

Workplace Psychosocial Factors Associated With Hypertension in the U.S. Workforce: A Cross-Sectional Study Based on the 2010 National Health Interview Survey

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Objective To explore associations between self-reported hypertension and workplace psychosocial factors that are common among U.S. workers and to identify industries and occupations (I&Os) that are associated with a high prevalence of hypertension, even after adjustment for common known risk factors.

Methods Data from the 2010 National Health Interview Survey were used to examine relationships between the prevalence of self-reported hypertension and job insecurity, hostile work environment, work-family imbalance, work hours and I&O.

Results Job insecurity (adjusted prevalence ratio (aPR): 1.11; 95% confidence interval (CI): 1.04–1.19) and hostile work environment (aPR: 1.15; 95% CI: 1.03–1.29) were significantly associated with hypertension. Hypertension prevalence was significantly elevated among those employed in Healthcare Support occupations and Public Administration industries.

Conclusion Addressing hostile work environments and the stress associated with job insecurity may improve workers' health. Other occupational factors that contribute to the variation in prevalence of hypertension by I&O should be sought. *Am. J. Ind. Med.* 57:1011–1021, 2014. © 2014 Wiley Periodicals, Inc.

KEY WORDS: hypertension; occupational health; occupational exposures; national survey

INTRODUCTION

Hypertension is a primary risk factor for cardiovascular diseases (CVDs) and stroke, the leading causes of death in

the United States [Chobanian et al., 2003]. According to the Centers for Disease Control and Prevention (CDC), nearly 67 million people in the United States have hypertension (defined as systolic blood pressure ≥ 140 mmHg or diastolic blood pressure ≥ 90 mmHg or being on hypertensive medication [CDC, 2011]. The American Heart Association recently estimated that direct and indirect costs of hypertension are more than \$93.5 billion per year [Heidenreich et al., 2011]. Many studies have documented associations between self-reported job stress, its risk factors, and CVD [Belkic et al., 2004; Kivimaki et al., 2006; Backe et al., 2012; Babu et al., 2013; Gilbert-Ouimet et al., 2013; Landsbergis et al., 2013]. While much of the previous research has focused on the job demand-control model [Karasek et al., 1998] or effort reward model [Siegrist, 1996] and

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has been limited specific work settings, we investigate whether selected psychosocial factors that are common among U.S. workers may be associated with hypertension at a population level.

Three potentially harmful workplace psychosocial factors that are common across work settings were included in the 2010 National Health Interview Survey-Occupational Health Supplement (NHIS-OHS): job insecurity, work-family imbalance, and hostile work environments. Job insecurity can be defined as “the employee’s perception of potential threat to continuity in one’s current employment” [Lee et al., 2004]. Among men in the general population, the fear or threat of unemployment has been shown to increase the likelihood of developing hypertension independent of demographic and behavioral risk factors [Levenstein et al., 2001]. Work-family imbalance, or work-family conflict, is defined as “a type of inter-role conflict that occurs as a result of incompatible role pressures from the work and family domains” [Greenhaus et al., 2006]. Work-family imbalance has been longitudinally linked to depression, poor physical health, and hypertension [Wang, 2006]. Although research on the association between hostile work environments (often measured as workplace bullying) and health is in the early stages, bullying has been associated with self-reported health status and depression [Kivimaki et al., 2003; Niedhammer et al., 2008]. To our knowledge, only one study has examined the association between bullying and hypertension, and it used hypertension as a measure of physiological activation and a moderator between bullying and adverse health outcomes [Moreno Jimenez et al., 2011].

The goal of this study was to estimate the prevalence of self-reported hypertension, and explore the associations between selected psychosocial factors (job insecurity, work-family imbalance, and hostile work environment) with hypertension among workers in a nationally representative sample of the U.S. adult population. Since some studies have suggested a relationship between hypertension and long work hours [Spurgeon et al., 1997; Iwasaki et al., 1998; Landsbergis et al., 2001; Yang et al., 2006; Wagstaff and Sigstad Lie, 2011], we also considered hours worked. Finally, we examined variation in the prevalence of hypertension among workers in different industry and occupation categories. Since, we were especially interested in exploring the potential impact of work factors on hypertension beyond any associations with common known personal (e.g., demographic, socioeconomic, and health behavioral) hypertension risk factors, we adjusted for several common known personal hypertension risk factors (e.g., age, race, body mass index [BMI], physical inactivity, smoking, and health insurance coverage) in many of our analyses. To our knowledge, this is the first study to examine these potential work-related risk factors for hypertension in a large nationally representative U.S. survey.

