Sedentary Work, Low Physical Job Demand, and Obesity in US Workers

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Abstract

Objective: To examine whether low physical activity at work (sedentary work or low physical job demand) is associated with total and central obesity in US workers.

Methods: The analysis included 955 male and 956 female workers (age range: 32 to 69), who completed both the telephone interview and mailed questionnaire of the National Survey of Midlife Development in the United States (MIDUS) II study (2004-2006). Sedentary work and physical job demand were each measured by one questionnaire item. Total obesity (based on body mass index) and central obesity (based on waist circumference) were defined using WHO criteria.

Results: After controlling for covariates (socio-demographic, psychosocial work characteristics, health status, and health behaviors including leisure-time physical activity and stress-induced overeating), sedentary work, low physical job demand, and their combination increased the risk for total and central obesity only in male workers, particularly when they worked longer than 40 hours per week. The risk of the combination of sedentary work and low physical job demand for central obesity was greater than those of either lack of leisure-time physical activity or stress-induced overeating in the longer working male group.

Conclusions: Low physical activity at work is a significant risk factor for total and central obesity in middle-aged US male workers. Increasing opportunities for physical activity at work and/or reducing long work hours could contribute to obesity prevention. More studies are needed to understand the role of physical activity at work in the obesity of US female workers.

Key words: total obesity, central obesity, physical activity, leisure-time, overeating, work hours.

1. Introduction

Obesity, an excess of body fat, has been a serious public health issue in the general population and among workers in the United States (US) since the 1980s (1-3). Obesity has been well documented as a key risk factor for a wide range of chronic diseases such as hypertension, coronary heart disease, osteoarthritis, dyslipidemia, Type II diabetes, some cancers as well as increased mortality (4-5). One estimate of the national cost of obesity amounted to 78.5 billion in 1998, which accounted for 9.1% of total U.S. medical expenditures in the same year (6).

Most experts agree that the obesity epidemic arises from changes in the environment and health behaviors rather than from changes in genes (7-9). However, due to the multifaceted characteristics of obesity etiology (10), there is not as yet a clear consensus on what environmental and behavioral changes have driven the current US obesity epidemic (11-17).

One promising explanation is that "the decline in work-related physical activity seems a prime suspect in the growth of obesity." (14, p. 12). In fact, there have been substantial changes in technology (eg, computers), the organization of work (eg, lean production system) as well as the structure of industries and occupations (eg, service-driven economy and increased women's labor force participation rate) and labor relations (ie, decreased union density) in the US since the 1980s (18-21). Consequently, routine manual and cognitive tasks at work (within detailed occupations) in the US have been reduced substantially over time by mechanization, automation, or computerization (13, 20). Strenuous jobs have decreased and sedentary jobs (ie, sitting most of time) have increased significantly in male workers, albeit not to the same extent in female workers (22). In addition, work-related dynamic physical activities have been further restricted

due to lean production system, squeezing workers in terms of work space as well as time and motion for profitability (18, 23-25).

However, to our knowledge, few studies (22, 26-28) have investigated the role of low physical activity at work (sedentary work or low physical job demand) in the increasing prevalence of obesity of US workers. In addition, the associations of low physical activity at work with obesity have been inconclusive across the few existing studies and between men and women as in non-US studies (29-36).

Physical inactivity at work was associated with total obesity (BMI $\geq$ 30 kg/m^2) in the third National Health and Nutrition Examination Survey (1988-1994), but it was not presented separately for male and female workers (28). Hu *et al*. (26) also reported that sedentary work was a risk factor for total obesity in female nurses, although sedentary work was defined broadly in this study to include not only sitting at work, but also sitting away from home or while driving. By contrast, Jeffery *et al*. (27) found no association (for men) and a significant, 'positive' association (for women) between physical job activity and total obesity in the Healthy Worker Project. Lakdawalla and Philipson (22) reported dynamic associations between occupational physical (ie, physical fitness-demanding) activity and total obesity using the National Longitudinal Survey of Youth data: no association between the two variables at baseline, but later increasing inverse associations over time in male workers; and a positive association at baseline, but no associations over time in female workers.

