The Association Between Depressive Symptoms and Blood Pressure (BP) Control Among US Adults with Hypertension

NHANES Analysis (2013–2020); ENAR DataFest 2025

Monal Daterao, Emma Hughes, Devin Nathan, Augustus Williams

New York University – School of Global Public Health, MS Biostatistics Program

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Abstract

Hypertension is a major risk factor for cardiovascular disease and stroke; and BP control among hypertensive US adults has declined over the past decade. This report analyzes NHANES survey data (2013-2020) to explore the association between self-reported depressive symptoms (SRDS) and BP control among hypertensive adults. Multiple logistic regression models assessed hypertension prevalence and BP control across SRDS levels, controlling for antidepressant use, demographics, and comorbidities (i.e. BMI, diabetes, CKD). Findings revealed that mild to moderately severe SRDS was linked with higher odds of hypertension. However, among those with hypertension, moderately severe and severe SRDS were protective factors against uncontrolled BP. Diabetes and antidepressant use (determined not to be an EMM) were also protective factors against uncontrolled BP among those with hypertension. This suggests severe SRDS, comorbidities, and antidepressant use may promote care-seeking behavior, thus improving BP control, highlighting a potential gap in education and access to care.

Keywords: *Antidepressant use, BMI, BP control, cardiovascular disease, chronic kidney disease, comorbidities, depressive symptoms, diabetes, healthcare disparities, care-seeking behavior, hypertension, medication adherence, mental health, multiple logistic regression, NHANES, protective factors, self-reported depressive symptoms, survey data analysis, uncontrolled BP*

Introduction

Hypertension, also known as high BP, increases the risk for cardiovascular disease (CVD) and stroke, both major causes of mortality in the US (CDC, 2025). Defined as BP ≥130/80 mmHg (Whelton, Carey, Aronow, et al., 2018), the prevalence of hypertension among US adults from 2021-2023 was 47.7%, with 51.2% on antihypertensive medication(s) and only 20.7% of those on medication achieving controlled BP (Fryar, 2024). The prevalence of controlled hypertension has declined from 53.9% in 2013 to 47.7% in 2023, raising public health concern (Lee, Wang, Carlson, 2023).

Previous studies report an association between hypertension and symptoms of depression and anxiety (Stein, Aguilar-Gaxiola, Alonso, et al., 2014; Lim, Solmi, Cortese, 2021), suggesting psychological factors as predictors of hypertension (Rutledge, 2002). This could be confounded by physiological mechanisms (i.e. cortisol reactivity to stress associated with incident hypertension [Hamer, Steptoe, 2012]), behavioral and psychosocial factors (i.e. depression associated with poor adherence to antihypertensive medication(s) [Wang, Bohn, Knight, et al, 2002; Eze-Nliam, Thombs, Lima, et al., 2010]), and potential depressive side effects of antihypertensive medication (Li, Fan, Sun, et al., 2021). This bidirectional relationship complicates BP control (Jeon, Chang, Lim, et al., 2020; Xu, Wu, Xiao, et al., 2024).

BMI (Landi, Calvani, Picca, et al., 2018), diabetes (Hamet, 1993), and chronic kidney disease (CKD [Burnier, Damianaki, 2023]) are additional predictors of hypertension that may also have an impact on the presence of uncontrolled BP and depression. Co-occurrence of diabetes and hypertension significantly increases mortality (Hamet, 1993), with 70.5% of type-2 diabetic patients having uncontrolled BP (Naseri, Esmat, Bahee, 2022). Additionally, hypertension and CKD have a bidirectional relationship, both serving as major risk factors for cardiovascular disease (Burnier, et al., 2023).

Problem Statement

This report analyzes data sourced from the US National Health and Nutrition Examination Survey (NHANES; 2013-2020) to examine the association between self-reported depressive symptoms (SRDS) and blood pressure (BP) control aiming to inform future research on hypertension management and prevalence of BP control, and refining interventions for cardiovascular health.

