Stereotype threat may be indirectly related to hypertension through weight changes and modulation of the neural hormonal system.[26,27] In addition, stereotype threat can lead affected persons to delay seeking needed medical care, and to have poor adherence to recommended therapies and generally poor patient-provider relationships.[14]

Other Sources of Stress

Occupational stress

Previous research suggests that working conditions that induce stress are associated with increased risk of hypertension.[2,28] Occupational stressors can include hostile work environments (eg, threatened, bullied, or harassed by anyone while on the job), work insecurity (eg, worried about becoming unemployed), time pressures, work hazards, and other work conditions (eg, sedentary tasks, uncontrollable tasks).[28] High job strain/stress (high job demand and low job control) is independently associated with hypertension, ambulatory blood pressure increase, and cardiovascular disease risk.[29–31]

Occupations with high job demand and low job control (eg, servers and clerks) are commonly overrepresented among ethnic minorities.[32] However, the relationship between job strain and hypertension has been mixed, particularly for black people. For instance, low decisional control has been found to be related to increased blood pressure reactivity among black people.[33,34] However, a recent study using Health and Retirement Study data found no association between high job strain (as well as workplace discrimination) and hypertension among African Americans.[35] Considering the paucity of epidemiologic studies examining

the relationship between work-related stressors and hypertension among racial/ethnic minority workers, these results require replication using national data sets. Furthermore, other job strain domains, especially those that may be more salient for ethnic minorities (eg, stressors linked to unemployment and underemployment, job conflict, or financial strain caused by low wages) should be explored in this area of research.[35]

An important direction for future research is to more comprehensively assess the broad range of stressors that might affect hypertension risk. For example, with regard to work stress, studies need to go beyond assessing high demand and low control and assess conditions in work environments that are likely to vary by race, such as physical and chemical environmental hazards and occupational stressors linked to injury risk.[8] Because research studies have assessed only a few domains of stressors, systematic attention needs to be given to understanding the contribution of a broader range of living conditions that could increase hypertension risk, including incarceration, which disproportionately affects black people. For example, the Coronary Artery Risk Development in Young Adults (CARDIA) study found that incarceration was associated with increased risk of incident hypertension 3 years later and greater end-organ damage related to hypertension.[36] Incarceration is a type of stressful experience that exacerbates social disadvantage by placing many people on a pathway of low education, poor job prospects, and low income. These examples highlight the need to fully characterize all aspects of the social context that can negatively affect hypertension risk.

Emotional States

High levels of anxiety and depression symptoms are common in adults, often comorbid with chronic illnesses such as hypertension, and can have deleterious effects on individual health and quality of life. A meta-analysis of prospective studies found that depressive symptoms predict a 42% increased risk of hypertension.[37] Similar to the findings for depressive symptoms, a meta-analysis of prospective studies found that anxiety symptoms were an independent risk factor for incident hypertension.[38] However, many studies are limited by the lack of control for confounding factors, such as risk behaviors and related psychological factors (eg, anger), which may attenuate observed relationships between these emotional states and hypertension. Future research should adjust for all related factors to accurately assess the independent contribution of depression and anxiety to hypertension.

Consistent with prior research, recent evidence continues to document that anger and hostility are associated with increased hypertension risk.[39] For example, using data from the Heart Strategies Concentrating On Risk Evaluation, researchers noted that high levels of hostility are associated with an attenuated nocturnal decline in blood pressure among black people and white people.[40] Most research in this area has been limited to white men,[39] which also limits the understanding of racial and gender differences in levels of exposures to these risk factors and the extent to which the effects of such exposures vary by social group. In addition, as noted by Trudel-Fitzgerald and colleagues,[39] few prospective studies with up-to-date methodology have been conducted within the last decade. However, longitudinal analyses from the Jackson Heart Study show that African Americans with high anger-out (expressed rather than repressed anger) scores have a 20% increased risk of blood pressure progression compared with African Americans with low anger-out scores.[41] Prospective studies are needed to identify the independent effect of anger (both experience and expression) on blood pressure in diverse population samples.