METHODS

National Health Interview Survey

The NHIS is a cross-sectional in-person household survey conducted continuously since 1957 by the National Center for Health Statistics (NCHS), CDC. Data are collected from the civilian non-institutionalized population of the United States, and thus exclude persons in long-term care facilities (e.g., nursing homes) or correctional facilities, active-duty Armed Forces personnel (although civilian family members are included), and U.S. nationals living in foreign countries [Pleis et al., 2010]. The survey uses a multi-stage clustered sample design, with oversampling of black, Hispanic, and Asian persons, and produces nationally representative data on various health-related topics.

Of the 17,524 sample adults in the 2010 NHIS who were employed in the past 12 months (current/recent workers) (weighted proportion = 67.7%), 30 had missing data for self-reported hypertension, leaving a study sample of 17,494 (15,627 current workers and 1,867 recent workers). The overall household response rate was 79.5%, the conditional sample adult response rate (i.e., the response rate for those sample adults identified as eligible) was 77.3%, and the final sample adult response rate (i.e., the response rate that takes into account both the conditional sample adult response rate and the household/family response rate) was 60.8%.

The NHIS questionnaire consists of a core set of questions that remain relatively unchanged from year to year, and supplemental questions that vary from year to year and ascertain additional data pertaining to current health issues of national importance. The core survey instrument has four main modules: Household, Family, Sample Child, and Sample Adult. Information from survey questions regarding self-reported hypertension, employment status, and industry and occupation of those currently employed was obtained from the Sample Adult core module. Other demographic characteristics were obtained from questions asked in the Household and Family core modules.

Information regarding the industry and occupation of most recent employment for those sample adults not currently employed but employed in the past 12 months, and information about occupational exposures (with the exception of work hours, which was obtained from the Family core module) was obtained from OHS questions specific to the 2010 survey.

Ethics Board Approval and Consent

The 2010 NHIS was approved by the Research Ethics Review Board of the National Center for Health Statistics (Protocol #2009-16) and the U.S. Office of Management and Budget (Control #0920-0214). Written consent for

participation in the 2010 NHIS was not received, but instead all 2010 NHIS respondents provided oral consent prior to participation.

Study Definitions

Hypertension

The questions used to assess the prevalence of hypertension were: (1) “Have you ever been told by a doctor or other health professional that you had hypertension, also called high blood pressure?” and (2) “Were you told on two or more different visits that you had hypertension, also called high blood pressure?” Hypertension was defined as answering “yes” to both of these questions.

Psychosocial occupational exposures

Job insecurity and work-family imbalance were measured by the following questions, which were administered to all sample adults employed in the past 12 months: “Please tell me whether you strongly agree, agree, disagree, or strongly disagree with each of these statements...I [fill: am/was] worried about becoming unemployed,” and “It [fill: is/was] easy for me to combine work with family responsibilities,” respectively. Responses of “strongly agree” and “agree” to the first statement were defined as job insecurity for this analysis, while responses of “strongly disagree” and “disagree” to the second statement were defined as work-family imbalance. Exposure to a hostile work environment was defined as answering “yes” to the question “During the past 12 months were you threatened, bullied, or harassed by anyone while you were on the job?”

Work hours

Analyses of the relationship between hypertension and long work hours were restricted to currently employed adults because only these adults were asked about work hours. Work hours were measured with the following question, which was asked of the family member answering the Family module of the NHIS, “How many hours did {person} work last week at all jobs or businesses?” (If the person was not at work during the last week [e.g., on leave], the family respondent was asked, “How many hours {does person} usually work at all jobs or businesses?”). Long work hours were defined as a person working more than 40 hr per week.

Industry and occupation

NCHS provides 21 simple industry categories, and 23 simple occupation categories. We excluded the military-specific industry and occupation (I&O) categories from our study because the NHIS is not designed to provide

representative samples of active duty military workers, so we report results for 20 industry categories and 22 occupation categories. When evaluating the association between working in different I&O categories and hypertension, we compared each I&O category to all other I&O categories.

Personal risk factors

Based on associations between hypertension and demographic, socioeconomic, and health behavioral variables described in the literature, we adjusted for the following personal risk factors in some models: age, race/ethnicity, BMI, smoking, education, health insurance coverage, and physical inactivity. BMI was classified as underweight/normal ($BMI < 25$) and overweight/obese (≥ 25). Health insurance coverage was classified as insured and uninsured. Uninsured were those who did not report having any health insurance (e.g., private plan, government plan) at the time of the interview. Physical inactivity was defined as never engaging in any moderate or vigorous leisure-time physical activity. The NHIS questions about physical activity do not provide a reference period. Each of these variables was missing for less than 1% of the study population.

