

# Prevalence of Obesity Among U.S. Workers and Associations with Occupational Factors

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**Background:** Along with public health and clinical professionals, employers are taking note of rising obesity rates among their employees, as obesity is strongly related to chronic health problems and concomitant increased healthcare costs. Contributors to the obesity epidemic are complex and numerous, and may include several work characteristics.

**Purpose:** To explore associations between occupational factors and obesity among U.S. workers.

**Methods:** Data from the 2010 National Health Interview Survey were utilized to calculate weighted prevalence rates and prevalence ratios (PRs) for obesity in relation to workweek length, work schedule, work arrangement, hostile work environment, job insecurity, work–family imbalance, and industry and occupation of employment. Data were collected in 2010 and analyzed in 2012–2013.

**Results:** Overall, 27.7% of U.S. workers met the BMI criterion for obesity. Among all workers, employment for more than 40 hours per week and exposure to a hostile work environment were significantly associated with an increased prevalence of obesity, although the differences were modest. Employment in health care and social assistance and public administration industries, as well as architecture and engineering, community and social service, protective service, and office and administrative support occupations was also associated with increased obesity prevalence.

**Conclusions:** Work-related factors may contribute to the high prevalence of obesity in the U.S. working population. Public health professionals and employers should consider workplace interventions that target organization-level factors, such as scheduling and prevention of workplace hostility, along with individual-level factors such as diet and exercise.

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## Introduction

The CDC recognizes obesity as a national epidemic.<sup>1,2</sup> At the same time, the CDC has identified obesity, along with nutrition and physical activity, as a “winnable battle” because measurable progress can be quickly made by developing policy, systems, and environmental initiatives that help make healthy choices available, affordable, and easy (<http://www.cdc.gov/WinnableBattles/Obesity/index.html>). Along with public health and clinical professionals, employers are taking note of rising obesity rates among their employees, as obesity is

strongly related to chronic health problems and concomitant increased healthcare costs.<sup>3</sup>

Contributors to the obesity epidemic are complex and numerous, and may include several work characteristics.<sup>4–6</sup> These range from work organization factors such as long workweeks<sup>6,7</sup> and shiftwork<sup>8–12</sup> to psychosocial factors such as job stress.<sup>6,13</sup> All of these factors may contribute to obesity, at least partially, by influencing health behaviors. For example, total caloric intake and unhealthy eating behaviors are positively associated with stress,<sup>14–17</sup> and long workweeks may decrease the opportunity for physical activity.<sup>18</sup> On the other hand, shift work may also increase the risk of obesity through physiologic maladaptation,<sup>19</sup> and chronic stress from any of these work factors may contribute directly to obesity by promoting deposition of intra-abdominal fat.<sup>20</sup> These factors may help explain why the prevalence of obesity has been shown to vary considerably across U.S. occupational groups.<sup>21</sup>

Job stress can be defined as the harmful physical and emotional responses that occur when job requirements

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do not match the capabilities, resources, or needs of the worker.<sup>22</sup> Much of the previous research regarding job stress and obesity has focused on the demand-control model<sup>6,23–25</sup> or effort–reward imbalance model,<sup>6,26–28</sup> with mixed results.<sup>4,6</sup> Specific individual work-related psychosocial stressors recently linked to physiological and psychological stress responses and poor health behaviors include a hostile work environment (i.e., exposure to threats, bullying, or harassment on the job),<sup>29,30</sup> job insecurity,<sup>6,31–33</sup> and work–family imbalance<sup>34</sup>; however, associations between these stressors and obesity have not been well described.

In 2010, the National Institute for Occupational Safety and Health (NIOSH) sponsored an Occupational Health Supplement to the National Health Interview Survey (NHIS-OHS) to collect nationally representative data on working conditions, potentially hazardous exposures, and work-related health outcomes among U.S. workers. The present study utilized the NHIS-OHS data regarding work organization characteristics (workweek length, work shift, and work arrangement)<sup>35</sup> and work-related psychosocial stressors (hostile work environment, job insecurity, and work–family imbalance)<sup>36</sup> to investigate whether these factors represent stressful work conditions that may be associated with obesity among a large, nationally representative sample that includes U.S. workers from all industry and occupation (I and O) categories. The findings may help explain differences in the prevalence of obesity by I and O.

## Methods

### Study Sample

The National Center for Health Statistics (NCHS) within the CDC has conducted the NHIS, a cross-sectional in-person household survey used to monitor the health of the nation, since 1957.<sup>37</sup> With the exclusion of individuals in long-term care facilities, correctional facilities, active-duty Armed Forces personnel, and U.S. nationals within foreign countries, the data are considered to be representative of the U.S. population. The survey employs a multistage clustered sample design with oversampling of Blacks, Hispanics, and Asians.

Each year the NHIS includes (1) a core set of questions that change little from year to year and (2) supplemental questions varying from year to year that are concerned with nationally important, timely health issues. Supplements to the 2010 NHIS included sample adult occupational health questions and a sample adult cancer control questionnaire. The data presented in this paper are based on 57.6% of 27,157 sample adults who were employed during the week preceding their interviews (i.e., current workers). The sample adult response rate was 60.8%.