Furthermore, the above studies have limitations in particular that leisure-time physical activity (LTPA) (22) and/or any energy intake information (22, 28) were not adjusted for the reported associations. In addition, none of the above studies (22, 26-28) examined central obesity as an outcome which has been known to be more strongly associated with chronic diseases than

BMI (2, 37-38) and has been a key criterion for clinical diagnosis of the metabolic syndrome (39).

In this study, we will test whether low physical activity at work (sedentary work or low physical job demand) is associated with total (based on BMI) and central (based on waist circumference) obesity in male and female US workers, after adjustment for various social and psychosocial variables, health conditions, and health behaviors (including leisure-time physical activity and stress-induced overeating behavior).

2. Methods

Study population

Data from the National Survey of Midlife Development in the United States (MIDUS) II study (40) was used for this study. From 1995 to 1996, the MacArthur Midlife Research Network carried out a national survey (ie, MIDUS I study) to investigate the role of social, psychological, and behavioral factors in understanding age-related differences in physical and mental health (40). 7,108 persons (males, 48% and females, 52%) completed both a telephone interview and mailed questionnaires for the MIDUS I study. All of the participants were non-institutionalized, English-speaking adults, aged 25-74, in the United States. They were drawn from four subsamples: (1) a national random-digit-dial (RDD) sample (n=3,487); (2) oversamples from five metropolitan areas (N=757); (3) siblings of individuals from the RDD sample (n=950); and (4) a national RDD sample of twin pairs (n=1,914). The response rates of the four subsamples ranged from 60% to 70%. The four subsamples were very similar to one another in terms of the distributions of age, education, and gender (40). The socio-demographic

characteristics of the RDD subsample were comparable to those of a US population representative sample, the October 1995 Current Population Survey (http://www.census.gov/cps). However, the RDD subsample relatively underrepresented those who were blacks, young (eg, aged 25 to 34), or had less education (ie, 12 or less than 12 years of formal education) (40).

A follow-up survey of the participants of the MIDUS I study respondents was conducted from 2004 to 2006. The average follow-up interval was approximately 9 years later and ranged from 7.8 to 10.4 years. The longitudinal retention rates among the four subsamples ranged from 65% to 78% (on average, 70%). In the follow-up, low educated persons were relatively more likely to have dropped out of the study. 4,963 persons (males, 47% and females, 53%) completed both a telephone interview and mailed questionnaires for the MIDUS II study. For this study, first we restricted study subjects to those (n = 2,157) who were working for a paid-job at the MIDUS II survey, had worked as full-time or part-time workers in 2003, and were aged less than 70 years. Finally 1,911 workers (955 males and 956 females) who had valid information on the exposure and outcome variables (see below) were chosen for this study.

Exposures – sedentary work and low physical job demand

Sedentary work was measured by one item (ie, "how often does your job require you to sit for long periods of time during your work-shift?") with a five-part Likert response set (All, most, some, little of the time, and never). For this analysis, the responses were grouped into high (all and most); middle (some); and low (little and never: the reference group) (Table 1). Physical job demand was also measured by one item (ie, "how often does your job require a lot of physical effort during your work-shift?") with the same response set. For this analysis, the responses were also trichotomized as in sedentary work. A preliminary data analysis revealed a

high negative correlation between the sedentary work and physical job demand variables (Spearman coefficients were -0.54 and -0.50 for men and women, respectively) so a variable combining sedentary work and physical job demand (hereafter called "physical inactivity at work") was additionally created for a potential interaction effect between sedentary work and physical job demand on obesity. The variable was then grouped into three categories: high (high sedentary work and low physical job demand); low (low sedentary work and high physical job demand); and middle (the other combination groups of sedentary work and physical job demand). Spearman correlations of quantitative job demand (see below) with sedentary work and physical job demand were weak (ie, less than 0.11) for both men and women. Despite the same response (eg, all of the time – *your work-shift*) to the sedentary work and physical job demand items, its meaning (ie, absolute exposure time) could differ by the length of the "work-shift" of the respondents (eg, 8 hours for a worker who works 8 hours per day vs. 12 hours for a worker who works 12 hours per day). To address this issue, the risks of sedentary work and low physical demand for total and central obesity in the multivariate analyses (see below) were additionally investigated with stratification for the working hours per week ($\leq$ 40 hrs and > 40 hrs per week) of the respondents.