Trudel-Fitzgerald and colleagues[39] introduced 2 emerging psychosocial factors that should be considered within the larger literature of emotional states and hypertension: positive psychological well-being (PPWB) and emotion regulation. Growing evidence suggests that PPWB, such as optimism, life satisfaction, and emotional vitality, is positively associated with hypertension and cardiovascular health risk factors (eg, physical activity).[39,42] However, the link between PPWB and hypertension has not been well established because of methodological and measurement issues (eg, the heterogeneity of hypertension measurements).[39] Similarly, although vitality predicts hypertension onset,[43] further research using a broader range of PPWB domains is needed to fully understand the influence of PPWB on hypertension. In addition, emotion regulation, which refers to the monitoring of a person's emotional experiences and responses, may also influence physical health, including hypertension risk, but research in this area is limited by lack of diversity and longitudinal studies.[39]

Social Relationships

Social relationships serve as sources of emotional support (eg, empathy), informational support, and instrumental support. These positive aspects of

social ties have been shown to directly enhance health and to reduce the negative effects of stressful experiences on health by enhancing the capacity of individuals to cope with stress. These processes are also likely to affect hypertension risk.[2,5] For example, a study using National Health Interview Survey data found that both emotional support and social integration were independently associated with decreased odds of hypertension.[44] The study also suggested that emotional support and social integration seemed to buffer the adverse effects of low SES on hypertension.[44] However, the interrelationships between race/ethnicity, hypertension, and social relationships have not been clearly elucidated. The limited available research in this area indicates that race/ethnic differences in hypertension are reduced among people who receive social support, compared with those who do not receive any form of support.[45] Although this study did not find an interaction effect between marital status and ethnicity in predicting hypertension, the potential contribution of marital status, a key component of social relationships, deserves more concerted attention in research on hypertension. Marital status, similar to other measures of social ties, can have both positive and negative effects on health, particularly hypertension.[2] However, inadequate attention has been given to examining the association between marital relationships and other types of social ties and blood pressure among ethnic minorities and their potential contribution to hypertension disparities. This omission is especially important given that black people are less likely to be married than white people and it is currently unclear whether other social relationships compensate for the lower levels of marital ties among black people.

Other Research Priorities

The role of genetics in racial/ethnic differences in hypertension remains as an ongoing debate. Although evidence suggests that polymorphisms in the APOL 1 (Apolipoprotein L1) gene may contribute to hypertension propensity in black people,[46] socioenvironmental influences are critical. For example, research shows that, although black people in the United States have higher rates of hypertension than white people in European countries such as Sweden and Italy, they have lower prevalence levels than white people in other countries such as Germany and Finland.[47] Increasing evidence also suggests that epigenetic modifications, caused by, for instance, childhood development or chemical exposure, are important contributors to the development of hypertension.[48] However, there are only a limited number of studies of epigenetic changes linked to hypertension risk factors, and only blood rather than the effector tissues have been examined, limiting the present understanding of the contribution of DNA methylation to high blood pressure.[48] Future studies should consider examining both blood methylation and effector tissues to more fully understand the contribution of epigenetics to hypertension disparities.

Another issue of concern relates to the lack of attention to, or the assumption of, nonheterogeneity within ethnic groups. Studies of black people tend to cluster immigrant African and Caribbean black people with US-born black people, regardless of acculturation status and country of origin. White people are also viewed as monolithic with, little attention given to recent eastern European immigrants or groups from North Africa and the Middle East that are grouped into the official 'White' category in the United States. Similarly, studies cluster Hispanic people, regardless of acculturation status, race, and country of origin, potentially diluting the measurement of the differential impact of environment on hypertension risk. Greater acculturation is associated with increased hypertension risk, independent of age, gender, race/ethnicity, education, smoking, alcohol, physical activity, body mass index, and diabetes.[49] In addition, there is disconcertingly little research about the determinants of hypertension risk in America's indigenous populations (Native Hawaiians and other Pacific Islanders and American Indians and Alaskan Natives), despite a higher prevalence of hypertension in these groups compared with other ethnic groups.[50] An enhanced understanding of psychosocial risks and resources associated with the historical and contemporary conditions in which these groups live, learn, work, play, and worship can facilitate the identification of culturally sensitive intervention strategies for hypertension.[51]

In addition, although other psychosocial factors, such as sleep disturbances, were not covered in depth in this article, their exclusion does not diminish the value of their inclusion in future research. For example, sleep quality and certain personality factors (eg, neuroticism) may contribute to hypertension risk.[5] However, similar to several other factors discussed, much of the evidence comes from studies of white people, which restricts understanding as to how they may contribute to existing hypertension disparities.

Psychosocial Interventions

At present, lifestyle modifications remain the most effective interventions to reduce hypertension risk.