The Research Ethics Review Board of the NCHS (Protocol #2009-16) and the U.S. Office of Management and Budget (Control #0920-0214) both approved the 2010 NHIS. In lieu of written consent, 2010 NHIS respondents provided oral consent before participating.

## Measures

**Obesity.** The main outcome for this study, obesity, was defined as a BMI of  $\geq 30$ , based on self-reported weight and height values.

**Industry and occupation.** Information about sample adults' current industry (employer's type of business) and occupation (employee's type of work) of employment was collected in narrative form. To these data, coding experts assigned four-digit Census I and O codes based on the 2007 North American Industrial Classification System (NAICS) and the 2010 Standard Occupational Classification (SOC) system. These codes were then collapsed into 20 industry groups that approximate NAICS sectors and 22 occupation groups that approximate SOC major groups to allow for more-reliable estimates.

**Work organization characteristics.** With the exception of work hours, which are collected as part of the core Family Module, data regarding work organization characteristics and work-related psychosocial stressors came from the OHS. Long work hours were defined as having worked more than 40 hours in the past week, and part-time work was defined as working less than 35 hours.

**Work-related psychosocial stressors.** 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?* Job insecurity and work–family imbalance were measured by asking the participant whether they strongly agreed, agreed, disagreed, or strongly disagreed with a particular statement regarding their current job. No specific time frame was specified. Job insecurity was assessed with the statement "I am worried about becoming unemployed." Responses of "strongly agree" and "agree" were defined as job insecurity. Work–family imbalance was assessed with the statement "It is easy for me to combine work with family responsibilities." Responses of "strongly disagree" and "disagree" were defined as work–family imbalance.

**Potential confounders.** Because the following demographic variables may be related to obesity and the exposure variables, they were treated as potential confounders: gender, age, race/ethnicity, and education. Race/ethnicity was stratified as non-Hispanic white, non-Hispanic black, non-Hispanic Asian, non-Hispanic other, or Hispanic.

Some models also included the following health behaviors, which have been shown to be associated with obesity and vary by employment characteristics (e.g., I and O): smoking, exercise, and fruit and vegetable consumption. Exercise was dichotomized as meeting vs. not meeting CDC recommendations for aerobic activity for adults (150 minutes of moderate-intensity aerobic activity or 75 minutes of vigorous-intensity aerobic activity per week or some combination of the two; <http://www.cdc.gov/physicalactivity/everyone/guidelines/adults.html>), based on the reported frequency of leisure-time light/moderate and vigorous activity per week multiplied by the duration of each level of exercise. Daily fruit and vegetable consumption was used as a surrogate for healthy eating behavior, based on the Dietary Guidelines for Americans recommendation that eating more of these foods instead of higher-calorie foods can help adults and

**Table 1.** Prevalence of obesity and mean BMI among U.S. workers by demographic characteristics and health behaviors, 2010

Characteristic	Unweighted sample size	Estimated population (in millions)	Weighted mean BMI (95% CI)	Unweighted obesity cases	Weighted prevalence (% SE)	PR (95% CI)
<b>BY DEMOGRAPHIC CHARACTERISTICS</b>						
<b>Gender</b>						
Male	7,529	72.2	28.0 (27.8, 28.1)	2023	28.2 (0.6)	1.05 (0.98, 1.11)
Female	7,592	62.3	27.2 (27.0, 27.4)	2132	27.0 (0.6)	ref
<b>Age group (years)</b>						
18–29	3,346	32.4	26.1 (25.9, 26.4)	654	19.7 (0.8)	ref
30–44	5,306	44.6	28.0 (27.8, 28.2)	1536	29.7 (0.7)	1.50 (1.37, 1.65)
45–64	5,700	51.6	28.2 (28.0, 28.4)	1766	31.2 (0.7)	1.58 (1.45, 1.73)
≥ 65	769	5.9	27.7 (27.3, 28.0)	199	25.3 (1.8)	1.28 (1.09, 1.51)
<b>Race/ethnicity</b>						
White, non-Hispanic	8,688	92.4	27.4 (27.3, 27.5)	2254	26.5 (0.5)	ref
Black, non-Hispanic	2,182	14.2	29.2 (28.9, 29.6)	834	37.7 (1.4)	1.42 (1.31, 1.55)
Asian, non-Hispanic	1,001	6.6	24.7 (24.4, 25.1)	97	11.0 (1.2)	0.41 (0.33, 0.52)
Other, non-Hispanic	292	2.3	29.0 (28.1, 30.0)	98	38.8 (3.3)	1.47 (1.24, 1.74)
Hispanic	2,958	19.0	28.3 (28.1, 28.5)	872	30.5 (1.0)	1.15 (1.07, 1.24)
<b>Education</b>						
Less than high school diploma	1,515	10.8	28.4 (28.0, 28.8)	460	30.6 (1.5)	1.37 (1.21, 1.55)
High school or GED diploma	3,213	28.4	28.5 (28.3, 28.8)	1050	33.8 (1.0)	1.51 (1.38, 1.66)
Some college	4,004	34.4	28.6 (28.4, 28.8)	1318	33.1 (0.9)	1.48 (1.36, 1.62)
College degree	4,749	43.3	26.9 (26.7, 27.1)	1035	22.3 (0.8)	ref
<b>BY HEALTH BEHAVIORS</b>						
<b>Smoking status</b>						
Current smoker	2,903	25.9	27.2 (27.0, 27.5)	724	25.3 (1.0)	0.94 (0.86, 1.03)

