

**Original Paper**

# Psychological Distress and Hypertension: Results from the National Health Interview Survey for 2004–2013

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**Key Words**

Hypertension · Emotional distress · Kessler Psychological Distress Scale

**Abstract**

**Background/Aims:** Psychological conditions are increasingly linked with cardiovascular disorders. We aimed to examine the association between psychological distress and hypertension. **Methods:** We used data from the National Health Interview Survey for 2004–2013. Hypertension was self-reported and the 6-item Kessler Psychological Distress Scale was used to assess psychological distress (a score  $\geq 13$  indicated distress). We used a logistic regression model to test the assumption that hypertension was associated with psychological distress. **Results:** Among the study participants completing the survey ( $n = 288,784$ ), 51% were female; the overall mean age ( $\pm$ SEM) was  $35.3 \pm 0.02$  years and the mean body mass index was  $27.5 \pm 0.01$ . In the entire sample, the prevalence of psychological distress was 3.2%. The adjusted odds of reporting hypertension in psychologically distressed individuals was 1.53 (95% CI = 1.31–1.80,  $p = 0.01$ ). **Conclusion:** The findings suggest that psychological distress is associated with higher odds of hypertension after adjusting for other risk factors for high blood pressure. Further studies are needed to confirm these findings and to elucidate the mechanisms by which stress increases hypertension risk.

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## Introduction

Hypertension contributes significantly to systemic organ damage, disability and premature death. Globally, it is linked with 7.6 million deaths (about 13.5% of the total) and 92 million disability-adjusted life years [1]. The annual cost of treating hypertension including that for office visits, home health visits, prescription medicines, and hospital emergency room and inpatient visits is currently in excess of USD 45 billion and increasing [2, 3].

Some evidence links psychological factors with hypertension. In a study of US veterans, Carroll et al. [4] showed that hypertension was positively associated with general anxiety disorders and major depressive disorders. This association was further increased for individuals experiencing both general anxiety disorders and major depressive disorders [4]. In a longitudinal study of Canadian participants, individuals who had major depression at baseline had a 60% higher risk of developing hypertension [5]. Other studies demonstrate psychological factors as important etiological drivers for the development of hypertension [6–8].

Kessler et al. [9] suggest serious psychological illness, measured by the 6-item Kessler Psychological Distress Scale (K6), as a tool for identifying any mental illness that is sufficient to cause moderate-to-serious impairment in social, occupational, or school functioning. The K6 is a well-validated measure of psychological symptoms [9, 10]. It could also be used as a mental health screening instrument in the primary care health setting [11, 12]. However, there is a dearth of information on the role of psychological distress and the occurrence of hypertension in the US at the national level.

The goal of this investigation was to determine the associations between psychological stress measured by the K6 index and hypertension.

## Methods

### *Study Population*

The study used data from the National Health Interview Survey (NHIS) for the years 2004–2013. The NHIS is a cross-sectional in-person household interview survey of noninstitutionalized representatives of the US civilian population conducted annually by the National Center for Health Statistics of the Centers for Disease Control and Prevention. For the current study, data were collected from 667,878 adult persons ( $\geq 18$  years) who completed the survey, representing an annual response rate of 60.8–72.5%. From the 667,878 adults who completed the interviews, 288,784 individuals provided valid data on hypertension that could be used for the analysis.

The data set amalgamates data from different samples using a complex multistage probability sampling design. The weights used represent a product of weights for the corresponding units computed in each of the sampling stages. All analyses performed in this study utilized weighted statistics based on the final weights provided with the NHIS data set.

During face-to-face interviews conducted by trained interviewers from the US Census Bureau, volunteers provided sociodemographic data and information about physician-diagnosed chronic conditions. The chronic conditions included hypertension, heart disease, stroke, cancer, diabetes, and rheumatoid arthritis. Surveys were conducted using computer-assisted personal interviewing, which utilizes a computer program for data collection and directs the interviewer through the questionnaire. Details on the NHIS sample design can be found in Parsons et al. [13].

### *Dependent and Independent Variables*

The primary dependent variable for the current investigation was the presence of hypertension. This was based on answers to survey questions, such as ‘Have you EVER been told by a doctor or other health professional that you had hypertension, also called high blood pressure?’ Only self-reports of hypertension or high blood pressure that were diagnosed by a doctor or other health care professional were included, thus excluding results from home blood pressure testing or testing by a machine in the mall or other commercial establishment.

