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Association of depressive symptoms and hypertension prevalence, awareness, treatment and control among US adults

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Abstract

Objective: To measure hypertension prevalence, awareness, treatment, and control by depressive symptoms among US adults.

Method: Using the National Health and Nutrition Examination Survey data from 2007–2018 (n=28,532), depressive symptoms were categorized as “none or minimum”, “mild”, “moderate”, and “moderately severe or severe” by the Patient Health Questionnaire. Hypertension was assessed by history, blood pressure measures, and antihypertensive medication use. Adjusted prevalence rates and adjusted prevalence ratios (APR) of hypertension prevalence, awareness, treatment and control were measured.

Results: By depressive, the adjusted prevalence of hypertension (32.0%, 34.2%, 37.3% and 36.6%), awareness (80.6%, 83.9%, 85.7% and 89.8%), and treatment (73.1%, 75.2%, 78.6% and 83.9%) increased with advanced depressive symptoms, respectively (all $p<0.001$). However, no difference in hypertension control was noted after full adjustment. Compared to those with no or minimum depressive symptoms, APRs of hypertension prevalence for mild, moderate, and moderately severe or severe depressive symptom were 1.07 (1.02–1.12), 1.16 (1.107–1.262), and 1.15 (1.05–1.26) respectively. The corresponding APRs were 1.04 (1.003–1.08), 1.06 (1.01–1.11), and 1.11 (1.06–1.17) for hypertension awareness, and 1.03 (0.98–1.07), 1.08 (1.02–1.14), and 1.15 (1.08–1.22) for hypertension treatment, respectively.

Conclusion: Among US adults, depressive symptoms were significantly associated with hypertension prevalence, awareness, and treatment, but not with hypertension control. When managing hypertension, healthcare providers should be aware of mental health status.

Condensed Abstracts

With nationally representative surveillance data, we reported hypertension prevalence, awareness, treatment and control by depressive symptoms. Depressive symptoms were significantly associated with hypertension prevalence, awareness, and treatment, but not with hypertension

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control. This report suggests that efforts should be taken when treating patients with hypertension with depression.

Keywords

Hypertension; depressive symptoms; National Health and Nutrition Examination Survey (NHANES)

Introduction

Hypertension affects up to 50% of the US adult population.[1] Prior to 2017, a threshold of systolic blood pressure (SBP) ≥140 mmHg or diastolic blood pressure (DBP) ≥90 mmHg was used and about 1 in 3 adults were classified as having hypertension.[2] In 2017, new hypertension guidelines were released, lowering the diagnostic threshold for hypertension as SBP ≥130mmHg or DBP ≥80 mmHg, and nearly 1 in 2 US adults were classified as having hypertension. [3] Regardless of the threshold adopted in clinical practice, hypertension is a high-burden condition, requiring individual behavior modification activities, and use of pharmacologic treatment to achieve control. [4]

The presence of depressive symptoms affects individuals' wellbeing and psychological, cognitive, somatic, and social functioning.[5] Depressive symptoms include feelings of sadness, emptiness, or irritability, accompanied by bodily and cognitive changes which significantly affect the individual's physical and mental function for at least two weeks.[6] In 2019, about 18.5% of adults in the US were estimated to have either mild, moderate or severe depressive symptoms in the prior two weeks.[6] Depressive symptoms can be initiated or exacerbated during difficult situations. A recent survey found 1 in 3 U.S. adults experienced anxiety or depressive symptoms during the COVID-19 pandemic. [7] Depression is a common comorbidity among those with hypertension[8 9] —the likelihood of hypertension among those with major depressive disorder was 22% higher than among the general population.[10] Among those with hypertension, the presence of depression was associated with higher medical care costs than hypertension alone.[11] In addition, patients with both hypertension and depression had a 15% higher risk for all-cause mortality than those with hypertension but without depression.[12]

Among US adults, the percentage of hypertension prevalence, awareness, treatment, and control have been continuously reported.[13 14 15] However, reports on hypertension prevalence, awareness, treatment, and control by depressive symptoms status among US adults are lacking. Many factors, including existed comorbidities, behavior and lifestyle may contribute to the association of hypertension and depressive symptoms. [16] The objective of this study is to assess the association of depressive symptoms and hypertension prevalence, awareness, treatment, and control, after controlling for comorbidities and behavior/lifestyle factors among representative US population.