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**Table 1.** Prevalence of obesity and mean BMI among U.S. workers by demographic characteristics and health behaviors, 2010 (continued)

Characteristic	Unweighted sample size	Estimated population (in millions)	Weighted mean BMI (95% CI)	Unweighted obesity cases	Weighted prevalence (% SE)	PR (95% CI)
Former smoker	2,812	26.1	28.3 (28.0, 28.5)	891	32.1 (1.0)	1.19 (1.11, 1.28)
Never smoked	9,390	82.4	27.5 (27.4, 27.7)	2533	27.0 (0.6)	ref
<b>Exercise</b>						
< recommended amount	7,432	63.5	28.3 (28.1, 28.4)	2395	32.7 (0.7)	1.42 (1.33, 1.52)
≥ recommended amount	7,406	68.3	27.0 (26.9, 27.2)	1686	23.0 (0.6)	ref
<b>Fruit and vegetable consumption, daily</b>						
< 5 servings	13,856	123.4	27.7 (27.5, 27.8)	3851	28.0 (0.5)	1.45 (1.21, 1.73)
≥ 5 servings	508	4.4	26.3 (25.9, 26.8)	109	19.3 (1.7)	ref

PR, prevalence ratio

children achieve and maintain a healthy weight (<http://www.health.gov/dietaryguidelines/Default.asp>). Data on daily fruit and vegetable consumption were derived from estimates of average intake based on the frequency of eating certain types of food during the month preceding the interview. Subjects were stratified based on whether their average daily consumption of fruits and vegetables was five or more servings.

## Data Analysis

Data were analyzed by survey procedures in SAS 9.3 and by SUDAAN 11 to account for the complex sample survey design. To represent the U.S. civilian, non-institutionalized population aged ≥ 18 years, all prevalence estimates were weighted using the NHIS individual sample adult record weights. Point estimates with relative SE > 30% are noted by dashes. Proportions of obese workers stratified by various work organization factors, psychosocial factors, and I and O categories were compared to reference categories by *t*-test. Statistical significance was defined as  $p \leq 0.05$ . For each industry (and occupation), the reference value was set as the prevalence among all other industry (or occupation) groups. For work organization and psychosocial factors, three different models were utilized to calculate prevalence ratios (PRs) with logistic regression: an unadjusted model; one adjusted for demographic variables (Model 1); and another adjusted for demographic variables and health behaviors (Model 2). For I and O, the following three models are presented: an unadjusted model; one adjusted for demographic variables and health behaviors (Model 2); and another model adjusted for all factors included in Model 2 plus work organization/psychosocial factors significantly associated with obesity in bivariate analyses (Model 3). Data were collected in 2010 and analyzed in 2012–2013.

Data were further probed for potential interactions that would help better explore the associations between work-related factors and obesity, and whether work-related factors modify relationships between health behaviors and obesity. Specifically, we tested for two-way interactions between each of the work organization and workplace psychosocial factors significantly associated with obesity and I and O. On the basis of associations found in previous studies, we also tested for interactions between work hours and gender and between work hours and physical activity level.

## Results

### Prevalence of Obesity by Demographic Characteristics and Health Behaviors

Data were available for 15,121 working adults representing approximately 135 million people. The overall prevalence of obesity among workers was 27.7%. Workers aged 18–29 years, non-Hispanic Asians, and workers with college degrees had the lowest prevalence of obesity in their respective categories (Table 1).

Former smokers had a higher prevalence of obesity compared to current smokers and those who never smoked. As expected, a lower obesity prevalence was found among respondents meeting national physical activity guidelines or consuming fruits and vegetables more than five times daily (Table 1).