The main independent variable was psychological distress measured by the nonspecific K6. The K6 is a simple evaluator of nonspecific psychological distress [9]. It asks about the frequency of 6 symptoms of mental illness: (1) during the past 30 days, how often did you feel so sad that nothing could cheer you up; (2) nervous; (3) restless or fidgety; (4) hopeless; (5) that everything was an effort, and (6) worthless. Based on the K6 scaling system, a score  $\geq 13$  indicated psychological distress, and this was referenced to those who reported a cumulative mood index  $< 13$  [14]. Internal consistency for the K6 scores has been reported by estimates of Cronbach's  $\alpha$  at 0.89 and 0.93 [9, 10]. Other independent variables included sociodemographic variables associated with psychological or social stress like age, sex, race, high school completion, poverty status, marital status, earnings and poverty level. Also, the relationships between hypertension and health risk factors like obesity [measured by the body mass index (BMI)], exercise, alcohol use, and smoking were determined. For comorbidities, links between other conditions, such as cancer and stroke, and the primary dependent variable were ascertained. In addition, the study assessed socioeconomic stress factors that may influence hypertension, including poverty status, total annual income, and income-to-poverty ratio. To determine the poverty status, the reported total family income was compared to the US Census Bureau's poverty thresholds for the year in question. These thresholds are based not only on income but also on family size and the number of children under the age of 18 years. For families where the number of children under the age of 18 years in the family is equivalent to the number of family members, family income is presumed to be nonexistent, and the ratio of such nonexistent income to the poverty line is undefinable.

#### *Statistical Analysis*

The present analyses focused on addressing differences between black and white Americans. Applying survey procedures, frequency and measures of central tendency were used to describe the sample, accounting for the complex sample design of the NHIS survey.

Demographics for the studied population, Blacks and Whites, with and without psychological distress within the previous 30 days are outlined in the tables. Crude and age-adjusted prevalence rates of psychological distress were determined for each sociodemographic, health risk, and associated comorbidity. Proportions and means were reported for each characteristic of interest. In preliminary analyses, the Student *t* test and ANOVA were used for group mean comparison, and the  $\chi^2$  test was employed to assess differences in categorical variables. To test the hypothesis that psychological distress (mood index score  $\geq 13$ ) was associated with hypertension (BMI  $\geq 30$ ), multivariate logistic regression modeling was applied. In the first model, the association of psychological distress with hypertension was assessed while adjusting effects of age and sex alone. In the 2nd to 4th models, associations of hypertension with psychological distress were ascertained while adjusting effects of covariates. Covariates entered in the models were: age, sex, income, smoking and drinking history, depression, and a history of hypertension, cancer, and stroke. Before constructing the model, univariate logistic regressions were performed to assess associations between hypothesized predictors and the dependent variable. Two-tailed tests with *p* values  $< 0.05$  were considered significant. All analyses were performed using SAS version 9.3 for Windows (SAS Inc., Cary, N.C., USA).

## **Results**

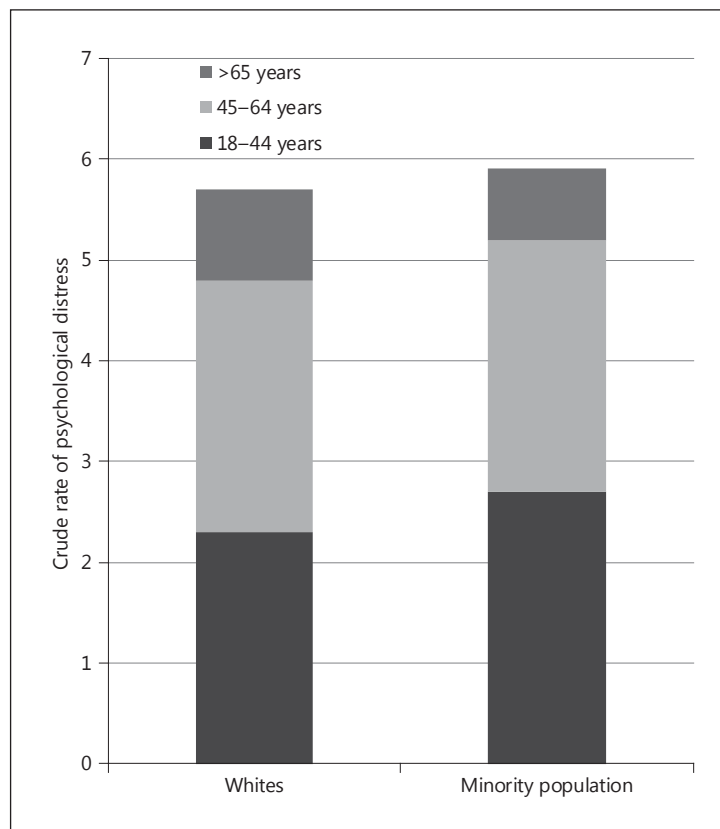
### *Prevalence of Psychological Distress*