Methods

Data

NHANES is a nationally representative cross-sectional survey of the non-military, non-institutionalized US population using a complex, multistage probability sampling design. Estimates are weighted to the US population. The survey, conducted in 2-year cycles, collects self-reported and directly measured information from participants. NHANES has been described in detail.[17] For this study, we used data from the NHANES cycles for 2007–2008, 2009–2010, 2011–2012, 2013–2014, 2015–2016, and 2017–2018. NHANES protocols were approved by the CDC's National Center for Health Statistics Research Ethics Review Board. An informed consent was obtained from all participants.

Assessing depressive symptoms

Depressive symptoms were measured using the validated Patient Health Questionnaire (PHQ-9), which includes nine questions ascertaining the frequency of 9 symptoms over the prior 2 weeks.[18] Response options to each symptom included "not at all," "several days," "more than half the days," and "nearly every day", with a score of 0, 1, 2 and 3, respectively. The total score ranged from 0 to 27, with higher scores indicating more severe depressive symptoms. Based on the scores, depressive symptoms were categorized as "none or minimum" (0–4), "mild" (5–9), "moderate" (10–14), "moderately severe" (15–19), and "severe" (20–27).[19] Due to sample size limitations to assess subgroups, we merged those with moderately severe" (15–19), and "severe" (20–27) into one group labeled, "moderately severe or severe".

Assessing hypertension prevalence, awareness, treatment and control

Trained health care providers measured blood pressure using a standard study protocol.[20] Three consecutive auscultatory blood pressure readings were obtained using a mercury sphygmomanometer with an appropriate-size blood pressure cuff, after participants rested for 5 minutes. If, for any reason, the blood pressure measurement was incomplete or interrupted, an additional reading was attempted. The average systolic and diastolic blood pressure was calculated based on up to three blood pressure readings.[21] Participants were categorized as having hypertension if the average systolic blood pressure was ≥140 mmHg, or the average diastolic blood pressure was ≥90 mmHg, or if the participants were currently using antihypertensive medication. This threshold was chosen because the data for this report were collected from 2007 to 2018 although we were aware that the hypertension was defined when systolic blood pressure ≥130 or diastolic blood pressure ≥80 mmHg since 2017.[3]

Hypertension prevalence was defined by dividing the total number of participants with hypertension by the total population aged 20 years and above. Hypertension awareness was defined as those who answered "yes" to the question, "Have you ever been told by a doctor or health professional that you had hypertension, also called high blood pressure?", among those with hypertension. Hypertension treatment was defined as those who answered "yes" to both questions, "Because of your high blood pressure/hypertension, have you ever been told to take prescribed medicine?" and "Are you now taking prescribed medicine for

high blood pressure?", among those with hypertension. Hypertension control was defined as those with both systolic and diastolic blood pressure below national thresholds (i.e., <140 mmHg and <90 mmHg) among those with hypertension. Hypertension control rates were assessed in two populations: 1) overall among those defined as having hypertension; and 2) among those with hypertension who were taking antihypertensive medications.

Descriptive characteristics

The following characteristics were included: age as a continuous variable, sex, race and Hispanic origin (categorized as non-Hispanic white, non-Hispanic black, non-Hispanic others and Hispanic), level of education (high school graduate or less, college education or more), any health insurance coverage (yes / no). In addition, the following cardiovascular-related risk factors were measured, which related to both hypertension and mental health.[22] High cholesterol was defined as a total cholesterol measurement ≥240 mg/dL,[23] or if the participants were using prescribed medication to treat high cholesterol. Diabetes was defined as a fasting glucose ≥126 mg/dL, hemoglobin A1c ≥6.5%, or having a history of being told they have diabetes, or if they were using prescribed medication to treat diabetes. Current smoking was determined as smoking ≥100 cigarettes at any point and currently smoking every day or some days, or smoking cessation <12 months prior.[24] Obesity was defined by a body mass index (BMI) of 30 kg/m^2 or greater, which was calculated using measured height and weight. Participants were classified as active if they reported ≥150 minutes/week of moderate-intensity activity or ≥75 minutes/week of vigorous-intensity activity or an equivalent combination of moderate and vigorous activity.[25] Heavy alcohol use was defined as consumption of an average of more than 14 alcoholic drinks per week for men or more than 7 drinks per week for women in the past year.[26]