**Table 2.** Prevalence of obesity and mean BMI among U.S. workers by job characteristics, 2010

Job characteristic	Unweighted sample size	Estimated population (in millions)	Weighted mean BMI (95% CI)	Estimated number of obese workers (in millions)	Weighted prevalence (% SE)	Unadjusted PR (95% CI)	Model 1: PR (95% CI) <sup>a</sup>	Model 2: PR (95% CI) <sup>b</sup>
<b>Weekly work hours</b>								
<35	3,517	31.7	27.0 (26.8, 27.2)	7.9	24.9 (0.9)	<b>0.90 (0.83, 0.97)</b>	0.96 (0.89, 1.05)	0.97 (0.89, 1.06)
35–40	7,405	64.2	27.7 (27.5, 27.8)	17.8	27.7 (0.6)	ref	ref	ref
> 40	3,924	36.0	28.0 (27.8, 28.3)	10.8	30.0 (0.9)	<b>1.09 (1.01, 1.17)</b>	1.08 (1.00, 1.16)	<b>1.08 (1.01, 1.17)</b>
<b>Work schedule</b>								
Day	10,931	96.9	27.7 (27.6, 27.8)	27.1	27.9 (0.5)	ref	ref	ref
Other	4,170	37.4	27.4 (27.2, 27.7)	10.1	27.1 (0.8)	0.97 (0.90, 1.04)	0.99 (0.92, 1.06)	0.99 (0.92, 1.07)
<b>Work schedule</b>								
Day	10,931	96.9	27.7 (27.6, 27.8)	27.1	27.9 (0.5)	ref	ref	ref
Evening shift	776	7.0	26.9 (26.4, 27.5)	1.8	26.2 (2.0)	0.94 (0.80, 1.10)	0.99 (0.85, 1.15)	1.01 (0.87, 1.18)
Night shift	564	4.8	28.0 (27.4, 28.6)	1.4	29.4 (2.2)	1.05 (0.90, 1.23)	1.09 (0.93, 1.27)	1.10 (0.94, 1.29)
Rotating shift	1,425	12.8	27.8 (27.4, 28.2)	3.7	29.2 (1.5)	1.05 (0.94, 1.16)	1.06 (0.94, 1.20)	1.07 (0.94, 1.20)
Other	1,405	12.7	27.1 (26.8, 27.5)	3.1	24.7 (1.3)	0.88 (0.79, 0.99)	0.89 (0.80, 1.00)	0.89 (0.79, 0.99)
<b>Work arrangement</b>								
Independent	1,531	13.0	27.1 (26.8, 27.5)	3.3	25.5 (1.4)	0.92 (0.82, 1.02)	0.88 (0.79, 0.97)	0.90 (0.81, 1.01)
On-call	371	3.3	27.2 (26.6, 27.8)	0.9	26.1 (2.7)	0.94 (0.76, 1.16)	0.89 (0.71, 1.11)	0.89 (0.70, 1.13)
Temporary agency	142	1.1	28.6 (27.3, 29.9)	0.4	36.7 (4.8)	1.32 (1.02, 1.71)	1.10 (0.79, 1.54)	1.11 (0.79, 1.55)
Contracting company	249	2.1	28.1 (27.2, 29.0)	0.7	31.9 (3.8)	1.15 (0.91, 1.45)	1.14 (0.90, 1.46)	1.09 (0.86, 1.38)
Regular/permanent	12,297	110.1	27.7 (27.5, 27.8)	30.7	27.8 (0.5)	ref	ref	ref
Other	507	4.6	27.5 (26.9, 28.1)	1.3	27.4 (2.4)	0.99 (0.82, 1.18)	0.97 (0.81, 1.16)	0.92 (0.77, 1.11)

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Table 2. Prevalence of obesity and mean BMI among U.S. workers by job characteristics, 2010 (continued)

Job characteristic	Unweighted sample size	Estimated population (in millions)	Weighted mean BMI (95% CI)	Estimated number of obese workers (in millions)	Weighted prevalence (% SE)	Unadjusted PR (95% CI)	Model 1: PR (95% CI) <sup>a</sup>	Model 2: PR (95% CI) <sup>b</sup>
<b>Hostile work environment</b>								
Yes	1,144	9.9	28.3 (27.8, 28.7)	3.1	31.0 (1.6)	<b>1.13 (1.02, 1.26)</b>	<b>1.12 (1.01, 1.25)</b>	<b>1.13 (1.01, 1.26)</b>
No	13,935	124.2	27.6 (27.5, 27.7)	34.0	27.4 (0.5)	ref	ref	ref
<b>Job insecurity</b>								
Yes	5,055	42.4	27.9 (27.7, 28.1)	12.7	29.9 (0.8)	<b>1.12 (1.05, 1.20)</b>	<b>1.07 (1.01, 1.15)</b>	1.05 (0.98, 1.13)
No	10,003	91.4	27.5 (27.3, 27.6)	24.3	26.6 (0.5)	ref	ref	ref
<b>Work–family imbalance</b>								
Yes	2,483	21.7	27.7 (27.5, 28.0)	6.2	28.6 (1.1)	1.04 (0.96, 1.13)	1.02 (0.94, 1.11)	1.02 (0.94, 1.11)
No	12,562	112.1	27.6 (27.5, 27.7)	30.9	27.5 (0.5)	ref	ref	ref

Note: Boldface indicates statistically significant differences from ref ( $p \leq 0.05$ ).