The study sample comprised 55.7% females, 61.4% (*n* = 175,428) non-Hispanic Whites, 15.4% (*n* = 44,115) non-Hispanic Blacks, 5.3% (*n* = 15,187) Asians, and 17.9% (*n* = 51,108) Hispanics. Participants of other races representing  $< 5\%$  of the study sample were excluded from the analysis.

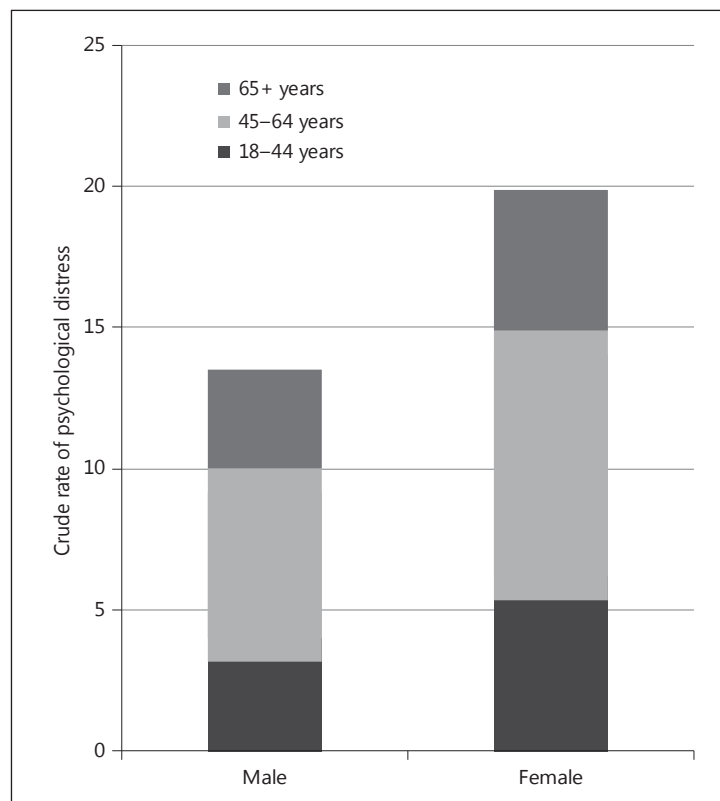
The prevalence of psychological distress in the US adult population was 3.2% over the 10 years from 2004 to 2013. Blacks had a higher rate of psychological distress (table 1). The rates were highest in middle-aged adults aged 45–64 years (4.6%), lower in younger adults (3.1%) and lowest in adults 65 years of age and over (2.4%) (fig. 1). Psychological distress also occurred more frequently among women (4.2%) than among men (2.9%) (fig. 2). The prevalence of hypertension was 30.8%. Hypertension was highest among Blacks (37.9%), compared to Whites (31.3%), Asians (21.5%), and Hispanics (21.5%; *p*  $< 0.01$ ).

**Table 1.** Comparison of the study population's sociodemographics by psychological stress

Variable	Psychological stress	No psychological stress	p value
Mean age ± SD, years	46.7±17.0	46.2±17.6	0.01
Age groups			
18–34 years	41.7	46.8	
35–64 years	42.9	32.8	
>65 years	15.4	20.4	0.01
Sex			
Female	64.8	55.2	0.01
Male	35.2	44.8	
Race/ethnicity			
Non-Hispanic Whites	59.2	61.5	0.01
Non-Hispanic Blacks	17.2	15.3	
Asians	3.2	5.4	
Hispanics	17.8	20.5	
Education			
No college	89.5	73.0	0.01
College	10.5	27.0	
No high school	27.4	14.2	0.01
High school	72.7	85.8	
Above poverty index	61.6	84.3	
Below poverty index	38.4	15.7	0.01
Exercise			
Inadequate moderate exercise	77.5	78.2	0.01
Adequate moderate exercise	22.5	21.8	
Employment			
Employed	48.3	72.3	
Unemployed in the previous 12 months	51.7	27.7	0.01
Marriage			
Married/living with a partner	63.0	48.3	0.01
Not married	37.9	51.7	
Mean BMI ± SD	28.6	27.2	0.01
Normal weight	31.4	36.7	0.01
Overweight (% BMI = 25–29.99)	31.2	36.9	0.01
Obese (% BMI ≥30)	37.4	26.3	
Sleep			
Short sleep (≤6 h)	8.7	94.3	0.01
Normal sleep (7–8 h)	2.9	98.4	
Long sleep	9.1	90.9	
Smoking			
Never smoker	38.4	18.5	0.01
Former smoker	20.1	21.8	
Current smoker	41.5	59.8	
Alcohol			
Never drinker	22.5	23.2	
Former drinker	24.1	14.9	
Current drinker	53.4	61.9	0.01