Statistical analyses

Overall, 34,770 participants aged ≥20 years were available for statistical analysis. We excluded those who were pregnant at the time of interview (n=372), those with missing information on hypertension (n=2,034) or depressive symptoms (n=3,305), as well as those with missing information on education (n=20), health insurance status (n=22), smoking status (n=194), BMI (n=261), alcohol use (n=21) and physical activity participation (n=9). The final study sample was 28,532. Since the assessment of hypertension prevalence, awareness, treatment and control (from total hypertension or from treated hypertension) involve different sample pool, we present the analytic sample sizes in figure 1.

Chi-square tests were used for comparison of categorical variables, and t-tests were used for continuous variables to assess statistically significant differences. We compared the unadjusted and adjusted percentage of hypertension prevalence, awareness, treatment, and control among participants by category of depressive symptoms using multiple logistic regression models adjusting for covariates. In addition, multiple logistic regression models were used to assess the prevalence ratio of hypertension prevalence, awareness, treatment, and control by category of depressive symptoms, using those with "none or minimum" as the referent. We assessed crude prevalence ratios and adjusted prevalence ratios. For both prevalence and prevalence ratio, multiple models were used: model 1 was unadjusted; model 2 was adjusted for sociodemographic characteristics (age, sex, level of education, race and

Hispanic origin and insurance status); model 3 and model 4 were adjusted with additional cardiovascular risk factors (high blood cholesterol, diabetes, smoking, heavy alcohol use, obesity, and physical activity). In model 3, body mass index and physical activities were entered as categorical variables as described before and in model 4, both variables were entered as continuous variable to assess the robust of the association. Sensitivity analyses were conducted excluding those with heart disease, stroke, kidney disease and cancer, as these were known associations with depression and hypertension.[27] Statistical significance was defined as $p<0.05$. SUDAAN (version 11) was used for analyses to account for the NHANES complex sampling design.

Results

Using the PHQ-9, 76.4%, 15.5%, 5.1% and 3.0% were categorized as having no or minimum, mild, moderate, and moderately severe or severe depressive symptoms, respectively. The demographic and cardiovascular risk characteristics by depressive symptoms levels are presented in Table 1. The proportion of women, non-Hispanic black and Hispanic, those without a college education and without health insurance coverage increased with depressive symptom severity, as did the percentage with cardiovascular disease risk conditions and behaviors (high cholesterol, diabetes, current smoking, obesity, and not physically active). Prevalence of hypertension and use of antihypertensive medication also showed dose-response increase with depressive symptoms severity.

Crude and adjusted percentages of hypertension prevalence, awareness, treatment, and control by depressive symptom severity are presented in Table 2. Hypertension prevalence, awareness, and treatment were positively related to greater depressive symptoms — the percentages were highest among those who reported severe depressive symptoms and lowest among those who reported no or minimal depressive symptoms. For hypertension control, no association was observed between severity of depressive symptoms and hypertension control.

Prevalence ratios from logistic regression models are shown in Table 3. Compared to those who reported no/minimal depressive symptoms, those who reported mild, moderate and moderately severe or severe depressive symptoms were more likely to have hypertension, more likely to be aware of their hypertension, and more likely to be under treatment for their hypertension. Furthermore, dose-response associations were observed for hypertension awareness, treatment and depressive symptoms. For hypertension control, no association of hypertension control and depressive symptoms were observed in either total hypertension or treated hypertension after adjusting for demographic characteristics and cardiovascular risk factors, although among total hypertension, those with moderate depressive symptoms were significant more likely to have hypertension controlled than those with no or minimal depressive symptoms when adjusted only for demographic variables. However, when adjusted for all covariables, no difference was noted for hypertension control by reported depressive symptom severity. Of note, the results were the same when body mass index and physical activities were either categorical variables or continuous variables.