Lifestyle modification, including increasing physical activity, reducing alcohol intake, and reducing sodium intake, through programs such as Dietary Approaches to Stop Hypertension (DASH), reduces hypertension risk.[52] Although lifestyle modification is important, especially for black and Hispanic people, who have high rates of overweight/obesity and physical inactivity, making lifestyle changes is challenging for disadvantaged populations in the absence of comprehensive efforts to address the underlying social conditions that give rise to the risk behaviors in the first place.[53] Socially disadvantaged groups face a multitude of stressors, coupled with limited resources, which can limit the effectiveness of interventions that are narrowly focused on the behavior without attention to the social conditions that initiate and sustain them.[54]

Stress and depression management/interventions should be complementary additions to lifestyle modification. Evidence suggests that stress-reducing interventions, such as transcendental meditation, decreases diastolic and systolic blood pressures.[55,56] To address race-related stressors, such as racial discrimination, Lewis and colleagues[57] highlighted promising interventions that can reduce the effects of discrimination on health, such as religious involvement, values affirmation, forgiveness, and racism countermarketing.

Interventions addressing SES disparities at the neighborhood level are also important.[8] Racial/ethnic and SES segregation in particular can increase the risk of morbidity and mortality through limited socioeconomic mobility, restrained access to health resources, exposure to toxins and environmental stressors (eg, violence), and weakened neighborhood social capital.[8] Further research priority needs to be given to understanding the complex influence of poverty and racial segregation on health. Policies and interventions that improve neighborhood and housing quality, increase household income, and improve education can help to improve the health of socially disadvantaged populations.[54] For example, randomized housing interventions (eg, Moving to Opportunity) showed that moving poor residents from high-poverty public housing apartments to lower-poverty neighborhood environments, with no health interventions, reduced obesity and diabetes risk 10 to 15 years later,[56] an action that likely also influences blood pressure outcomes.

SUMMARY

Understanding hypertension disparities remains an important and complex issue in human health. There is a great need for further research to better understand and effectively address the role of psychosocial factors in the disproportionate burden of hypertension on racial/ethnic minorities. Taking a life-course perspective that captures the accumulation of risks over time may help address some of the questions about the effect of psychosocial factors on hypertension risk that still puzzle researchers. In addition, future research should address methodological limitations of the existing literature, including identifying and controlling for a broad set of core confounding factors, using appropriately accurate measures of blood pressure (eg, self-reported hypertension vs ambulatory blood pressure), and doing more longitudinal research. Addressing such issues could help disentangle existing complexities and generate new insights that can potentially greatly improve the effectiveness of interventions that seek to reduce hypertension disparities.

REFERENCES

1. Mozaffarian D, Benjamin EJ, Go AS, et al. Executive summary: heart disease and stroke Statistics—2016 update. Circulation 2016;133(4):447–54.
2. Spruill TM. Chronic psychosocial stress and hypertension. Curr Hypertens Rep 2010;12(1):10–6.
3. Black PH, Garbutt LD. Stress, inflammation and cardiovascular disease. J Psychosom Res 2002; 52(1):1–23.
4. Everson-Rose SA, Lewis TT. Psychosocial factors and cardiovascular diseases. Annu Rev Public Health 2005;26(1):469–500.
5. Cuffee Y, Ogedegbe C, Williams NJ, et al. Psychosocial risk factors for hypertension: an update of the literature. Curr Hypertens Rep 2014;16(10):483.
6. Williams DR, Priest N, Anderson N. Understanding associations between race, socioeconomic status and health: patterns and prospects. Health Psychol 2016;35(4):407–11.
7. Leng B, Jin Y, Li G, et al. Socioeconomic status and hypertension: a meta-analysis. J Hypertens 2015; 33(2):221–9.
8. Williams DR, Mohammed SA, Leavell J, et al. Race, socioeconomic status, and health: complexities, ongoing challenges, and research opportunities. Ann N Y Acad Sci 2010;1186:69–101.
9. Dolezsar CM, McGrath JJ, Herzig AJM, et al. Perceived racial discrimination and hypertension: a comprehensive systematic review. Health Psychol 2014;33(1):20–34.
10. James SA, Van Hoewyk J, Belli RF, et al. Life-course socioeconomic position and hypertension in African American men: the Pitt County study. Am J Public Health 2006;96(5):812–7.
11. Crowell JA, Davis CR, Joung KE, et al. Metabolic pathways link childhood adversity to elevated blood