**Fig. 1.** Crude prevalence of psychological distress by race and age category.



**Fig. 2.** Crude prevalence of psychological distress by sex and age category.

**Table 2.** Odds ratio (95% CI) for the likelihood of hypertension by psychological distress for groups defined by sex, BMI, and stroke

Stratified model	No psycholo- gical distress	Psychological distress	p value
<b>Male</b>			
Participants, n	41,878	604	
Hypertension, n (%)	9,459 (23)	213 (35)	0.01
Unadjusted odds ratio	1.00 (ref.)	1.79 (1.68–1.90)	0.01
Adjusted odds ratio	1.00 (ref.)	1.89 (1.54–2.39)	0.01
<b>Female</b>			
Participants, n	41,254	928	
Hypertension, n (%)	7,854 (19)	267 (29)	0.01
Unadjusted odds ratio	1.00 (ref.)	1.72 (1.36–2.17)	0.01
Adjusted odds ratio	1.00 (ref.)	1.12 (0.87–1.44)	0.38
<b>Normal weight (BMI 18.5–24.99)</b>			
Participants, n	31,083	476	
Hypertension, n (%)	3,419 (11)	93 (20)	0.01
Crude odds ratio	1.00 (ref.)	2.02 (1.36–3.01)	0.01
Adjusted odds ratio	1.00 (ref.)	2.21 (1.30–3.75)	0.01
<b>Overweight (BMI 25–29.99)</b>			
Participants, n	28,888	429	
Hypertension, n (%)	6,543 (23)	140 (33)	0.01
Crude odds ratio	1.00 (ref.)	1.60 (1.46–1.75)	0.01
Adjusted odds ratio	1.00 (ref.)	1.47 (1.41–1.53)	0.01
<b>Obese (BMI ≥30)</b>			
Participants, n	17,159	454	
Hypertension, n (%)	5,927 (35)	184 (41)	0.01
Crude odds ratio	1.00 (ref.)	1.22 (0.74–2.00)	0.43
Adjusted odds ratio	1.00 (ref.)	1.10 (0.75–1.60)	0.63
<b>No history of stroke</b>			
Participants, n	82,262	1,478	
Hypertension, n (%)	16,749 (20)	447 (30)	0.01
Unadjusted odds ratio	1.00 (ref.)	1.65 (1.59–1.71)	0.01
Adjusted odds ratio	1.00 (ref.)	1.39 (1.34–1.45)	0.01
<b>History of stroke</b>			
Participants, n	856	50	
Hypertension, n (%)	556 (65)	32 (64)	0.89
Unadjusted odds ratio	1.00 (ref.)	1.03 (0.28–3.74)	0.01
Adjusted odds ratio	1.00 (ref.)	2.49 (0.40–15.65)	0.33

Adjusted model controlling for sociodemographic and health risk, and disease factors: age, sex, race, marriage, educational status, employment in the previous 12 months, poverty index, smoking, alcohol, sleep, adequate exercise, obesity, diabetes, coronary heart disease, and failing kidneys.

We also assessed the odds ratio of hypertension by psychological distress when stratifying the groups defined by sex, BMI, or stroke on the likelihood for hypertension (table 2). From the evaluation of interaction effects (online suppl. table 4a–c; for all online suppl. material, see [www.karger.com/doi/10.1159/000443933](http://www.karger.com/doi/10.1159/000443933)), we found that psychological distress and sex, BMI, or stroke conditions had significant interaction effects on hypertension. This means that depending on sex, or various levels of BMI and stroke, the association between

psychological distress and hypertension was different. Thus, when considered separately, the likelihood of having hypertension when psychologically distressed was significant for men, but not for women. Therefore, it appeared that psychological distress occurred more frequently in women, but was more importantly associated with hypertension in men.