Outcome – obesity (body mass index and waist circumference)

General obesity was defined by the body mass indexes ($\geq$ 30 kg/m^2) (10), based on self-reported height and weight information. There were strong correlations between self-reported and measured values of BMI in a subsample (n = 464) of the MIDUS II participants (11): Pearson correlation coefficients were 0.93 in men and 0.92 in women. Central obesity was

defined by the self-reported waist circumferences (> 40 inches for men; > 35 inches for women) (10).

Covariates

Various potential covariates were considered in the analysis: data sources, socio-demographic (2, 3, 17), psychosocial working conditions (11, 41-44), health status, and health behaviors (16, 41, 45, 46). Specifically, four data sources: city; siblings; and twin subsamples (vs. the national random subsample), age (< 40; 40 to 49; 50 to 59; and ≥ 60 years old), sex, marital status (married and non-married), any children aged 0 to 6 years at home, race (whites and others), annual household income (<$ 60,000; $ 60,000 to $ 99,999; and ≥ $100,000), and education (high - university/graduate school graduate; middle - some college education, but unfinished; and low - high school graduate and lower education). Several psychosocial working conditions were measured by questionnaire items (see Appendix A): job control (skill discretion plus decision authority, 5 items), quantitative job demands (3 items), coworker (2 items) and immediate supervisor (2 items) support, and no coworkers (2 items) and immediate supervisors (2 items). Job control, quantitative job demands, coworker support, and supervisor support were dichotomized into high and low at their median values. In addition, hours of work per week (from a main job and other jobs: ≤ 40 hrs and > 40 hrs per week) were also self-reported.

The following health status and health behaviors were measured: depression (those who felt sad, blue, or depressed for ‘all’ or ‘almost all’ of two weeks or more in a row during the past 12 months); anxiety (those who worried ‘every day’ or ‘most of days’ during the last 12 months and worried all day long or most of the days); chronic diseases (those who have experienced or been treated for any of the following during the past 12 months: arthritis, sciatica, recurring

stomach trouble or diarrhea, persistent foot troubles, trouble with varicose veins, multiple sclerosis, stroke, and hernia; or those who have ever had heart problems or ever had cancer); smoking (current smokers vs. non-smokers); alcohol consumption (moderate drinking – up to two drinks per day for men and one drink per day for women (47) during the past month and heavy drinking – more than moderate drinking vs. no drinking); active leisure-time physical activity (ie, vigorous or moderate physical activity long enough to work up a sweat, several times a week or more during the summer or the winter); and stress-induced overeating (those who endorsed either of the following two items about "how you respond when you are confronted with difficult or stressful events in your life": "I eat more than I usually do" and "I eat more of my favorite foods to make myself feel better").

Statistic analyses

The univariate associations of the study variables (including sedentary work, low physical job demands, and physical inactivity at work) with total and central obesity were examined through chi square tests (Table 1). The associations of sedentary work, low physical job demands, and physical inactivity at work with total and central obesity were also investigated through a series of multivariate logistic regression models (Tables 2, 3, and 4) for men and women, separately: Model 1 – only one variable (sedentary work, physical job demand, or their combination variable, physical inactivity at work); Model 2 – additionally with data sources, psychosocial working conditions, and socio-demographic variables; and Model 3 – additionally with health status and health behavior variables. The multivariate analyses were replicated with stratification for working hours per week ($\leq$ 40 hrs and > 40 hrs per week) in order to examine the effect of the aforementioned work hours differential meanings of the responses to the

sedentary work and low physical job demand items (Table 4). Due to space limitations, the odds ratios in the multivariate analyses were presented in Tables 2 and 3 only for the covariates which were significant ($p < 0.05$) in the univariate analyses or in Model 3.