Data Analyses

To account for the complex sampling design of the NHIS, analyses were completed using SAS Survey procedures, software version 9.3. To represent the U.S. civilian, non-institutionalized population age 18 years and over, and to estimate the total number of employed U.S. civilian workers represented by each individual in the sample, all estimates were weighted using the NHIS sample adult record weights.

Bivariate analyses were performed to assess the relationship between hypertension (dependent variable) and each independent demographic and health behavior categorical variable. Logistic regression analyses were performed to assess the relationship between hypertension (as the dependent variable) and each of the following independent variables: job insecurity, work-family imbalance, hostile work environment, hours worked per week, type of occupation, and industry group. Multivariate models for each of the primary independent variables were built to adjust for common personal risk factors for hypertension. Multivariate models for industry and occupation were further adjusted for workplace psychosocial factors found to be associated with hypertension. Data were further probed with regards to potential interactions between the individual work factors, including whether respondents were employed at the time of interview. Based on previous studies that found sex modified the relationship between long work hours and hypertension [Artazcoz et al., 2007, 2009, 2013] we also tested for interactions between sex and each work factor. A P -value of < 0.05 was considered statistically significant for all tests.

RESULTS

Hypertension by Demographic and Health Behavior Variables

As shown in Table I, the prevalence of hypertension was significantly higher among men (20.1%) as compared to women (18.6%), and higher among non-Hispanic black

workers (26.0%) but lower among Hispanic workers (13%) and workers of other non-Hispanic races (15.7%) compared to non-Hispanic white workers (20.1%). The prevalence of hypertension significantly increased with age, was significantly higher among overweight/obese (25.6%) compared to non-overweight workers (8.4%), and was significantly higher in individuals who had health insurance (21.1%) than among those who did not have health insurance (12.7%).

TABLE I. Sample Size, Estimated Annual Number of Cases, Weighted Prevalence (%), Prevalence Ratios (PR) and 95% Confidence Intervals (CI) of Self-Reported Hypertension* Among U.S. Adults Who Worked in the Past 12 Months, by Demographic Characteristics and Health Behaviors, NHIS, 2010

Characteristics	Unweighted sample size	Estimated annual cases (in millions)	Weighted prevalence (% SE)	PR	95% CI
Total	17,494	30.1	19.4 (0.39)		
Sex					
Male	8,481	16.3	20.1 (0.54)	1.08	1.01–1.16
Female	9,013	13.7	18.6 (0.52)	Ref.	
Age category					
18–24 years	2,038	0.6	2.6 (0.38)	Ref.	
25–34 years	4,016	2.4	7.2 (0.53)	2.76	2.00–3.80
35–44 years	3,951	5.0	14.9 (0.65)	5.72	4.22–7.77
45–54 years	3,775	9.0	25.3 (0.87)	9.73	7.27–13.01
55–64 years	2,723	9.1	38.8 (1.05)	14.90	11.13–19.96
>65 years	991	4.1	53.0 (1.79)	20.35	15.25–27.15
Race/ethnicity					
Non-Hispanic White	9,981	21.2	20.1 (0.48)	Ref.	
Non-Hispanic Black	2,593	4.3	26.0 (1.09)	1.30	1.18–1.42
Non-Hispanic other race	1,462	1.5	15.7 (1.31)	0.78	0.66–0.92
Hispanic	3,458	2.8	13.0 (0.68)	0.65	0.58–0.73
Education					
<High school	2,064	3.0	19.7 (1.14)	Ref.	
High school	4,232	8.2	21.5 (0.66)	1.09	0.96–1.24
Some college	5,567	9.9	19.9 (0.60)	1.01	0.89–1.14
≥College degree	5,585	8.9	17.4 (0.65)	0.88	0.77–1.00
Current smoker					
Yes	3,410	5.6	18.4 (0.78)	0.94	0.85–1.03
No	13,982	24.3	19.6 (0.45)	Ref.	
Physically inactive ^a					
Yes	87	0.12	16.4 (4.55)	0.85	0.49–1.46
No	17,407	30.0	19.4 (0.39)	Ref.	
Overweight/obese ^b					
Yes	11,286	25.5	25.6 (0.53)	3.06	2.74–3.41
No	6,208	4.6	8.4 (0.43)	Ref.	
Health insurance coverage					
Uninsured	3,677	3.7	12.7 (0.68)	Ref.	
Insured	13,765	26.3	21.1 (0.44)	1.66	1.49–1.86

*Hypertension defined as having been told by a healthcare provider that [respondent] had hypertension on ≥ 2 visits.