Stratification by BMI showed that there were higher rates of hypertension among obese/psychologically distressed and obese/non-psychologically distressed adults than among the other BMI groups. Psychological distress was associated with hypertension among normal-weight, overweight, and obese adults, all in the same direction.

Participants with a history of stroke had significantly higher rates of hypertension than participants without a history of stroke. This observation was similar for both psychologically distressed and non-psychologically distressed adults, perhaps due to a progression of vascular dysfunction seen in hypertension-related strokes. When we stratified by history of stroke, psychological distress had a stronger association with hypertension among individuals with a history of stroke than among those without.

#### *Association Findings*

In all the models (adjusted for age and sex), psychological distress was significantly associated with hypertension (table 3). For survey respondents, decreasing economic distress exhibited by an increasing income-to-poverty ratio was associated with a corresponding reduction in the odds of hypertension. The multivariate analyses showed that psychologically distressed individuals had 49% greater odds of being hypertensive, relative to nondistressed patients. The attenuation of the results after multivariate adjustment indicates that associations of psychological distress and hypertension were significantly affected by several factors. These included obesity (BMI  $\geq 30$ ), age ( $\geq 65$  years), unemployment in the previous 12 months, widow status, past history of alcohol drinking, a history of cancer, as well as a history of stroke.

#### **Discussion**

This study shows links between psychological and hypertensive disease. This is an important issue because mental health symptoms are very common in the US, and nearly 50% of all adults will develop at least one mental illness during their lifetime [11]. About 3.2% of the studied participants were determined to be psychologically distressed. Higher rates in women and Blacks suggest a higher psychological symptom burden among women and black populations. However, men with psychological distress were more likely to report hypertension (table 4). Several studies show that major depression and anxiety states are much more common in women than in men [15–17]. However, in men, stressful conditions could be linked to alcohol and smoking habits as a potential coping measure [15, 18].

The current study also shows that psychologically distressed persons are more likely to live below the poverty line, or at least report a lower annual income. This is consistent with other studies that demonstrate striking associations between poverty and mental disease [19–23]. Tampubolon and Hanandita [22] showed that a 1% reduction in per capita household expenditure is associated with a corresponding increase in depressive symptoms. Many individuals who become unemployed or experience dynamic levels of job insecurity and economic deprivations/wealth loss may encounter significant reductions in mental health scores, increased psychological stress, and an increase in the use of antidepressant medications [19–21].

The findings from this study are particularly noteworthy as individuals with nonspecific psychological stress were 1.5 times as likely to suffer from hypertension as individuals without psychological stress. An earlier study using the K6 observed higher rates of hypertension among individuals with psychological distress (39.2%) compared to those without



**Table 3.** Associations between psychological distress and hypertension using logistic regression

Variable model	Odds ratio	95% CI	p value
Model 1 <sup>a</sup>			
Psychological distress	2.34	2.18–2.54	0.01
Model 2 <sup>b</sup>			
Psychological distress	1.92	1.84–2.01	0.01
Model 3 <sup>c</sup>			
Psychological distress	1.74	1.53–1.98	0.01
Model 4 <sup>d</sup>			
Psychological distress	1.53	1.31–1.80	0.01
Age 35–64 years	3.55	3.41–3.70	0.06
Age >65 years	8.35	8.22–8.48	0.01
Female sex	0.92	0.88–0.95	0.01
Minority population (non-Hispanic Blacks, Asians, Hispanics)	1.46	1.40–1.52	0.01
Married/living with partner	1.01	1.00–1.03	0.16
College education	0.90	0.88–0.91	0.01
Employment in the previous 12 months	1.37	1.29–1.46	0.01
Below poverty index	0.98	0.96–0.99	0.01
Inadequate exercise (<2,500 min of moderate-intensity exercise/week)	1.10	1.08–1.12	0.01
Short sleep	1.15	1.15–1.16	0.01
Long sleep	1.06	0.98–1.16	0.81
Smoking	1.16	1.13–1.19	0.01
Former smoker	1.05	1.03–1.08	0.01
Current smoker	0.88	0.80–0.97	0.01
Alcohol			
Former drinker	1.16	1.11–1.22	0.01
Current drinker	1.06	0.96–1.17	0.67
Overweight	1.96	1.86–2.06	0.43
Obesity (BMI ≥30)	3.74	3.44–4.08	0.01
Diabetes	2.75	2.65–2.85	0.01
Kidney disease	3.30	2.77–3.94	0.01
Coronary heart disease	2.72	2.50–2.97	0.01