Methods

The blood pressure-related data, sourced from NHANES, was provided via the ENAR CardioStatsUsa GitHub repository, while the "Mental Health—Depression Screener", "Prescription Medications", and "Prescriptions Medications—Drug Information" data were obtained directly from NHANES. This report focuses on data from 2013-2020, analyzing demographic, comorbidity, blood pressure-related, self-reported depressive symptoms (SRDS; measured by the Patient Health Questionnaire [PHQ-9; Kroenke, Spitzer, Williams, 2001]), and antidepressant use (classified according to the "Prescriptions Medications—Drug Information") variables.

All analyses were conducted using R (version 4.4.1 and 4.4.2). A new variable, *svy_year*, was created to track survey cycles at the observation-level; *svy_id* and *SEQN*, being synonymous, were used as unique identifiers to merge the blood pressure-, depression-, and antidepressant-related datasets, which will be referred to as the "combined data" throughout the report. Data processing included handling missing values and standardizing and operationalizing categorical variables. Responses marked as "Don't Know" or "Refused…" were removed as missing values and hypertension- or uncontrolled BP-related variables following the 2017 American College of Cardiology (ACC)/American Heart Association (AHA) were selected.

For SRDS-related data, *Total Score* (0-27) and *Category* (None [<5], Mild [5-9], Moderate [10-14], Moderately Severe [15-19], Severe [20+]) variables were created based on PHQ-9 responses for each observation. DPQ-100, an additional variable from NHANES that is not traditionally included in the PHQ-9, was excluded from *Total Score* summation. For antidepressant-related data, the "Prescription Medication–Drug Information" dataset along with its NHANES codebook was used to identify antidepressant medication codes.

To account for the nature of NHANES/survey data, survey designs incorporated individual-level weights, strata, and primary sampling units via the "survey" R package in all analysis. A multiple logistic regression approach was used to examine the relationship between SRDS and BP control among hypertensive US adults, controlling for antidepressant use, demographics (i.e. age, gender), and comorbidities (i.e. BMI, diabetes, CKD).

Four regression models were developed, Model 1 examined hypertension among all respondents while Models 2-4 examined uncontrolled BP among only hypertensive respondents, each varied in type and quantity of predictors (Table 2), except all included *svy_year* and *Category* of *Total* [SRDS] *Score*.

Odds ratios (ORs) were calculated from model outputs to further understand the impact of SRDS on hypertension (Model 1) and uncontrolled BP (Models 2-4). Models 2-4 were stratified by additional variables for deeper insight. All analyses were conducted at significance level, $\alpha = 0.05$.

Key Results

The combined dataset included 20,624 observations (respondents): 5,924 (2013-2014), 5,735 (2015-2016), and 8,965 (2017-2020). 10,005 of respondents were defined as hypertensive (Table 1). Most variables had a 100% response rate, except for smoking status (99.92%) and BMI (97.28%).

Model 1 examined hypertension among all respondents across depressive symptom levels (DSLs) and survey year. Compared to the reference group (*Total Score* <5), mild, moderate, and moderately severe DSLs were significantly associated with higher odds of hypertension (Table 2). A positive correlation was observed, showing the chance of developing hypertension increases as the severity of DSL increases.

Model 2 examined uncontrolled BP among hypertensive respondents across DSLs and survey year. Compared to the reference group, moderately severe and severe DSLs were found to be protective factors for uncontrolled blood pressure among hypertensive adults (Table 2).

Model 3 was an extension of Model 2 and explored additional covariates (i.e. gender, age, diabetes, CKD, and BMI). Older age was shown to have the largest impact on uncontrolled BP while diabetes showed significance as a protective factor, while chronic kidney disease did not (Table 2). Severe DSL remained linked to lower odds of uncontrolled blood pressure, whereas CKD's impact was not found significant (Table 2).

Model 4 examined uncontrolled BP among hypertensive respondents across DSLs and antidepressant use. Both severe DSL and antidepressant use were significant protective factors

against uncontrolled BP. Interaction analysis within the model found no evidence that antidepressant use modified the relationship between SRDS and uncontrolled BP, despite antidepressants being found to reduce the risk of uncontrolled BP among hypertensive adults.