^aPhysically inactive defined as never engaging in any moderate or vigorous leisure-time physical activity.

^bOverweight/obese defined as a body mass index greater than or equal to 25.

Hypertension by Occupational Psychosocial Exposures

In the crude analysis, no association was found between hypertension and job insecurity; however, after adjusting for demographic and health behaviors, job insecurity was significantly associated with hypertension (Table II; adjusted prevalence ratio [aPR]: 1.11, 95% confidence interval [CI]: (1.04–1.19)).

The prevalence of hypertension was found to be significantly higher among workers who reported hostile work environments (22.4%) than among those who did not (19.2%; aPR: 1.15, 95% CI: 1.03–1.29). In our study no association was found between hypertension and experiencing work-family imbalance or between hypertension and work hours. When job insecurity and hostile work environment were included in the same model, along with all demographic and health behavior covariates, the associations between hypertension and job insecurity and hostile work environment were essentially unchanged (data not shown). We did not find any evidence of interactions between long work hours and job insecurity nor between long work hours and hostile work environment. We also did not find evidence for interactions between sex or employment status (current

worker vs. recent worker) and any of the main predictor variables (job insecurity, hostile work environment, occupation, industry).

Hypertension and Occupation Category

Legal occupations were the occupation category with the lowest prevalence of hypertension, and this was the only occupation category with a significantly reduced adjusted hypertension risk (aPR: 0.57; 95% CI: 0.37–0.88; Table III). The only occupation category with a significantly increased adjusted hypertension risk was Healthcare support occupations (aPR: 1.27; 95% CI: 1.06–1.53).

Hypertension and Industry Category

Professional, scientific, and technical services industries was the only industry category with a significantly reduced adjusted hypertension risk (aPR: 0.83; 95% CI: 0.70–0.97; Table IV). Public administration was the industry category with the highest prevalence of hypertension and was the only industry category with a significantly increased adjusted hypertension risk (aPR: 1.18; 95% CI: 1.04–1.34).

TABLE II. Sample Size, Estimated Number of Annual Cases, Weighted Prevalence (%), Prevalence Ratios (PRs) and 95% Confidence Intervals (CI) of Self-Reported Hypertension* Among U.S. Adults Who Worked in the Past 12 Months by Work Factors, NHIS, 2010

Characteristics	Unweighted sample size	Estimated annual cases (in millions)	Weighted prevalence (% SE)	Crude PR	95% CI	Adjusted PR ^a	95% CI
Hours worked per week ^b							
11–20	1,238	2.1	18.2 (1.19)	0.94	0.81–1.10	0.97	0.84–1.12
21–39	3,033	4.8	18.2 (0.86)	0.96	0.86–1.08	1.02	0.92–1.13
40	6,602	10.9	19.0 (0.65)	Ref.		Ref.	
41–48	1,300	2.4	20.4 (1.52)	1.07	0.92–1.26	1.08	0.93–1.24
48+	2,775	4.9	19.5 (0.86)	1.02	0.92–1.14	0.98	0.89–1.09
Job insecurity ^c							
Yes	6,073	10.3	20.4 (0.64)	1.07	0.99–1.16	1.11	1.04–1.19
No	11,340	19.6	19.0 (0.49)	Ref.		Ref.	
Hostile work environment ^d							
Yes	1,419	2.7	22.4 (1.30)	1.17	1.04–1.32	1.15	1.03–1.29
No	16,021	27.3	19.2 (0.40)	Ref.		Ref.	
Work-family imbalance ^e							
Yes	14,462	25.2	19.6 (0.43)	1.04	0.94–1.13	0.96	0.88–1.05
No	2,935	4.8	18.9 (0.81)	Ref.		Ref.	

*Hypertension defined as having been told by a healthcare provider that [respondent] had hypertension on ≥ 2 visits.

^aAdjusted for age, sex, race, body mass index (BMI), physical inactivity, smoking, and health insurance coverage.

^bWork hours were only asked for current workers.

^cJob Insecurity was defined as agreeing or strongly agreeing with the following statement: "I [am/was] worried about becoming unemployed."