3. Results

Descriptive statistics of total and central obesity

The means and standard deviations of BMI were 28.42 kg/m^2 and 4.87 for men, and 27.02 kg/m^2 and 6.15 for women, respectively. Total obesity percentages were 28.9% and 26.6% for male and female workers, respectively. The means and standard deviations of waist circumference were 39.18 inches and 4.80 for men, and 34.85 inches and 5.79 for women, respectively. Central obesity percentages were 32.9% and 41.7% for male and female workers, respectively. Spearman correlations between continuous body mass indexes and waist circumferences were 0.81 ($p < 0.001$) for men and 0.84 ($p < 0.001$) for women. The kappa values between total obesity and central obesity were 0.69 ($p < 0.05$) for men and 0.58 ($p < 0.05$) for women.

Descriptive statistics of sedentary work and physical job demand

The distributions of sedentary work, physical job demand, and physical inactivity at work in male workers were very similar to those in female workers (Table 1). For instance, 35.1% of male and female workers, respectively, reported high physical inactivity at work. As expected, sedentary work was most prevalent in the high education group, while physical job demand was most prevalent in the low education group. As a result, the percentages of physical inactivity at

work were highest in the high education group (51.7%) and followed by the middle education group (23.0%) and the low education group (13.2%) for men, and 38.0%, 35.0%, and 30.8%, respectively, for women.

Univariate correlations with total and central obesity

In the univariate analysis, sedentary work, physical job demand, and physical inactivity at work were not associated with total and central obesity in male workers, while the prevalence of obesity was lowest at the middle levels of sedentary work and physical inactivity at work in female workers when compared to those at low or high levels (Table 1). On the other hand, lower levels of education, lack of LTPA, stress-induced overeating, less alcohol consumption, and any chronic diseases were strongly associated with total and central obesity in both men and women. Age and being married were associated with central obesity in male workers. Race (non-whites), low job control, and depression were associated with total and central obesity in female workers. Lower annual income and having a supervisor were associated only with central obesity while low coworker support and being a non-smoker were associated only with total obesity in female workers.

Multivariate associations with total obesity

In the multivariate analyses, both physical job demand and physical inactivity at work were not associated with total obesity in both men and women (data not shown). However, high and middle levels of sedentary work increased the risk for total obesity in male workers, when compared to the low level of sedentary work: their odds ratios for total obesity (95% confidence

intervals (CIs)) were 1.53 (1.04-2.24) and 1.60 (1.05-2.45), respectively (Table 2). However, such significant risk increases were not observed in female workers.

In both men and women, lower levels of education, any chronic diseases, and stress-induced overeating were risk factors for total obesity, while active LTPA and alcohol consumption were inversely associated with total obesity as in the univariate analyses (Table 2). In male workers, depression was associated with a decreased risk for total obesity. In female workers, race (non-whites), low coworker support, and long working hours per week increased the risk for total obesity, while smoking decreased the risk. Depression and low job control were not associated with total obesity in female workers in multivariate models.

Multivariate associations with central obesity

After controlling for all of the covariates, sedentary work, low physical job demand, and high physical inactivity at work were associated with central obesity in male workers. Increased risk was observed in both high and middle levels of sedentary work in male workers, with odds ratios (95% CIs) of 1.97 (1.36-2.85) and 1.68 (1.11-2.53), respectively (Table 3). Similarly, high and middle levels of physical job demand were associated with central obesity in male workers, with odds ratios (95% CIs) of 0.63 (0.41-0.97) and 0.76 (0.52-1.11), respectively. Finally, the combined variable (physical inactivity at work) was associated with even stronger associations with central obesity: and odds ratio of 2.08 (1.23-3.54) for high levels of physical inactivity at work and 1.70 (1.06-2.73) for middle levels. However, these variables were not significantly associated with central obesity in female workers.

In both men and women, race (non-whites), low education, any chronic diseases, and stress-induced overeating increased the risk for central obesity, while active LTPA, smoking, and

moderate alcohol consumption decreased the risk for central obesity (Table 3). Interestingly, having a supervisor (vs. no immediate supervisors) increased the risk for central obesity in female workers. Depression and low job control were not significantly associated with central obesity in female workers.