Limitations

This analysis has several limitations that should be considered when interpreting findings. The cross-sectional design of NHANES prevents establishing causality, limiting findings to associations. Self-reported data on depressive symptoms, any medication use, and comorbidities (i.e. BMI) may introduce recall and social desirability bias. While the PHQ-9 is widely used, it does not replace a clinical diagnosis, risking misclassification. BMI does not account for variations in body composition, making it an inaccurate indicator of overall health. Differences in controlled blood pressure across survey years were not statistically significant. Regression models controlled for several confounders (i.e. age, gender, BMI, diabetes, and chronic kidney disease) but did not include race/ethnicity or lifestyle factors (i.e. smoking status), which may influence findings. Additionally, treating “Don’t Know”/ “Refused” responses as missing may introduce bias.

Conclusion

The multiple logistic regression models were used to investigate the complex relationship between depressive symptomology and hypertension and uncontrolled blood pressure, adjusting for potential covariates. Model 1 (Table 2) established that individuals who reported mild to moderately severe depressive symptoms had greater odds of prevalent hypertension, confirming the results established in the initial literature.

Based on Model 1, we hypothesized that hypertensive individuals who report depressive symptoms would have greater odds of uncontrolled BP. Unexpectedly, Model 2 revealed that reports of moderately severe and severe depressive symptoms were protective factors against uncontrolled BP among hypertensive individuals.

Model 3 was utilized to address potential confounders, adjusting for age, gender, BMI, diabetes, and CKD. Also unexpectedly, severe depressive symptoms, increases across BMI category, increases across age category, and having diabetes were all protective factors against uncontrolled BP among hypertensive individuals. These results led to further investigation into antidepressant use as a potential effect measure modifier (EMM). Theorizing antidepressant use

as a potential EMM speculated that individuals who report use would be less likely to report moderate to severe depressive symptoms, ultimately underestimating the number of people in each DSL. To explore this, Model 4 was run but found no significance in the interaction terms, indicating antidepressant use does not modify the observed relationship. However, antidepressant use was identified, and severe DSL remained, as a statistically significant protective factor for uncontrolled BP. Possible explanations of observations include greater health care engagement among individuals with more severe depressive symptoms and/or antidepressant use, thus may be more likely to adhere to antihypertensive management, more likely to engage in stress reducing activities and employing lifestyle changes (i.e. sleep, diet, exercise), all of which improve BP control (Aronow, 2017).

The results from this analysis provide insight into protective factors for uncontrolled BP among hypertensive adults. Variables such as more severe depressive symptoms, older age, higher BMI, and diabetes are all associated with an increased risk of hypertension, but act as protective factors for uncontrolled BP among those with hypertension. It is hypothesized that hypertensive individuals with these factors are more likely to engage in care-seeking behaviors and address uncontrolled BP. For example, hypertensive adults with diabetes are more likely to seek care for both conditions and thus receive more educational and helpful resources, especially since the co-presentation of both conditions increases one's risk of CVD (Hamet, 1993). These findings and inference of possible care-seeking behaviors highlight potential imbalances in knowledge of or access to treatment among hypertensive adults and introduces avenues for future research.

Future studies regarding BP control among hypertensive adults should consider the prevalence of healthcare-seeking behaviors and access to care amongst this population, stratifying by demographic variables and comorbidities to identify potential gaps. By identifying gaps in care-seeking behavior, targeted efforts to address uncontrolled BP among hypertensive adults can be implemented for these subpopulations. Additionally, since antidepressant use was found to be a protective factor for uncontrolled BP among hypertensive adults, future research should include analysis on antihypertensive medication adherence and how the adherence to medications for hypertension co-morbidities influence the relationship with uncontrolled BP.

Table 1. Distribution of Demographic Characteristics Among Hypertensive Respondents

	Count	Percent (%)
Gender		
Male	5,148	51.45
Female	4,857	48.55
TOTAL	*10,005*	*100.00*
Age Category		
18-44	2,040	20.39
45-64	4,182	41.80
65-74	2,109	21.08
75+	1,674	16.73
TOTAL	*10,005*	*100.00*
Race/Ethnicity		
Non-Hispanic		
Asian	977	9.77
Black	2,816	28.15
White	3,670	36.68
Hispanic	2,163	21.62
Other	379	3.79
TOTAL	*10,005*	*100.00*