^dHostile Work Environment—was defined as answering yes to the following question: "DURING THE PAST 12 MONTHS were you threatened, bullied, or harassed by anyone while you were on the job?"

^eWork-family imbalance was defined as agreeing or strongly disagreeing with the following statement: "It [fill: is/was] easy for me to combine work with family responsibilities."

TABLE III. Sample Size, Estimated Annual Cases, Weighted Prevalence (%), Prevalence Ratios (PRs) and 95% Confidence Intervals (CI) of Self-Reported Hypertension* Among U.S. Adults Who Worked in the Past 12 Months by Occupational Category, NHIS, 2010

Occupational category [‡]	Unweighted sample size	Estimated annual cases (in millions)	Weighted prevalence (%; SE)	Unadjusted PR (95% CI)	aPR ^a (95% CI)
White collar					
Management	1,497	3.0	20.1 (1.31)	1.09 (0.96–1.24)	0.91 (0.81–1.02)
Business and financial operations	821	1.4	20.3 (1.60)	1.05 (0.89–1.23)	1.04 (0.88–1.22)
Computer and mathematical	471	0.6	14.7 (2.10)	0.75 (0.56–1.00)	0.91 (0.71–1.16)
Architecture and engineering	305	0.7	24.0 (3.23)	1.24 (0.95–1.62)	1.22 (0.96–1.56)
Life, physical and social science	180	0.2	14.7 (2.73)	0.76 (0.52–1.09)	0.89 (0.64–1.24)
Legal	194	0.2	10.1 (2.31)	0.52 (0.33–0.81)	0.57 (0.37–0.88)
Education, training and library	1,123	2.0	19.6 (1.52)	1.01 (0.87–1.18)	1.14 (1.00–1.30)
Art, Design, Entertainment, sports, and media	379	0.4	12.8 (1.84)	0.66 (0.50–0.87)	0.78 (0.60–1.01)
Healthcare practitioners and technical	855	1.4	19.1 (1.46)	0.99 (0.84–1.15)	1.06 (0.92–1.21)
Sales and related	1,740	2.9	18.1 (1.15)	0.92 (0.81–1.06)	1.02 (0.90–1.15)
Office and administrative support	2,396	4.3	21.1 (0.93)	1.10 (1.00–1.21)	0.98 (0.90–1.08)
Service					
Community and social service	333	0.6	21.6 (2.74)	1.12 (0.87–1.44)	1.09 (0.88–1.35)
Healthcare support	485	0.9	23.1 (2.24)	1.19 (0.99–1.44)	1.27 (1.06–1.53)
Protective service	358	0.7	24.3 (2.89)	1.26 (1.00–1.60)	1.08 (0.86–1.35)
Food preparation and serving related	994	1.1	12.8 (1.13)	0.65 (0.54–0.77)	1.08 (0.93–1.25)
Building and ground cleaning and maintenance	765	1.1	17.8 (1.76)	0.92 (0.75–1.11)	0.93 (0.76–1.13)
Personal care and service	671	1.0	17.5 (1.84)	0.90 (0.73–1.11)	0.90 (0.75–1.10)
Farm					
Farming, fishing and forestry	135	0.2	17.7 (4.14)	0.91 (0.57–1.45)	1.10 (0.73–1.66)
Blue collar					
Construction and extraction	904	1.6	18.3 (1.69)	0.94 (0.78–1.13)	0.91 (0.77–1.08)
Installation, maintenance and repair	560	1.2	23.3 (2.09)	1.21 (1.01–1.45)	1.09 (0.93–1.29)
Production	1,051	1.9	21.4 (1.51)	1.11 (0.96–1.28)	0.96 (0.84–1.09)
Transportation and material moving	977	2.0	22.5 (1.56)	1.17 (1.02–1.34)	1.02 (0.89–1.17)

[‡]For each occupation category's odds ratio, all other occupations combined was taken as reference.

*Hypertension defined as having been told by a healthcare provider that [respondent] had hypertension on ≥ 2 visits.

^aAdjusted for age, sex, race, body mass index (BMI), physical inactivity, smoking, health insurance, job insecurity and hostile work environment.

Healthcare and social assistance also had a significantly elevated adjusted hypertension risk, but only when BMI was excluded from the model (aPR: 1.12; 95% CI: 1.01, 1.24).