<sup>a</sup>In Model 1, PRs are adjusted for demographic covariates (gender, age, race/ethnicity, and education)

<sup>b</sup>In Model 2, PRs are adjusted for demographic covariates and health behaviors (smoking, exercise, and fruit and vegetable consumption) PR, prevalence ratio

### Prevalence of Obesity by Work Organization and Psychosocial Factors

Working more than 40 hours per week was significantly associated with obesity in the unadjusted model (PR=1.09, 95% CI=1.01, 1.17), and this effect was only slightly attenuated when adjusted for demographics and health behaviors (PR=1.08, 95% CI=1.01, 1.17; Table 2). Workers who reported exposure to a hostile work environment were significantly more likely to be obese according to the unadjusted model (PR=1.13, 95% CI=1.02, 1.26), and the significance of this effect persisted after adjustment for demographic characteristics and health behaviors (PR=1.13, 95% CI=1.01, 1.26; Table 2). Job insecurity was significantly associated with obesity in the unadjusted model (PR=1.12, 95% CI=1.05, 1.20) and Model 1 (PR=1.07, 95% CI=1.01, 1.15), but adjustment for health behaviors made this effect nonsignificant. There was no significant association between obesity and work–family imbalance.

### Prevalence of Obesity by Industry and Occupation

Among industry categories, public administration (PA) workers had the highest prevalence of obesity (36.3%, SE=2.1; Table 3). There were four industry categories with unadjusted PRs that were significantly elevated. The PRs for both manufacturing and transportation and warehousing became nonsignificant after adjustment for demographic factors (Model 1, data not shown); however, the PRs for both healthcare and social assistance (HCSA) and PA industries remained significantly elevated after adjustment for all covariates (Model 3; PR for HCSA=1.19, 95% CI=1.08, 1.30; PR for PA=1.26, 95% CI=1.12, 1.43). On the other hand, four industry categories had unadjusted PRs that were significantly low, and the significance of three of these persisted after adjustment for all covariates.

Among occupation categories, protective service (PS) workers had the highest prevalence of obesity (40.7%, SE=3.2, Table 4). Although eight occupational categories exhibited significantly elevated PRs in the unadjusted model, only the PRs for architecture and engineering (AE); community and social service (CS); PS; and office and administrative support (OAS) workers remained significantly elevated after adjustment for all covariates (Model 3; PR for AE=1.34, 95% CI=1.12, 1.62; PR for CS=1.30, 95% CI=1.06, 1.60; PR for PS=1.23, 95% CI=1.03, 1.49; PR for OAS=1.12, 95% CI=1.02, 1.22). Six occupational categories had unadjusted PRs that were significantly low, and the significance of two of these persisted after adjustment for all covariates.

**Table 3.** Prevalence of obesity and mean BMI among U.S. workers by industry (North American Industrial Classification System Sector), 2010

Industry	Unweighted sample size	Estimated population (in millions)	Weighted mean BMI (95% CI)	Estimated number of obese workers (in millions)	Weighted prevalence (% SE)	Unadjusted PR (95% CI)	Model 2: PR (95% CI) <sup>a</sup>	Model 3: PR (95% CI) <sup>b</sup>
Agriculture, forestry, fishing, and hunting (11)	225	2.0	27.8 (26.8, 28.7)	0.5	26.4 (3.9)	0.95 (0.71, 1.27)	0.99 (0.73, 1.32)	0.99 (0.72, 1.35)
Mining (21)	67	0.7	28.7 (26.7, 30.6)	0.2	27.9 (7.6)	1.00 (0.59, 1.72)	1.11 (0.73, 1.69)	1.11 (0.74, 1.67)
Utilities (22)	128	1.3	28.6 (27.8, 29.4)	0.5	34.1 (4.8)	1.23 (0.93, 1.62)	0.92 (0.65, 1.32)	0.88 (0.61, 1.29)
Construction (23)	946	9.1	28.0 (27.6, 28.4)	2.7	29.8 (1.6)	1.08 (0.96, 1.20)	0.99 (0.88, 1.12)	1.01 (0.90, 1.14)
Manufacturing (31–33)	1395	12.8	28.3 (28.0, 28.7)	3.9	30.8 (1.4)	<b>1.12 (1.02, 1.23)</b>	1.02 (0.92, 1.13)	1.01 (0.91, 1.12)
Wholesale trade (42)	355	3.4	27.7 (27.1, 28.4)	0.9	25.8 (2.7)	0.92 (0.75, 1.14)	0.88 (0.72, 1.09)	0.87 (0.71, 1.08)
Retail trade (44–45)	1527	14.7	27.5 (27.1, 27.8)	3.8	25.7 (1.3)	0.91 (0.82, 1.02)	0.93 (0.83, 1.04)	0.93 (0.83, 1.04)
Transportation and warehousing (48–49)	625	5.5	28.5 (28.0, 28.9)	1.8	33.1 (2.2)	<b>1.20 (1.05, 1.37)</b>	1.04 (0.90, 1.20)	1.03 (0.89, 1.19)
Information (51)	389	3.4	28.3 (27.3, 29.2)	1.1	33.1 (3.0)	1.19 (1.00, 1.42)	1.16 (0.96, 1.39)	1.15 (0.95, 1.38)
Finance and insurance (52)	648	5.8	27.4 (26.9, 28.0)	1.4	24.4 (2.1)	0.87 (0.74, 1.03)	0.94 (0.80, 1.10)	0.94 (0.81, 1.10)
Real estate, rental and leasing (53)	300	2.5	26.9 (26.2, 27.7)	0.5	19.9 (2.8)	<b>0.71 (0.54, 0.94)</b>	<b>0.69 (0.52, 0.91)</b>	<b>0.68 (0.51, 0.90)</b>
Professional, scientific, and technical services (54)	1013	9.2	26.7 (26.3, 27.0)	2.0	21.5 (1.4)	<b>0.76 (0.66, 0.87)</b>	<b>0.87 (0.76, 0.99)</b>	<b>0.86 (0.75, 0.98)</b>
Management of companies and enterprises (55)	8	0.1	—	—	—	—	—	—
Administrative, support, waste management, and remediation services (56)	717	5.9	27.9 (27.4, 28.4)	1.7	29.0 (1.9)	1.04 (0.91, 1.19)	0.99 (0.85, 1.16)	1.01 (0.87, 1.18)
Education services (61)	1462	13.2	27.2 (26.8, 27.5)	3.5	26.1 (1.4)	0.93 (0.83, 1.04)	1.06 (0.95, 1.19)	1.07 (0.96, 1.20)
Healthcare and social assistance (62)	2136	17.8	28.1 (27.7, 28.4)	5.7	32.0 (1.3)	<b>1.18 (1.08, 1.28)</b>	<b>1.18 (1.08, 1.30)</b>	<b>1.19 (1.08, 1.30)</b>