Table 2. Odds Ratios (OR; 95% Confidence Interval [CI]) from Four Multiple Logistic Regression Models of Demographic & Clinical Predictors of Hypertension & Uncontrolled Blood Pressure Among Populations of NHANES Survey Respondents

	OR (95% CI)			
	Outcome: *Hypertension* ***Population:*** *All Respondents*	***Outcome:*** *Uncontrolled BP /* ***Population:*** *Hypertensive Respondents*		
Predictor *[reference group]*	**Model 1**	**Model 2**	**Model 3**	**Model 4**
Survey Year *[2013-2014]*	*1.00*	*1.00*	*1.00*	
2015-2016	1.09 (0.98, 1.22)	1.26 (0.98, 1.62)	**1.29 (1.01, 1.64)**	
2017-2020	1.06 (0.94, 1.20)	1.05 (0.89, 1.24)	1.12 (0.95, 1.31)	
Gender *[Male]*			*1.00*	
Female			**0.80 (0.69, 0.92)**	
Age Category *[18-44]*			1.00	
45-64			**0.42 (0.33, 0.54)**	
65-74			**0.31 (0.24, 0.40)**	
75+			**0.38 (0.28, 0.52)**	
Depressive Symptom Level *[None]*	*1.00*	*1.00*	*1.00*	*1.00*
Mild	**1.17 (1.04, 1.30)**	0.87 (0.70, 1.10)	0.90 (0.70, 1.17)	0.99 (0.76, 1.27)
Moderate	**1.31 (1.10, 1.55)**	0.82 (0.62, 1.08)	0.89 (0.65, 1.21)	0.85 (0.61, 1.19)
Moderately Severe	**1.50 (1.13, 2.00)**	**0.66 (0.47, 0.93)**	0.74 (0.52, 1.06)	0.70 (0.37, 1.35)
Severe	1.25 (0.76, 2.06)	**0.50 (0.28, 0.87)**	**0.48 (0.26, 0.90)**	**0.43 (0.21, 0.91)**
Antidepressant Use *[No]*				*1.00*
Yes				**0.65 (0.50, 0.85)**
Diabetes ***[****No]*			*1.00*	
Yes			**0.63 (0.53, 0.75)**	
Chronic Kidney Disease *[No]*			*1.00*	
Yes			1.08 (0.89, 1.29)	
BMI *[< 25]*			*1.00*	
25-30			**0.63 (0.51, 0.80)**	
30-35			**0.60 (0.48, 0.74)**	
35+			**0.57 (0.46, 0.71)**	

Figure 1. Proportions of Hypertension Among All NHANES Respondents by Depressive Symptom Level & Survey Year