After excluding those with heart attack, stroke, cancer and with kidney disease, the observed associations remained similar (Supplemental table).

Discussion

Using a nationally representative sample of US adults, our results add to the literature that depressive symptoms were not only associated with hypertension prevalence, but also with hypertension awareness and treatment. Interestingly, a dose-response association was observed for hypertension awareness and treatment - the percentage increased more among those with greater depressive symptom and were highest among those with moderate severe or severe depressive symptoms. For hypertension control, there was no difference after adjustment for cardiovascular risk. To our knowledge, this is the first report of the associations of hypertension prevalence, awareness, treatment, and control by depressive symptoms status among a representative sample of US adults.

A positive association between hypertension prevalence and psychological distress, including anxiety and depression, has been reported, [8 9 10] and studies showed that both conditions share common risk factors including physical inactivity, smoking and obesity.[8 9] For hypertension awareness and depression, early reports showed that both labelling people as having hypertension [19 28] and awareness of hypertension[17] had a negative impact on psychological well-being. In addition, it has been reported that increased health care utilization among those with depression could enhance the probability of being diagnosed with hypertension. [29] The association of hypertension treatment and psychological well-being is complicated. The positive association of using antihypertensive medication and psychological distress[30] could be due to either increasing mental distress from more healthcare utilization related to treating hypertension,[32] or mental distress or depression caused by nonadherence to antihypertensive medications.[31] A recent study assessing whether the 41 most used antihypertensive drugs were associated with an altered risk of incident depression found that a decreased risk of depression was associated with 9 drugs, including 2 of 16 angiotensin agents; 3 of 10 calcium antagonists; and 4 of 15 β-blockers. Importantly, no antihypertensive drug increased the risk of depression.[32] Of note, we found that there were tendency of dose-response association of depressive symptoms and hypertension awareness and treatment - greater depressive symptoms were associated with greater awareness and treatment.

Studies assessing association of depression and hypertension control have produced mixed results. In general, patients with hypertension who also had depression were more likely to use health care services than those without depression.[33 34] It is possible that those reporting depressions were more likely to have other cardiovascular risk factors[35] and more likely to be treated for hypertension. Higher healthcare utilization among hypertensive patients with depression could result in faster and better blood pressure control.[36] However, studies also found that hypertensive patients with depression were less likely to have intensified treatment for hypertension or adherence to treatment than those without depression.[37 38]

The finding that greater depressive symptoms was associated with great hypertension awareness and treatment but not with control may be associated with several factors

associated with either hypertension or depression, including health care system use, other co-existing conditions, and adherence to treatment.[37–41] Additionally, a recently report from Netherlands showed significant differences in the association between depression and hypertension awareness, treatment and control between ethnic groups,[39] suggesting that further study to assess the ethnicity-related factors affecting the association between depression status and hypertension is needed among diversity population.

This study has some limitations. First, assessment of hypertension awareness and treatment were based on self-report and subject to recall biases. The clinical definition for hypertension changed during the end of our analytic period (2007–2018)[3]. We therefore used the former clinical definition of hypertension as systolic blood pressure ≥140 mmHg or diastolic blood pressure ≥90 mmHg. Further, studies have suggested a different cut point for blood pressure readings taken outside of the office.[40] However, NHANES procedures follow strict measurement protocols and studies have traditionally used the clinical definition. These could result in underestimates of hypertension prevalence, awareness and treatment. Second, the PHQ-9 assessed depression-related symptoms in the prior 2 weeks, not a history of depression. Therefore, it is possible that those with well controlled depression would not be identified with the PHQ-9. However, the PHQ-9 has high sensitivity and specificity to identify major depression.[22] Third, it is possible that the association observed here might be due to more healthcare contact among those with more depressive symptoms, which might result in greater screening for and identification and treatment of hypertension. Fourth, the data were cross-sectional, and causality association between hypertension prevalence, awareness, treatment, and depressive symptoms cannot be inferred. Fifth, about 18% NHANES sample had missing records (mostly missing information on depressive symptom and hypertension). It is possible that those with missing records might be different from those without missing. Sixth, some chronic conditions, such as cirrhosis and heart failure, may related to both depression and hypertension. However, we were unable to exclude those with these conditions, as the information was not presented in NHANES through the period. Finally, it is unknown whether other factors such as regression dilution bias may have impacted any results.