Stratified analyses by working hours per week

The above multivariate analyses for total and central obesity were replicated after stratification by hours worked per week. Increased risks of total obesity due to sedentary work and physical inactivity at work was observed in male workers (n=572) who worked longer (ie, > 40 hours per week) (Table 4), but not in male workers (n=383) who worked shorter (ie, 40 hours per week or less). The risk of central obesity due to high level of sedentary work was somewhat greater in the >40 hours per week male group (2.17, 95% CI, 1.30-3.63) than in the ≤40 hours per week male group (1.78, 95% CI, 1.00-3.14). The risk of central obesity due to physical job demand and physical inactivity at work increased substantially and were significant only in the group of men working >40 hours per week. For example, the odds ratio of high physical inactivity at work for central obesity was 4.39 (95% CI, 1.93-10.01), which was greater than the risks of non-active LPTA and stress-induced overeating in the male group: 1.85 (1.20-2.78) and 3.20 (1.99-5.12), respectively. There were no such effect modifications by working hours per week in female workers.

4. Discussions

There were significant associations of low physical activity at work (sedentary work, low physical job demand, or their combination) with total and central obesity among US male

workers participating in the MIDUS II study, particularly those who worked longer than forty hours per week. However, we failed to find such associations in female workers. These findings partially support the hypothesis that substantial reductions of work-related physical activity may be an important cause of the current obesity epidemic in the US. Increasing opportunities for physical activity at workplaces and/or reducing long work hours could contribute to obesity prevention in US workers. More sophisticated prospective studies are needed to examine the role of physical activity at work in reducing the prevalence of obesity in male and female workers in the US.

Comparisons with other studies

To the best of our knowledge, this is one of only a few studies showing an association of low physical activity at work (sedentary work or low physical job demand) with central obesity in male workers. This finding is consistent with one Japanese study at a metal manufacturing factory (33). This study is also one of a very few studies controlling for many key risk factors for obesity (ie, socioeconomic status, LTPA, and overeating behavior) in assessing the association between low physical activity at work and total obesity in male workers, although several studies have observed such an association (22, 29, 30, 33-35).

However, this study is not consistent with one US cross-sectional study (27) and two non-US cross-sectional studies (31, 32) reporting no associations between work-related physical activity and total obesity in male workers. Differences in measurement of physical activity at work might explain the inconsistency of this study with the other US study (27). In the other US study, “occupational physical activity” did not specifically assess the extent of sedentary (ie, sitting) work. In the current study, low physical job demand was not associated with total obesity

in male workers as in the other study (27), however, sedentary work was associated with total obesity in the current study. We can not rule out socio-cultural differences in obesity etiology (48), which may explain differences between this study and non-US studies (31, 32).

On the other hand, we found no significant, albeit positive, associations between low physical activity at work and total or central obesity in female workers. The literature on this hypothesis in female workers has been very inconclusive: no association in four non-US studies (30, 31, 34, 35); a positive association in one US study (26) and two non-US studies (29, 33); an inverse association in one US study (27) and one non-US study (36); and a changing (inverse to the null) association over time in one US study (22).

Several explanations are possible for the gender differences in this study. Obese female workers might underreport their weight, height, and waist circumference more frequently than obese male workers. However, this seems unlikely for two reasons. First, there were very high (> 0.90) correlations between self-reported and measured BMI values in both men and women of the subsample of the MIDUS II (11). Second, the self-reported BMI values were slightly more accurate in female than in male US adults (49, 50) as in the MIDUS II subsample study (11). Two-level rather than three-level definitions of sedentary work and physical job demand (high = all and almost of the time vs. low = some, little, and never) did not make a difference in results (data not shown).