DISCUSSION

This study was designed to broadly investigate how general workplace psychosocial factors that have recently been measured at a national level might contribute to variations in the prevalence of hypertension among U.S. workers. We found self-reported hypertension to be significantly associated with job insecurity and hostile work environment, but not with long work hours or work-family imbalance. After adjusting for job insecurity, hostile work environment, demographics and health behavior variables, few industry and occupation categories were

significantly associated with hypertension risk when compared to all other industries or occupations combined. Healthcare support occupations and the Public administration industry were the only I&O categories associated with an increased hypertension risk. Legal occupations and Professional, scientific, and technical services industries were the only I&O categories associated with a reduced hypertension risk.

Hypertension and Occupational Psychosocial Exposures

Although overall work stress was not directly measured in the 2010 NHIS-OHS, we found that two specific occupational psychosocial exposures were associated with hypertension. Our finding that self-reported (perceived) job

TABLE IV. Sample Size, Estimated Number of Annual Cases, Weighted Prevalence (%), Prevalence Ratios (PRs) and 95% Confidence Intervals (CI) of Self-Reported Hypertension* Among U.S. Adults Who Worked in the Past 12 Months by Industry Category, NHIS, 2010

Industry category ^a	Unweighted sample size	Estimated annual cases (in millions)	Weighted prevalence (% SE)	Unadjusted PR (95% CI)	aPR ^b (95% CI)
Office-based					
Wholesale trade	396	0.9	22.1 (2.5)	1.14 (0.91–1.43)	1.03 (0.84–1.28)
Retail trade	1,794	2.9	17.0 (1.03)	0.86 (0.76–0.98)	0.96 (0.85–1.08)
Information	449	0.8	19.7 (2.3)	1.01 (0.80–1.28)	1.03 (0.83–1.27)
Finance and insurance	728	1.1	17.7 (1.53)	0.91 (0.76–1.08)	0.94 (0.80–1.09)
Real estate and rental and leasing	344	0.6	20.2 (2.75)	1.04 (0.79–1.37)	0.92 (0.71–1.21)
Professional, Scientific, and technical services	1,152	1.6	15.2 (1.35)	0.77 (0.65–0.92)	0.83 (0.70–0.97)
Management of companies and enterprise ^c	10	—	—	—	—
Public administration	932	2.2	27.5 (1.88)	1.43 (1.24–1.64)	1.18 (1.04–1.34)
Non-office-based					
Agriculture, Forestry, fishing and hunting	269	0.5	21.4 (3.2)	1.10 (0.82–1.49)	0.99 (0.75–1.30)
Mining	75	0.2	21.8 (7.66)	1.12 (0.56–2.24)	1.12 (0.58–2.19)
Utilities	140	0.3	23.5 (3.9)	1.21 (0.88–1.68)	1.07 (0.79–1.46)
Construction	1,113	2.1	20.1 (1.4)	1.04 (0.89–1.20)	0.98 (0.86–1.12)
Manufacturing	1,587	3.1	21.4 (1.20)	1.11 (0.99–1.24)	0.93 (0.83–1.04)
Transportation and warehousing	714	1.5	24.9 (2.01)	1.29 (1.10–1.52)	1.06 (0.91–1.23)
Other					
Administrative and support and waste management and remediation services	847	1.4	20.5 (1.64)	1.06 (0.90–1.24)	1.09 (0.94–1.27)
Education Services	1,692	3.1	20.3 (1.13)	1.05 (0.94–1.17)	1.07 (0.96–1.18)
Healthcare and social assistance	2,442	4.3	21.1 (1.0)	1.10 (1.00–1.22)	1.10 (0.99–1.21) ^d
Arts, Entertainment and recreation	384	0.5	14.5 (2.06)	0.74 (0.56–0.98)	0.79 (0.61–1.02) ^e
Accommodation and food services	1,219	1.1	10.5 (0.91)	0.52 (0.44–0.62)	0.93 (0.80–1.07)
Other services (except public administration)	915	1.5	19.5 (1.56)	1.00 (0.85–1.18)	0.99 (0.85–1.15)

^yFor each industry category's odds ratio, all other industries combined was taken as reference.

*Hypertension defined as having been told by a healthcare provider that [respondent] had hypertension on ≥ 2 visits.

^aSimple Industry categories based on NAICS sectors.

^bThe aPR for this industry category was significantly elevated when BMI was not included in the model (aPR: 1.12; 95% CI: 1.01, 1.24).

^cThe sample size was too small to generate stable estimates for this industry category.

^dAdjusted for age, sex, race, body mass index (BMI), physical inactivity, smoking, job insecurity, hostile work environment and health insurance coverage.