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**Table 3.** Prevalence of obesity and mean BMI among U.S. workers by industry (North American Industrial Classification System Sector), 2010 (continued)

Industry	Unweighted sample size	Estimated population (in millions)	Weighted mean BMI (95% CI)	Estimated number of obese workers (in millions)	Weighted prevalence (% SE)	Unadjusted PR (95% CI)	Model 2: PR (95% CI) <sup>a</sup>	Model 3: PR (95% CI) <sup>b</sup>
Arts, entertainment, and recreation (71)	319	2.8	26.2 (25.4, 27.1)	0.6	20.5 (2.9)	<b>0.73 (0.55, 0.97)</b>	0.77 (0.57, 1.02)	<b>0.73 (0.54, 0.99)</b>
Accommodation and food services (72)	1005	8.8	26.3 (25.9, 26.7)	2.0	22.7 (1.6)	<b>0.81 (0.70, 0.93)</b>	<b>0.86 (0.74, 1.00)</b>	0.86 (0.74, 1.01)
Other services (except public administration) (81)	816	6.8	27.0 (26.6, 27.4)	1.7	24.9 (1.7)	0.89 (0.77, 1.02)	0.87 (0.75, 1.03)	0.88 (0.75, 1.03)
Public administration (92)	815	7.0	29.0 (28.5, 29.5)	2.6	36.3 (2.1)	<b>1.33 (1.17, 1.50)</b>	<b>1.27 (1.13, 1.43)</b>	<b>1.26 (1.12, 1.43)</b>

Note: Boldface indicates statistically significant differences from ref ( $p \leq 0.05$ ).

<sup>a</sup>In Model 2, PRs are adjusted for demographic covariates (gender, age, race/ethnicity, and education) and health behaviors (smoking, exercise, and fruit and vegetable consumption)

<sup>b</sup>In Model 3, PRs are adjusted for demographic covariates; health behaviors (smoking, exercise, and fruit and vegetable consumption); long work hours; and hostile work environment PR, prevalence ratio

We found no statistically significant interactions between work hours and I and O, gender, or physical activity, or between hostile work environment and I and O.

## Discussion

This study found significant, albeit modest, associations between long work hours, hostile work environments, and obesity among a nationally representative sample inclusive of U.S. workers from all I and O categories. These associations persisted after adjustment for demographic characteristics and health behaviors. There were also a few I and O categories that were associated with increased prevalence of obesity, even after adjustment for demographic characteristics, health behaviors, long work hours, and hostile work environment. These findings suggest that there may be other work-related variables not included in this study (e.g., occupational physical activity or occupational sedentariness) that vary by I and O and contribute to obesity.

The finding regarding long work hours is consistent with a previous longitudinal study in which men (but not women) had increased odds of having excess body weight if they worked long hours at baseline, and men who changed from standard to long hours over the course of the study had increased odds of experiencing an unhealthy weight gain compared with men who continued to work standard hours.<sup>7</sup> Similarly, Ostry et al.<sup>13</sup> found elevated BMIs among men working 35 or more hours per week, even after controlling for job strain. Unlike previous studies, the current study included analyses that controlled for health behaviors, and found that the association between long work hours and obesity persisted.

This study also found an association between exposure to a hostile work environment and obesity, which persisted after adjustment for demographic and health behavior variables. It may be that hostile work environments, like other stressors, promote obesity through an increase in total caloric intake,<sup>16,38</sup> which is unexplained by fruit and vegetable consumption. Alternatively, as the present study is cross-sectional, a reverse association cannot be ruled out. That is, workers who are already obese may be more likely to experience harassment or bullying on the job. Longitudinal studies of workplace and hostility may help clarify this relationship.