Our results suggest that there is a positive association between hypertension prevalence, awareness, and treatment and depressive symptoms among US adults. Specifically, a dose-response tendency was noted between depressive symptom status and hypertension awareness and treatment. There was no association between hypertension control and depressive symptoms. With increasing comorbidity of depression among the population, it might be expected that more awareness of hypertension and more patients would be on treatment. Further efforts to improve hypertension management to achieve control are needed overall and for those with co-existing depression.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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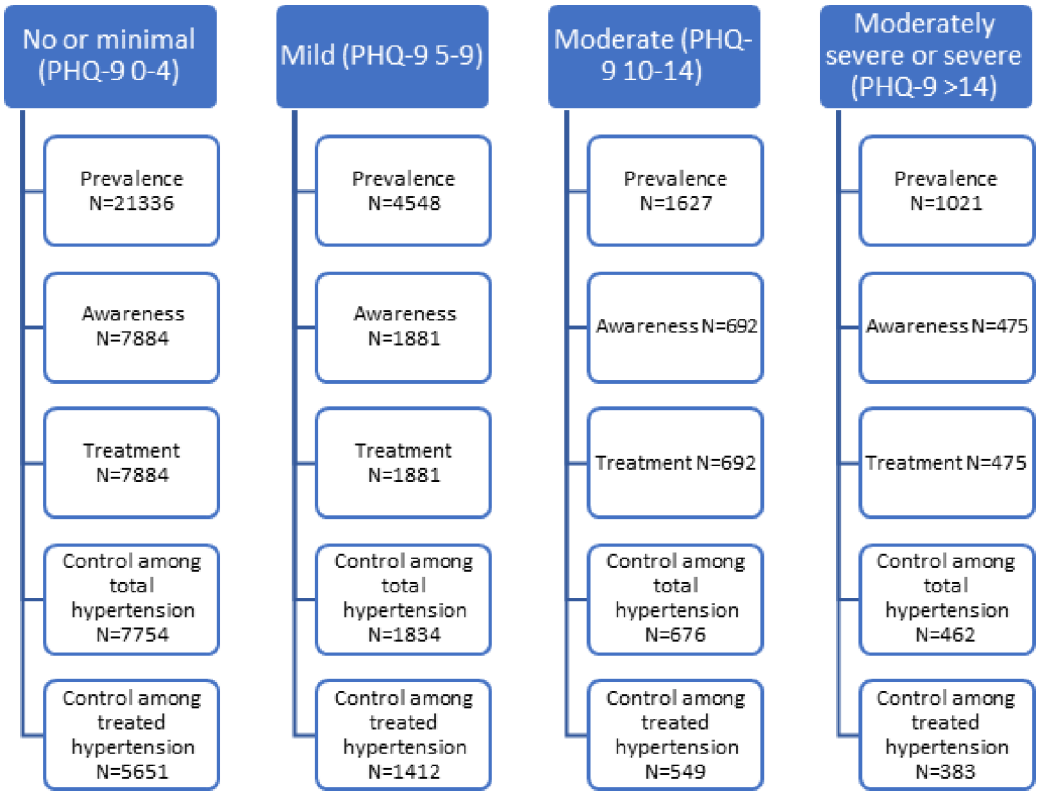

Figure 1.

Sample size for estimating hypertension prevalence, awareness, treatment and control by depressive symptom status (no or minimal, mild, moderate, and moderately severe or severe) from total eligible population (N=28532). National Health and Nutrition Examination Survey, 2007–2018

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Table 1.