^eThe aPR for this industry category was significantly low when BMI was not included in the model (aPR: 0.73; 95% CI: 0.56, 0.95).

Bold entities indicate significant results.

insecurity was significantly associated with hypertension among U.S. workers was consistent with other studies that reported job insecurity as a possible predictor for hypertension [Landsbergis et al., 2001; Kalil et al., 2010]. A number of studies have shown that job insecurity is associated with feelings of lack of control over one's situation, and anticipation of economic and family strain caused by future unemployment which can lead to psychological strain that adversely affects health and well-being [Karasek et al., 1998; Witte, 1999; Sverke et al., 2002]. Physical health effects could emerge from the biological dysregulation associated with release of stress hormones that affect body functions, particularly the immune system [Cohen et al., 2006]. The perception of job insecurity may be particularly harmful during periods of recession when the labor market is weak

and job opportunities are limited. According to a survey conducted during 2008 through 2010, workers consistently overestimated their probability of losing their job in the upcoming years, suggesting that job insecurity was a notable issue during the recent recession [Hurd and Rohwedder, 2010].

After controlling for personal risk factors, exposure to a hostile work environment was also found to be significantly associated with hypertension. Our results were consistent with a few other studies that have reported an association between hostile work environment and hypertension [Mays, 1995; Mays et al., 1996]. We found no association between hypertension and work-family imbalance. Although little research has been done on the association between hypertension and work-family imbalance, our results were

consistent with a study conducted by Thomas and Ganster that reported that work-family conflict is unrelated to hypertension [Thomas and Ganster, 1995]. There are a few studies that have found that work-family imbalance affects health, and to some extent hypertension, especially in women [Xu et al., 2004; Sperlich et al., 2012]. Use of a single question for measuring the work-family imbalance rather than a validated scale for measurement of work-family imbalance may be the reason for not finding an association in the present study.

Hypertension and Work Hours

Most previous studies of long work hours have been restricted to specific occupation groups such as medical interns and physicians [Wagstaff and Sigstad Lie, 2011] nurses [Trinkoff et al., 2011] police officers [Vila, 2006] and construction workers [Dong, 2005]. Very few researchers have investigated large national population databases with regard to long work hours [Grosch et al., 2006; Lee et al., 2007]. In our study using national survey data we found no significant association between working long hours and hypertension. This is not particularly surprising, given the inconsistent results of previous studies [Nakanishi et al., 2001; Park et al., 2001; Yang et al., 2006]. Two small studies conducted by Artazcoz et al., suggested that sex modifies the effect of long work hours on hypertension [Artazcoz et al., 2007, 2009]. We tested for an interaction between sex and work hours in the NHIS-OHS dataset, but did not find any significant effect modification (data not shown). One reason for the contradictory results could be that the Artazcoz studies only included individuals from Catalonia, a region in the north-east of Spain that has about 7 million inhabitants, which may be very different than the U.S. In addition, in the 2009 paper, the prevalence of hypertension was very low (12% in men and 8.6% in women), and the prevalence was even lower in the 2007 paper (9% in men and 5% in women). Also, the findings between long work hours and hypertension were not consistent between the two Artazcoz papers. In the 2007 paper (that used data from 2002), a significant association between hypertension and work hours was found only for women, but not men. In contrast, in the 2009 paper (that used 2006 data), a significant association between hypertension and work hours was found only for men, but not for women.

Hypertension and Occupation

After controlling for personal risk factors, we observed that Healthcare support workers had significantly higher odds of hypertension than all other occupations combined. On the other hand, Healthcare practitioners, and technicians had a relatively low prevalence of hypertension. Similar results

have been reported from other countries such as Mexico, Brazil, and Singapore [Mion et al., 2004; Leong and Chia, 2012]. Differences in the prevalence of hypertension by occupation, even after controlling for the occupational psychosocial exposures found to be associated with hypertension in the present study (job insecurity and hostile work environment), suggest that there may be additional job characteristics contributing to this health disparity that were not measured in this study. For example, some differences might be explained by the theory of occupational racial segregation [Tak et al., 2010]. According to this theory, occupations with a higher proportion of African Americans (>20%), such as Healthcare support, have higher rates of adverse outcomes among all workers, both White and African Americans [Chung-Bridges et al., 2008]. Another contributor to the higher odds of hypertension among Healthcare support workers could be shift work. Previous studies have documented that shift workers have higher rates of hypertension [Chau et al., 1989; Morikawa et al., 1999; Di Milia et al., 2013].