Another possible explanation is that the level of BMI or waist circumference may influence choice of job in females, but not in males, which was demonstrated in a recent study with the National Longitudinal Survey of Youth data (22). There is also some evidence that obese workers are discriminated against in both hiring and job placement/promotion and such discrimination is more prevalent in females than in males (51, 52). If obese female workers were

hired more frequently in physically demanding jobs, a positive association between high physical activity at work and obesity would be observed in a cross-sectional study. However, given no substantial changes in job and employment, the association might eventually change to the null or to an inverse association due to the causal impact of physical activity at work on weight (eg, obese female workers start to lose weight due to physical work, while thinner female workers start to gain weight due to sedentary work). Prospective studies, which can assess changes in jobs and weight due to social selection and discrimination, are needed to better test the hypothesis that reductions in physical activity at work contribute to the current obesity epidemic in US male and female workers.

Policy perspectives: increasing physical activity at work and/or reducing long work hours

This study highlights the importance of physical activity at work for obesity prevention in US male workers. In this study, the risk of high physical inactivity at work (combination of sedentary work and low physical job demand) for central obesity was greater than those of either lack of leisure-time physical activity or stress-induced overeating, especially in male workers who work longer than 40 hrs per week. In addition, the longer working hours (> 40 hours per week) was a significant independent risk factor for total obesity in female workers. These indicate that increasing opportunities for physical activity at work as well as in leisure time and/or reducing long working hours per week should be major components of a public health policy for obesity prevention. Such policies should be helpful in counteracting the current positive energy imbalance of the US population: increased average total energy intake (53, 54) and stable leisure-time physical activity (LTPA) (1, 55) since the 1980s.

Enacting such policies will not be easy. According to the 2004 national survey of worksite health promotion activities (56), only about 20% of US workplaces conduct a worksite weight management or physical activity program. Stairs in US buildings are usually hidden from entrances and the use of stairs is not recommended as a way of work activities (57). More problematically, reduction of dynamic physical activity at work has been quite often praised for increased efficiency or productivity (8). For instance, after introduction of a lean production system at car assembly factories (18, 23), the assembly line was reconfigured from flow lines toward U-shaped. Work-related physical activities such as waking with the car along the line and walking between the car and parts racks were substantially removed under the name of non-value added motions. A similar case in a medical center was reported (eg, on average, reduction of 5,000 steps) (25). Increasing physical activity at work, through health promotion programs, physical workspace design, or by not physically constricting work activities, seems to be contingent on how much our society is willing to view dynamic physical activity at work as a social value-adding (ie, health promoting) activity and to maintain/reflect this perspective in designing technology and organizing work. A recent study (58) suggested that it might be possible to increase physical activity at work without sacrificing productivity: frequent micro-breaks in sedentary work, independent of the total sedentary time, was inversely associated with total and central obesity. The percentages of long (50 hours per day or more) working hours in US workers increased 21.0% in 1970 and 26.5% in 2000 for men and 5.2% in 1970 and 11.2% in 2000 for women (59). According to a recent study using the 2002 US General Social Survey data (60), overtime (ie, >40 hours per week) workers were more prevalent in male, white, and middle-aged workers with higher levels of education and income. Therefore, the impact of reducing

working hours per week on obesity prevention would be greatest in male high status workers who are mostly subjected to high physical inactivity at work.

Limitations of this study

This study has several limitations. First, as a cross-sectional study, we cannot draw a causal inference about the effect of low physical activity at work on obesity in US workers. Second, although the MIDUS II was a national study, with participants recruited from diverse occupations and industries across the US, it is not necessarily representative of the US working population. In fact, the dataset under-represents minorities (eg, blacks) and people with low levels of education. If such groups had been represented in the study relative to their proportion in the US population, the prevalence of obesity in this study would have been higher. Third, interpretations about the associations of other exposures with obesity should be made carefully because they were not the main focus of this study. For example, in this study, despite some expected associations of psychosocial working conditions with obesity in female workers, there were no such associations in male workers. Such null associations mean no "direct" effects of psychosocial working conditions on obesity, which does not exclude the possibility of any "indirect" impacts of psychosocial working conditions on obesity via health behaviors (not addressed in this study). Fourth, self-reported measures of physical activity at work and waist circumference could be vulnerable to self-report bias. However, it was reported in a study on 111 US male and female workers (61) that self-reported waist circumference values were highly (ie, > 0.80) correlated with technician-measured ones. In addition, self-reported sitting time at work and physical job demand items, very similar to ones used in this study, were valid in comparisons to some objective measures in the National Longitudinal Survey of Youth and a

sample of Australian workers (22, 62). Therefore, it is unlikely that the use of self-reported measures affected the results of this analysis substantially.