Population characteristics (percentage and standard error) by depression status, National Health and Nutrition Examination Survey, 2007–2018

	No or minimal (PHQ 9: 0–4) (n=21,336)	Mild (PHQ 9: 5–9) (n=4,548)	Moderate (PHQ 9: 10–14) (n=1,627)	Moderately severe or severe (PHQ 9: ≥15) (n=1,021)	p-value*
Age (years)Mean and standard error	47.9±0.26	47.4±0.42	47.0±0.53	47.3±0.59	0.458
Sex					
Men	52.1±0.37	42.0±0.87	36.0±1.51	36.7±1.92	<0.001
Women	47.9±0.37	58.0±0.87	64.0±1.51	63.3±1.92	<0.001
Race/ethnicity					
Non-Hispanic white	67.9±1.41	66.7±1.56	64.3±2.18	62.6±2.30	0.011
Non-Hispanic black	10.6±0.70	11.8±0.92	12.9±1.11	13.2±1.35	0.025
Non-Hispanic other	7.68±0.44	6.99±0.52	7.60±0.88	6.83±0.97	0.390
Hispanic	13.8±1.00	14.6±1.00	15.2±1.49	17.3±1.70	0.009
Level of education					
UP to high school graduate	35.7±0.95	43.7±1.35	49.3±1.84	56.5±2.18	<0.001
College or above	64.3±0.95	56.3±1.35	50.7±1.84	43.5±2.18	<0.001
Health insurance					
Yes	84.4±0.52	79.7±1.04	77.6±1.57	78.4±1.50	<0.001
No	16.6±0.52	20.3±1.04	22.4±1.57	21.6±1.50	<0.001
High cholesterol					
Yes	27.6±0.51	31.6±0.92	31.9±1.62	33.3±1.59	0.001
No	72.4±0.51	68.4±0.92	68.1±1.62	66.7±1.59	0.001
Diabetes					
Yes	12.4±0.32	16.9±0.73	20.0±1.30	20.6±1.26	<0.001
No	87.6±0.32	83.1±0.73	80.0±1.30	79.4±1.26	<0.001
Current smoking					
Yes	16.5±0.42	26.0±0.86	38.0±1.67	41.4±2.06	<0.001
No	83.5±0.42	74.0±0.86	62.0±1.67	58.6±2.06	<0.001
Alcohol use					
Heavy Drink	7.3±0.31	10.0±0.66	10.5±1.04	10.8±1.51	0.027

	No or minimal (PHQ 9: 0–4) (n=21,336)	Mild (PHQ 9: 5–9) (n=4,548)	Moderate (PHQ 9: 10–14) (n=1,627)	Moderately severe or severe (PHQ 9: ≥15) (n=1,021)	p-value*
Not heavy drink	92.7±0.31	90.0±0.66	89.5±1.04	89.2±1.51	0.027
Body Mass Index					
Normal	30.0±0.58	26.1±0.94	28.0±1.66	22.2±1.93	<0.001
Overweight	34.1±0.55	29.9±0.88	25.2±1.47	27.2±1.80	<0.001
Obesity	36.0±0.65	44.0±1.07	46.8±1.64	50.6±2.26	<0.001
Recommended physical activities					
Yes	41.5±0.80	30.4±0.98	22.0±1.37	17.0±1.90	<0.001
No	58.5±0.80	69.6±0.98	78.0±1.37	83.0±1.90	<0.001
Hypertension					
Yes	31.4±0.57	35.8±1.09	39.2±1.69	39.5±2.24	<0.001
No	68.6±0.57	64.2±1.09	60.8±1.69	60.5±2.24	<0.001
Antihypertensive medications					
Yes	72.7±0.87	76.2±1.51	79.4±1.98	83.8±2.37	<0.001
No	27.3±0.87	23.8±1.51	20.6±1.98	16.2±2.37	<0.001

All estimates are weighted to the US adult population.

PHQ-9: The Patient Health Questionnaire.

*A t-test was used for age comparisons. The chi-square test was used for categorical variables.

Table 2.

Prevalence of hypertension prevalence, awareness, treatment and control by depression status, National Health and Nutrition Examination Survey, 2007–2018