Hypertension and Industry

Public administration had a significantly elevated prevalence of hypertension compared to all other industries combined. A high proportion of Public administration workers are police and firefighters. Studies of firefighters and police have reported strong and independent associations between hypertension and adverse health outcomes such as incident CHD, stroke, disability retirements due to heart disease, nonfatal myocardial infarction and on duty fatalities [Glueck et al., 1996; Pyorala et al., 1998; Geibe et al., 2008; Kales et al., 2009]. The physical and psychological stresses of firefighting, law enforcement, and emergency medical services are thought to place these workers at higher risk of elevated blood pressure [Kales et al., 2009]. A study conducted by Geibe showed that among on-duty CHD fatalities in firefighters, left ventricular hypertrophy or cardiomegaly was found in 56% of those who had undergone an autopsy, suggesting chronically uncontrolled hypertension [Geibe et al., 2008]. Healthcare and social assistance also had a significantly elevated adjusted hypertension risk, but only when BMI was excluded from the model. This same category previously was found to have a significantly increased obesity prevalence compared to all other industry groups [Luckhaupt et al., 2014]. Hypertension and obesity share a similar set of risk factors, and these risk factors may be influencing both conditions among Healthcare and social assistance workers. Because this industry category includes Healthcare support workers, it corroborates the findings for this occupational category. Some other industry groups had relatively high, but not statistically significant, odds of hypertension, which may partially be due to small sample

sizes within some of the categories. On the other hand, many of the industry categories used were broad and workers within each category might experience a range of working conditions. For instance, the Transportation and warehousing category not only includes motor vehicle operators and material handlers, but also accountants, administrators, etc.

Strengths and Limitations

This study has several limitations, which fall into three categories. First, there are limitations that apply to the NHIS as a whole. As the study design is cross-sectional, we cannot infer causality of the relationship between potentially hazardous workplace psychosocial exposures and hypertension. Also, the sample adult response rate for the 2010 NHIS was relatively low at 60%. Selection bias could have occurred if, for example, individuals working long work hours were less likely to participate in the survey compared to those who do not work as many hours.

Second, there are limitations associated with how work organization and workplace psychosocial factors were measured. Single questions were used to measure complex psychosocial constructs such as exposure to a hostile work environment and job insecurity because more detailed information on these factors was beyond the scope of the NHIS [Alterman et al., 2013]. As part of the family questionnaire, the information about a sample adult's work hours was provided by the family representative who may have been a different person than the sample adult from the family, which may reduce the accuracy of this exposure.

Third, there are limitations related to the measurement of hypertension. The prevalence of hypertension was based on self-report of a healthcare provider diagnosis, leading to a potential for under-reporting. However, self-reported hypertension is a common form of assessment in large surveys. A study conducted by Okura et al., [2004] found that there is substantial agreement between self-reported hypertension and medical record data on hypertension. On the other hand, some cases of hypertension may go undiagnosed due to the lack of health insurance and being unable to afford medical care, lack of awareness, or a dislike of healthcare visits. Furthermore, the definition of hypertension is arbitrary because the prevalence of vascular disease steadily increases across blood pressure values above the optimal level of 115/75 mmHg [Miura et al., 2001]. Unfortunately, because the NHIS does not capture information on blood pressures in the pre-hypertensive range, we are unable to assess the predictors of having blood pressures in this range.

Despite these limitations, this study has a number of strengths. First, the data come from a large nationally representative sample that includes U.S. workers from all major industries and occupations. Second, the inclusion of occupational health questions in the 2010 NHIS provided an

opportunity to collect information on workplace exposures that are rarely included in national health surveys.

CONCLUSION

Using a large nationally representative survey, we found evidence for associations between job insecurity and hostile work environments and self-reported hypertension among adults who had worked in the past 12 months. We also found that a few industry and occupation categories were significantly associated with hypertension risk after adjustment for these occupational psychosocial factors and personal risk factors. Public health professionals and employers should consider workplace interventions aimed at reducing hypertension that take organization-level factors, such as prevention of workplace hostility, into account along with individual-level health behaviors such as diet and exercise. This could be done as part of the Total Worker Health™ approach advocated by NIOSH, which involves integration of occupational safety and health protection with health promotion to prevent worker injury and illness and to advance health and well-being (see <http://www.cdc.gov/niosh/TWH/>). More in-depth studies are needed to further examine the mechanisms by which each of these factors may contribute to hypertension at the individual worker level.

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