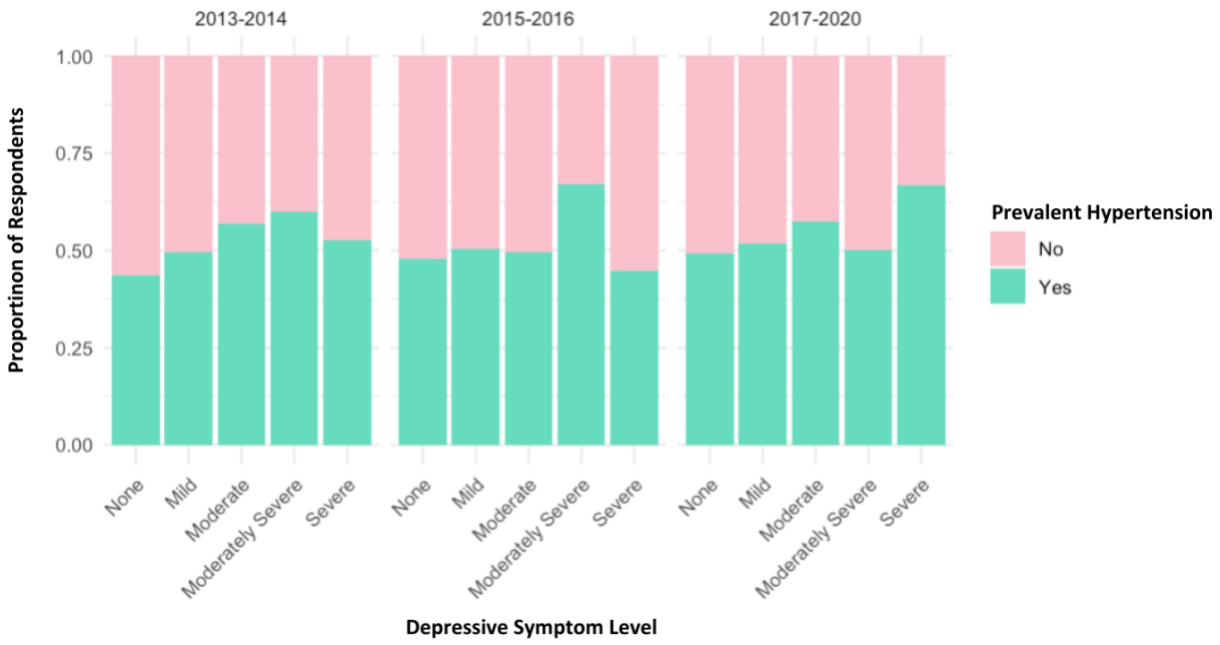
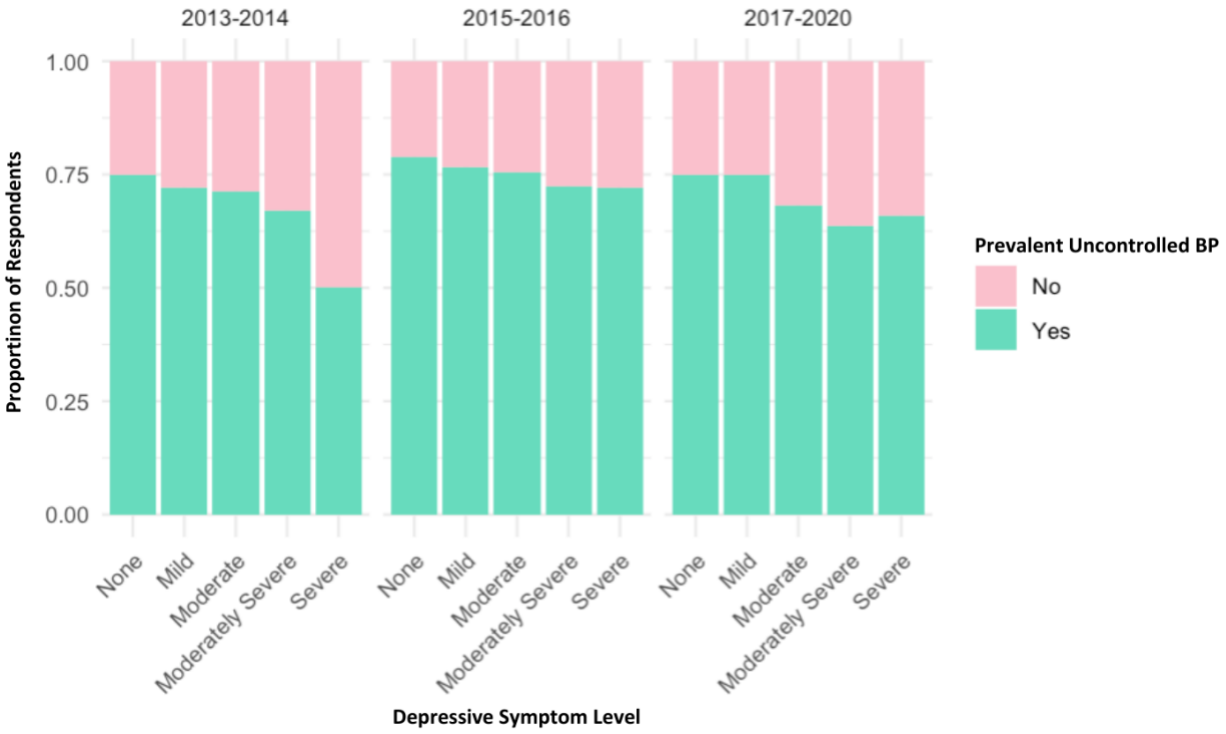


Figure 2. Proportions of Uncontrolled BP Among Hypertensive NHANES Respondents by Depressive Symptom Level & Survey Year



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