After adjustment, there was an association between obesity and employment in HCSA industries. The occupational categories of CS and healthcare support were also positively associated with obesity, but the category of healthcare practitioners and technical occupations was not. This finding is consistent with a previous study based on NHIS data from 1986 through

**Table 4.** Prevalence of obesity and mean BMI among U.S. workers by occupation (Standard Occupational Classification Major Group), 2010

Occupation	Unweighted sample size	Estimated population (in millions)	Weighted mean BMI (95% CI)	Estimated number of obese workers (in millions)	Weighted prevalence (% , SE)	Unadjusted PR (95% CI)	Model 2: PR (95% CI) <sup>a</sup>	Model 3: PR (95% CI) <sup>b</sup>
Management (11)	1352	13.1	28.1 (27.7, 28.4)	3.7	28.2 (1.4)	1.01 (0.91, 1.13)	1.08 (0.96, 1.20)	1.06 (0.94, 1.19)
Business and financial operations (13)	718	6.2	27.3 (26.8, 27.8)	1.5	24.9 (1.9)	0.89 (0.77, 1.04)	1.02 (0.88, 1.17)	1.02 (0.89, 1.17)
Computer and mathematical (15)	431	3.9	27.3 (26.6, 28.0)	1.0	25.7 (2.6)	0.92 (0.75, 1.12)	1.00 (0.82, 1.22)	1.01 (0.83, 1.22)
Architecture and engineering (17)	276	2.7	28.0 (27.3, 28.7)	0.9	34.1 (3.4)	<b>1.23 (1.01, 1.49)</b>	<b>1.36 (1.13, 1.63)</b>	<b>1.34 (1.12, 1.62)</b>
Life, physical, and social science (19)	167	1.6	25.7 (24.9, 26.5)	0.2	14.2 (2.9)	<b>0.51 (0.34, 0.76)</b>	0.73 (0.51, 1.06)	0.74 (0.51, 1.07)
Community and social service (21)	296	2.5	28.2 (27.5, 29.0)	0.9	35.6 (3.7)	<b>1.28 (1.05, 1.57)</b>	<b>1.30 (1.06, 1.58)</b>	<b>1.30 (1.06, 1.60)</b>
Legal (23)	178	1.7	27.3 (26.3, 28.2)	0.4	23.3 (3.9)	0.83 (0.60, 1.16)	0.85 (0.62, 1.15)	0.80 (0.58, 1.10)
Education, training, and library (25)	956	8.8	27.1 (26.6, 27.5)	2.2	24.7 (1.7)	0.88 (0.76, 1.02)	1.06 (0.92, 1.22)	1.07 (0.93, 1.23)
Art, design, entertainment, sports, and media (27)	325	2.8	26.0 (25.2, 26.8)	0.6	20.1 (2.8)	<b>0.72 (0.55, 0.94)</b>	0.80 (0.61, 1.03)	0.77 (0.59, 1.01)
Healthcare practitioners and technical (29)	771	6.6	26.5 (26.0, 26.9)	1.4	22.0 (1.7)	<b>0.78 (0.67, 0.91)</b>	0.88 (0.76, 1.03)	0.89 (0.76, 1.03)
Healthcare support (31)	411	3.3	28.7 (27.8, 29.7)	1.1	34.8 (3.0)	<b>1.26 (1.06, 1.49)</b>	1.16 (0.96, 1.40)	1.15 (0.94, 1.40)
Protective service (33)	321	2.7	29.8 (29.2, 30.5)	1.1	40.7 (3.2)	<b>1.48 (1.26, 1.73)</b>	<b>1.24 (1.04, 1.49)</b>	<b>1.23 (1.03, 1.49)</b>
Food preparation and serving related (35)	824	7.3	26.3 (25.8, 26.8)	1.7	23.1 (1.8)	<b>0.82 (0.70, 0.96)</b>	0.85 (0.72, 1.01)	0.86 (0.72, 1.02)
Building and ground cleaning and maintenance (37)	660	5.2	27.0 (26.5, 27.4)	1.2	23.5 (2.0)	<b>0.84 (0.71, 0.99)</b>	<b>0.74 (0.61, 0.90)</b>	<b>0.76 (0.62, 0.92)</b>

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**Table 4.** Prevalence of obesity and mean BMI among U.S. workers by occupation (Standard Occupational Classification Major Group), 2010 (continued)