pressure in midlife adults. Obes Res Clin Pract 2016;10(5):580–8.
12. Slopen N, Non A, Williams DR, et al. Childhood adversity, adult neighborhood context, and cumulative biological risk for chronic diseases in adulthood. Psychosom Med 2014;76(7):481–9.
13. Sternthal M, Slopen N, Williams DR. Racial disparities in health: how much does stress really matter? Du Bois Review 2011;8(1):95–113.
14. Williams DR, Mohammed SA. Racism and health I: pathways and scientific evidence. Am Behav Sci 2013;57(8). http://dx.doi.org/10.1177/0002764213487340.
15. Cuffee YL, Hargraves JL, Allison J. Exploring the association between reported discrimination and hypertension among African Americans: a systematic review. Ethn Dis 2012;22(4):422–31.
16. Sims M, Diez-Roux AV, Dudley A, et al. Perceived discrimination and hypertension among African Americans in the Jackson Heart Study. Am J Public Health 2012;102(Suppl 2):S258–65.
17. Brondolo E, Love EE, Pencille M, et al. Racism and hypertension: a review of the empirical evidence and implications for clinical practice. Am J Hypertens 2011;24(5):518–29.
18. Slopen N, Lewis TT, Williams DR. Discrimination and sleep: a systematic review. Sleep Med 2016;18:88–95.
19. Hicken MT, Lee H, Morenoff J, et al. Racial/ethnic disparities in hypertension prevalence: reconsidering the role of chronic stress. Am J Public Health 2014;104(1):117–23.
20. Sellers SL, Neighbors HW, Zhang R, et al. The impact of goal-striving stress on physical health of white Americans, African Americans, and Caribbean blacks. Ethn Dis 2012;22(1):21–8.
21. Bennett GG, Merritt MM, Sollers JJ III, et al. Stress, coping, and health outcomes among African-Americans: a review of the John Henryism hypothesis. Psychol Health 2004;19(3):369–83.
22. Chae DH, Nuru-Jeter AM, Adler NE. Implicit racial bias as a moderator of the association between racial discrimination and hypertension: a study of midlife African American men. Psychosom Med 2012;74(9):961–4.
23. Steele CM. A threat in the air. How stereotypes shape intellectual identity and performance. Am Psychol 1997;52(6):613–29.
24. Blascovich J, Spencer SJ, Quinn D, et al. African Americans and high blood pressure: the role of stereotype threat. Psychol Sci 2001;12(3):225–9.
25. Inzlicht M, Kang SK. Stereotype threat spillover: how coping with threats to social identity affects aggression, eating, decision making, and attention. J Pers Soc Psychol 2010;99(3):467–81.
26. Meyer N, Richter SH, Schreiber RS, et al. The unexpected effects of beneficial and adverse social experiences during adolescence on anxiety and aggression and their modulation by genotype. Front Behav Neurosci 2016;10:97.
27. Rana S, Pugh PC, Katz E, et al. Independent effects of early-life experience and trait aggression on cardiovascular function. Am J Physiol Regul Integr Comp Physiol 2016;311(2):R272–86.
28. Rosenthal T, Alter A. Occupational stress and hypertension. J Am Soc Hypertens 2012;6(1):2–22.
29. Babu GR, Jotheeswaran AT, Mahapatra T, et al. Is hypertension associated with job strain? A meta-analysis of observational studies. Occup Environ Med 2014;71(3):220–7.
30. Landsbergis PA, Dobson M, Koutsouras G, et al. Job strain and ambulatory blood pressure: a meta-analysis and systematic review. Am J Public Health 2013;103(3):e61–71.
31. Slopen N, Glynn RJ, Buring JE, et al. Job strain, job insecurity, and incident cardiovascular disease in the Women's Health Study: results from a 10-year prospective study. PLoS One 2012;7(7):e40512.
32. Buchanan S, Vossenas P, Krause N, et al. Occupational injury disparities in the US hotel industry. Am J Ind Med 2010;53(2):116–25.
33. Thomas KS, Nelesen RA, Ziegler MG, et al. Job strain, ethnicity, and sympathetic nervous system activity. Hypertension 2004;44(6):891–6.
34. Curtis AB, James SA, Raghunathan TE, et al. Job strain and blood pressure in African Americans: the Pitt County study. Am J Public Health 1997;87(8):1297–302.
35. Mezuk B, Kershaw KN, Hudson D, et al. Job strain, workplace discrimination, and hypertension among older workers: the health and retirement study. Race Soc Probl 2011;3(1):38–50.
36. Wang E, Pletcher M, Lin F, et al. Incarceration, incident hypertension, and access to health care: findings from the Coronary Artery Risk Development in Young Adults (CARDIA) study. Arch Intern Med 2009;169(7):687–93.
37. Meng L, Chen D, Yang Y, et al. Depression increases the risk of hypertension incidence: a meta-analysis of prospective cohort studies. J Hypertens 2012;30(5):842–51.
38. Pan Y, Cai W, Cheng Q, et al. Association between anxiety and hypertension: a systematic review and meta-analysis of epidemiological studies. Neuropsychiatr Dis Treat 2015;11:1121–30.
39. Trudel-Fitzgerald C, Gilsanz P, Mittleman MA, et al. Dysregulated blood pressure: can regulating emotions help? Curr Hypertens Rep 2015;17(12):1–9.
40. Mezick EJ, Matthews KA, Hall M, et al. Low life purpose and high hostility are related to an attenuated decline in nocturnal blood pressure. Health Psychol 2010;29(2):196–204.
41. Ford CD, Sims M, Higginbotham JC, et al. Psychosocial factors are associated with blood pressure