		Depression severity				
		No or minimal (PHQ 9: 0–4)	**Mild (PHQ 9: 5–9)**	**Moderate (PHQ 9: 10–14)**	**Moderately severe or severe (PHQ 9: ≥15)**	**p-value**
Model 1	Prevalence	31.4±0.57	35.8±1.09	39.2±1.69	39.5±2.24	<0.001
	Awareness	80.2±0.72	84.9±1.39	86.9±1.72	90.2±2.00	<0.001
	Treatment	72.7±0.87	76.2±1.51	79.4±1.98	83.8±2.37	<0.001
	Controlled among total hypertension	49.9±1.02	50.8±1.85	54.6±2.48	54.6±2.98	0.132
	Control among treated hypertension	69.0±0.85	67.3±1.74	69.2±2.64	65.4±3.30	0.307
Model 2	Prevalence	31.2±0.55	36.2±0.97	40.2±1.46	39.9±1.92	<0.001
	Awareness	80.0±0.73	85.2±1.37	87.4±1.57	90.9±1.93	<0.001
	Treatment	72.5±0.88	76.5±1.47	80.3±1.76	85.0±2.22	<0.001
	Controlled among total hypertension	49.8±1.02	50.9±1.84	55.0±2.44	55.4±3.07	0.081
	Control among treated hypertension	69.2±0.84	67.1±1.72	68.0±2.65	63.3±3.42	0.102
Model 3	Prevalence	32.0±0.56	34.2±0.92	37.3±1.40	36.6±1.78	0.007
	Awareness	80.6±0.73	83.9±1.48	85.7±1.77	89.8±2.04	<0.001
	Treatment	73.1±0.87	75.2±1.55	78.6±1.89	83.9±2.24	<0.001
	Controlled among total hypertension	50.3±1.01	49.7±1.82	53.1±2.54	53.4±3.06	0.332
	Control among treated hypertension	69.3±0.85	67.1±1.71	67.8±2.71	62.9±3.48	0.086
Model 4	Prevalence	32.1±0.56	34.0±0.93	36.8±1.38	36.3±1.76	0.013
	Awareness	80.7±0.73	83.8±1.50	85.3±1.79	89.5±2.14	<0.001
	Treatment	73.2±0.87	75.0±1.57	78.2±1.91	83.5±2.33	<0.001
	Controlled among total hypertension	50.4±1.02	49.6±1.84	52.8±2.59	53.2±3.04	0.379
	Control among treated hypertension	69.3±0.85	67.0±1.72	67.9±2.73	63.2±3.45	0.098

All estimates are weighted to the US adult population.

All analyses were conducted using multiple logistic regression.

PHQ-9: the Patient Health Questionnaire.

Prevalence of hypertension was defined as a systolic blood pressure ≥ 140 mm Hg, or a diastolic blood pressure ≥ 90 mm Hg, or current use of blood pressure lowering medications, or awareness of hypertension among the total population;

Awareness of hypertension was defined as an affirmative response to the question “Have you ever been told by a doctor or health professional that you had hypertension, also called high blood pressure?” among those with hypertension;

Treatment of hypertension was defined as affirmative responses to both questions “Because of your high blood pressure/hypertension, have you ever been told to take prescribed medicine?” and “Are you now taking prescribed medicine for high blood pressure?” among those with hypertension;

Controlled among total hypertension was defined as an SBP < 140 mm Hg and DBP < 90 mm Hg among the total hypertension;

Controlled among treated hypertension was defined as an SBP < 140 mm Hg and DBP < 90 mm Hg among hypertension who were taking antihypertensive medications.

Model 1: Crude percentage;

Model 2: Adjusted percentage by demographic characteristics including age, sex, race/ethnicity, level of education and insurance status;

Model 3: Adjusted percentage by demographic characteristics including age, sex, race/ethnicity, level of education, insurance status, high cholesterol, diabetes, smoking, alcohol use, BMI (obesity, yes/no) and physical activities (engaged with recommended physical activities, yes/no);

Model 4: Adjusted percentage by demographic characteristics including age, sex, race/ethnicity, level of education, insurance status, high cholesterol, diabetes, smoking, alcohol use, BMI and physical activities as continuous variables.

Table 3.