<sup>a</sup> Minimally adjusted model (sex and age). <sup>b</sup> Model adjusted for sociodemographic factors: age, sex, race/ethnicity, educational status, marriage, employment in the previous 12 months, and poverty index. <sup>c</sup> Model adjusted for the following sociodemographic and health risk, and disease factors: age, sex, race/ethnicity, marriage, educational status, employment in the previous 12 months, poverty index, smoking, alcohol, sleep, and weekly physical activity. <sup>d</sup> Model adjusted for the following sociodemographic and health risk, and disease factors: age, sex, race/ethnicity, marriage, educational status, employment in the previous 12 months, poverty index, smoking, alcohol, sleep, adequate exercise, obesity, diabetes, coronary heart disease, and failing kidneys.

(24.2%) [12]. Another longitudinal study of black South Africans, normotensive at baseline, showed that psychological distress was associated with twice the risk for future development of hypertension [24]. In a related cross-sectional study of hypertension across 9 countries (Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Russia and Ukraine), Footman et al. [25] found a significant association between psychological distress



**Table 4.** Hypertension rate stratified by sex and psychological distress

Subjects, n (%)		No hypertension, n (%)	Hypertension, n (%)	p
Male				
No psychological distress	122,083 (97.1)	86,053 (98.0)	36,030 (95.2)	0.01
Psychological distress	3,583 (2.9)	1,759 (2.0)	1,824 (4.8)	
Female				
No psychological distress	151,925 (95.8)	105,521 (96.8)	46,404 (93.8)	0.01
Psychological distress	6,615 (4.2)	3,535 (3.2)	3,080 (6.2)	

(measured using the 12-item distress component of the Living Conditions, Lifestyles and Health Project) and hypertension with an odds ratio of 2.27 (95% CI 1.91–2.70).

Basic science studies have provided evidence that disruptions of the hypothalamic-pituitary-adrenal axis occurring in chronic stress response may be involved in the pathophysiology of essential hypertension [26, 27]. With lower odds for female participants, hypertension-related, chronic hypothalamic-pituitary-adrenal axis reactivity may be more important for males [28]. Moreover, the study results also mirror conclusions reached by other studies, which demonstrate higher rates of cardiovascular disease among patients with psychiatric symptoms [29–33].

The burden of psychological health on hypertension or hypertension-related morbidity cannot be overstated. Poor mental health hygiene is associated with deficient health belief/perception, inadequate utilization of health care, and improper smoking/alcohol habits [34, 35]. A person's mental health status critically affects his/her ability to maintain a healthy lifestyle, seek early treatment of comorbid conditions, or consistently adhere to treatment programs [36, 37]. In supporting the evidence for emotional stress and hypertension, the study strengthens the literature surrounding the behavioral aspects of hypertension.

Finally, interaction results show that psychological distress had a stronger association with hypertension among men, normal-weight adults, and individuals with a history of stroke when compared to women, overweight or obese adults, and individuals without a history of stroke, respectively.

#### *Limitations of This Study*

The NHIS data are largely self-reported, not authenticated by clinical measurement, and, therefore, exposed to recall bias. Some social desirability bias may affect the survey respondents' answers, and there might be the possibility of misclassification bias from categorization of continuous variables. Given that the survey design is cross-sectional, it is challenging to determine the temporality or causality of specific conditions. Also, the possibility exists for unmeasured confounders that affect race and hypertension, for example salt intake, or other genetic variations.

#### **Conclusions**

This investigation suggests that psychological and social factors may be important contributors to the current burden of hypertension in the US. The psychological health and hypertension relationship suggests the need for a wider adoption of behavioral care tools as part of a broad approach to facilitating cardiovascular well-being.

## Acknowledgements

This work was supported by funding from the NINDS (U54NS081765) and the NHLBI (K24HL111315). However, the funders had no role in the study design, data collection and analysis, decision to publish, or preparation of the manuscript.

## Disclosure Statement

All authors declare that they have no proprietary, financial, professional, nor any other personal interest of any nature or kind in any product or services and/or company that could be construed or considered to be a potential conflict of interest that might have influenced the views expressed in this study. This article does not contain any studies with human or animal subjects performed by any of the authors.

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