progression among African Americans in the Jackson Heart Study. Am J Hypertens 2016;29(8):913–24.
42. Boehm JK, Kubzansky LD. The heart's content: the association between positive psychological well-being and cardiovascular health. Psychol Bull 2012;138(4):655–91.
43. Trudel-Fitzgerald C, Boehm JK, Kivimaki M, et al. Taking the tension out of hypertension: a prospective study of psychological well being and hypertension. J Hypertens 2014;32(6):1222–8.
44. Gorman BK, Sivaganesan A. The role of social support and integration for understanding socioeconomic disparities in self-rated health and hypertension. Soc Sci Med 2007;65(5):958–75.
45. Bell CN, Thorpe RJ, LaVeist TA. Race/ethnicity and hypertension: the role of social support. Am J Hypertens 2010;23(5):534–40.
46. Freedman BI, Murea M. Target organ damage in African American hypertension: role of APOL1. Curr Hypertens Rep 2012;14(1):21–8.
47. Cooper RS, Wolf-Maier K, Luke A, et al. An international comparative study of blood pressure in populations of European vs. African descent. BMC Med 2005;3:2.
48. Wise IA, Charchar FJ. Epigenetic modifications in essential hypertension. Int J Mol Sci 2016;17(4):451.
49. Teppala S, Shankar A, Ducatman A. The association between acculturation and hypertension in a multiethnic sample of US adults. J Am Soc Hypertens 2010;4(5):236–43.
50. Centers for Disease Control and Prevention (CDC). Health status of American Indians compared with other racial/ethnic minority populations–selected states, 2001-2002. MMWR Morb Mortal Wkly Rep 2003;52(47):1148–52.
51. Kaholokula JK, Iwane MK, Nacapoy AH. Effects of perceived racism and acculturation on hypertension in native Hawaiians. Hawaii Med J 2010;69(5 suppl 2):11–5.
52. Schwingshackl L, Hoffmann G. Diet quality as assessed by the Healthy Eating Index, the Alternate Healthy Eating Index, the Dietary Approaches to Stop Hypertension score, and health outcomes: a systematic review and meta-analysis of cohort studies. J Acad Nutr Diet 2015;115(5):780–800.e5.
53. Brook RD, Appel LJ, Rubenfire M, et al. Beyond medications and diet: alternative approaches to lowering blood pressure a scientific statement from the American Heart Association. Hypertension 2013;61(6):1360–83.
54. Williams DR, Mohammed SA. Racism and health II: a needed research agenda for effective interventions. Am Behav Sci 2013;57(8). http://dx.doi.org/10.1177/0002764213487341.
55. 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 2008;9(6):520–8.
56. Ludwig J, Sanbonmatsu L, Gennetian L, et al. Neighborhoods, obesity, and diabetes — a randomized social experiment. N Engl J Med 2011;365(16):1509–19.
57. Lewis TT, Cogburn CD, Williams DR. Self-reported experiences of discrimination and health: scientific advances, ongoing controversies, and emerging issues. Annu Rev Clin Psychol 2015;11(1):407–40.