Crude and adjusted prevalence ratio of hypertension management outcomes by depression status, National Health and Nutrition Examination Survey 2007–2018

		No or minimal (PHQ 9: 0–4)	Mild (PHQ 9: 5–9)	Moderate (PHQ 9: 10–14)	Moderately severe or severe (PHQ 9: ≥15)
Prevalence	Model 1	1.00	1.14 (1.08–1.21)	1.25 (1.14–1.37)	1.26 (1.12–1.41)
	Model 2	1.00	1.16 (1.10–1.22)	1.29 (1.19–1.39)	1.28 (1.17–1.40)
	Model 3	1.00	1.07 (1.02–1.12)	1.16 (1.07–1.26)	1.15 (1.05–1.26)
	Model 4	1.00	1.06 (1.01–1.11)	1.15 (1.06–1.24)	1.13 (1.03–1.24)
Awareness	Model 1	1.00	1.06 (1.02–1.10)	1.08 (1.04–1.13)	1.12 (1.07–1.18)
	Model 2	1.00	1.06 (1.03–1.10)	1.09 (1.05–1.14)	1.14 (1.08–1.19)
	Model 3	1.00	1.04 (1.003–1.08)	1.06 (1.01–1.11)	1.11 (1.06–1.17)
	Model 4	1.00	1.04 (1.003–1.08)	1.06 (1.01–1.11)	1.11 (1.05–1.17)
Treatment	Model 1	1.00	1.05 (1.01–1.09)	1.09 (1.03–1.16)	1.15 (1.08–1.23)
	Model 2	1.00	1.06 (1.01–1.10)	1.11 (1.05–1.17)	1.17 (1.11–1.24)
	Model 3	1.00	1.03 (0.98–1.07)	1.08 (1.02–1.14)	1.15 (1.08–1.22)
	Model 4	1.00	1.03 (0.98–1.07)	1.07 (1.01–1.13)	1.14 (1.07–1.22)
Control among total hypertension	Model 1	1.00	1.02 (0.94–1.10)	1.09 (0.996–1.20)	1.10 (0.98–1.23)
	Model 2	1.00	1.02 (0.94–1.11)	1.10 (1.01–1.21)	1.11 (0.99–1.25)
	Model 3	1.00	0.99 (0.91–1.07)	1.06 (0.96–1.17)	1.06 (0.94–1.20)
	Model 4	1.00	0.98 (0.91–1.07)	1.05 (0.95–1.16)	1.06 (0.94–1.19)
Control among treated hypertension	Model 1	1.00	0.98 (0.92–1.03)	1.00 (0.93–1.09)	0.95 (0.86–1.05)
	Model 2	1.00	0.97 (0.91–1.03)	0.98 (0.91–1.06)	0.92 (0.82–1.02)
	Model 3	1.00	0.97 (0.91–1.03)	0.98 (0.90–1.06)	0.91 (0.81–1.02)
	Model 4	1.00	0.96 (0.91–1.03)	0.98 (0.90–1.07)	0.91 (0.81–1.02)

All estimates are weighted to the US adult population.

All analyses were conducted using multiple logistic regression.

PHQ-9: the Patient Health Questionnaire.

Prevalence of hypertension was defined as a systolic blood pressure ≥ 140 mm Hg, or a diastolic blood pressure ≥ 90 mm Hg, or current use of blood pressure lowering medications, or awareness of hypertension among the total population;

Awareness of hypertension was defined as an affirmative response to the question “Have you ever been told by a doctor or health professional that you had hypertension, also called high blood pressure?” among those with hypertension;

Treatment of hypertension was defined as affirmative responses to both questions “Because of your high blood pressure/hypertension, have you ever been told to take prescribed medicine?” and “Are you now taking prescribed medicine for high blood pressure?” among those with hypertension;

Controlled among total hypertension was defined as an SBP < 140 mm Hg and DBP < 90 mm Hg among the total hypertension;

Controlled among treated hypertension was defined as an SBP < 140 mm Hg and DBP < 90 mm Hg among hypertension who were taking antihypertensive medications.

Model 1: Crude;

Model 2: Adjusted by demographic characteristics including age, sex, race/ethnicity, level of education and insurance status;

Model 3: Adjusted percentage by demographic characteristics including age, sex, race/ethnicity, level of education, insurance status, high cholesterol, diabetes, smoking, alcohol use, BMI (obesity, yes/no) and physical activities (engaged with recommended physical activities, yes/no);

Model 4: Adjusted percentage by demographic characteristics including age, sex, race/ethnicity, level of education, insurance status, high cholesterol, diabetes, smoking, alcohol use, BMI and physical activities as continuous variables.