Occupation	Unweighted sample size	Estimated population (in millions)	Weighted mean BMI (95% CI)	Estimated number of obese workers (in millions)	Weighted prevalence (% SE)	Unadjusted PR (95% CI)	Model 2: PR (95% CI) <sup>a</sup>	Model 3: PR (95% CI) <sup>b</sup>
Personal care and service (39)	581	4.9	28.1 (27.4, 28.8)	1.6	32.7 (2.4)	<b>1.18 (1.02, 1.37)</b>	1.14 (0.97, 1.34)	1.16 (0.98, 1.37)
Sales and related (41)	1489	13.9	27.2 (26.9, 27.5)	3.4	24.4 (1.3)	<b>0.86 (0.77, 0.97)</b>	<b>0.87 (0.77, 0.98)</b>	<b>0.86 (0.76, 0.97)</b>
Office and administrative support (43)	2011	17.3	27.9 (27.6, 28.3)	5.3	30.7 (1.2)	<b>1.12 (1.03, 1.22)</b>	<b>1.11 (1.01, 1.21)</b>	<b>1.12 (1.02, 1.22)</b>
Farming, fishing, and forestry (45)	106	0.9	27.5 (26.3, 28.8)	0.2	27.5 (4.5)	0.99 (0.71, 1.37)	1.01 (0.73, 1.40)	0.97 (0.69, 1.37)
Construction and extraction (47)	753	7.3	27.9 (27.5, 28.3)	2.0	27.5 (1.9)	0.99 (0.86, 1.13)	0.88 (0.76, 1.03)	0.89 (0.76, 1.04)
Installation, maintenance, and repair (49)	508	4.8	28.2 (27.6, 28.7)	1.4	29.6 (2.5)	1.07 (0.90, 1.26)	0.92 (0.77, 1.10)	0.92 (0.76, 1.10)
Production (51)	896	7.8	28.6 (28.1, 29.1)	2.5	32.1 (1.9)	<b>1.17 (1.03, 1.32)</b>	0.98 (0.85, 1.13)	0.98 (0.85, 1.13)
Transportation and material moving (53)	851	7.7	28.5 (28.0, 29.1)	2.5	32.8 (1.9)	<b>1.19 (1.05, 1.35)</b>	1.06 (0.92, 1.22)	1.06 (0.92, 1.22)

Note: Boldface indicates statistically significant differences from ref ( $p \leq 0.05$ ).

<sup>a</sup>In Model 2, PRs are adjusted for demographic covariates (gender, age, race/ethnicity, and education) and health behaviors (smoking, exercise, and fruit and vegetable consumption)

<sup>b</sup>In Model 3, PRs are adjusted for demographic covariates; health behaviors (smoking, exercise, and fruit and vegetable consumption); long work hours; and hostile work environment  
PR, prevalence ratio

2002, which reported that female health services were among the occupational categories with the highest pooled obesity rates, while both male and female workers in health-diagnosing occupations, which generally have higher incomes, exhibited some of the lowest obesity rates.<sup>21</sup> These conflicting findings support observations from a recent qualitative, participatory investigation suggesting that the impact of working conditions on obesity may be especially harmful for lower-income workers.<sup>39</sup>

The only other industry category significantly associated with obesity in the present study after controlling for all covariates was PA. Similar to the earlier NHIS study, the present study also found a high prevalence of obesity among workers in the PS occupations, many of whom are employed in PA industries. The other occupational categories significantly associated with obesity in this study after controlling for all covariates were OAS support and AE. The finding of increased obesity among the latter group was surprising given that the previous NHIS study found very low prevalence rates of obesity among female architects and surveyors.<sup>21</sup> More in-depth studies of workers within these groups are needed to elucidate the specific factors contributing to their increased obesity prevalence. Consistent with a recent Gallup study,<sup>40</sup> the present study found high unadjusted PRs for obesity among transportation and material moving occupations and production occupations, but these results were no longer significant after adjustment.

Associations between work organization and psychosocial workplace exposure variables captured by the 2010 NHIS-OHS and I and O have been described previously.<sup>35,36</sup> The fact that most of the differences in the prevalence of obesity among I and O groups persisted after adjustment for the subset of work organization and workplace psychosocial factors significantly associated with obesity suggests that I and O differences in obesity prevalence may be related, at least partially, to occupational factors that were not captured in this study (e.g., income, job strain, and/or aerobic occupational physical activity).

### Strengths and Limitations

The main strengths of this study are (1) that it is based on a large, nationally representative sample that includes U.S. workers from all I and O categories and (2) that the 2010 NHIS includes data on many demographic variables, health behaviors, and supplemental occupational variables useful for multivariable analyses. Some of the main limitations are that all data are self-reported and cross-sectional. In particular, BMI calculations based on

self-reported height and weight values are subject to error, as they tend to underestimate obesity prevalence.<sup>41,42</sup> In addition, as described by Alterman et al.,<sup>36</sup> single questions were used to measure complex 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. There are also limitations associated with the measures used to assess health behaviors, which were based on published guidelines. In particular, the low prevalence of meeting fruit and vegetable consumption recommendations limited the utility of this variable.

The economic climate and high unemployment rates in the U.S. in 2010 should also be considered when interpreting our findings, as these conditions could have influenced the NHIS-OHS estimates. Finally, this is an exploratory study that involves many comparisons. Significance was defined as  $p < 0.05$  to provide a high level of sensitivity for meaningful associations, but some of the significant findings may be due to chance.

### Conclusions

In summary, this study presents additional evidence that selected occupational factors, specifically long work hours, hostile work environments, and employment in certain industries and occupations, may contribute to the current epidemic of obesity in the U.S. Public health professionals and employers should consider workplace interventions aimed at reducing obesity that take organization-level factors, such as scheduling and 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/>).

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