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Table 1. Total and central obesity prevalence for the variables for this study in 955 male and 956 female US workers.

Major variable category	Minor variable category	Subcategory	Frequency (%)		Total obesity, % (based on BMI)		Central obesity, % (based on WC)	
			Men	Women	Men	Women	Men	Women
Data source	Subsamples	National random	42.4	41.8	29.1	23.8	35.3	39.8
		City	11.0	7.6	36.2	27.4	33.3	39.7
		Siblings	15.9	16.6	27.0	28.3	30.3	42.1
		Twin	30.7	33.9	27.0	29.0	30.7	44.4
Socio-demographic	Age (years old)	< 40	10.4	13.3	22.2	28.3	22.2*	39.4
		40 to 49	35.1	36.5	28.1	27.8	30.4*	42.7
		50 to 59	38.0	35.0	32.2	26.6	36.9*	40.0
		≥ 60	16.5	15.2	27.2	22.1	35.4*	45.5
	Marital status	Married	78.8	68.6	29.5	25.2	34.5*	39.8
		Non-married	21.2	31.4	26.7	29.7	26.7*	46.0
	Race	White	93.5	91.8	28.3	24.9***	32.1	40.4**
		Others	6.5	8.2	37.1	44.9***	43.5	56.4**
	Education	High school or less	23.8	26.5	37.0**	31.2*	39.2**	49.4**
		Some college	26.0	31.7	31.9**	29.0*	36.7**	43.2**
		University or more	50.3	41.8	23.5**	21.8*	27.9**	35.8**
	Annual household income	< $ 60,000	26.7	36.8	29.4	29.0	34.1	46.0**
		$ 60,000 to $ 99,999	35.6	31.0	32.6	27.7	34.4	44.6**
		≥ $ 100,000	37.7	32.2	25.0	22.7	30.6	34.1**
	Any children, aged 0 to 6 years	No	88.3	90.8	29.5	26.4	33.5	41.8
		Yes	11.7	9.2	24.1	28.4	28.6	40.9
Working conditions	Sedentary work (S)	Low	34.1	35.6	26.7	25.3	28.2	42.9*
		Middle	22.6	21.9	30.1	21.5	33.8	34.4*
		High	43.2	42.6	30.0	30.2	36.1	44.5*
	Physical job demand (P)	Low	54.1	59.2	27.9	27.6	33.8	41.2
		Middle	24.8	22.4	30.8	23.4	33.8	40.2
		High	21.0	18.4	29.4	27.3	29.4	45.5
	Physical inactivity at work (= S + P)	Low	14.5	14.0	25.4	29.1*	24.6	47.8*
		Middle	50.5	50.8	30.5	22.8*	34.4	38.1*
		High	35.1	35.1	28.1	31.0*	34.0	44.6*
	Job control	Low	45.9	52.7	30.1	30.0*	33.6	46.6**

		High	54.1	47.3	27.9	22.8*	32.3	36.3**
	Psychological job demands	Low	41.3	42.7	29.9	25.2	35.5	41.2
		High	58.7	57.3	28.2	27.6	31.0	42.2
	Supervisor support	Low	44.2	40.8	30.8	27.9	32.0	43.6*
		High	36.8	48.1	27.6	27.2	32.8	43.0*
		No immediate supervisors	19.1	11.1	26.9	18.9	35.2	29.2*
	Coworker support	Low	50.6	45.0	30.4	31.6**	32.1	45.6
		High	40.6	46.3	28.4	21.9**	34.8	38.8
		No coworkers	8.8	8.7	22.6	25.3**	28.6	37.3
	Hours of work per week	40 or less	40.1	69.2	29.5	25.1	33.9	41.5
		> 40	59.9	30.8	28.5	29.9	32.2	42.2
Health status	Any chronic diseases	No	53.4	49.5	24.5**	21.8**	27.3***	33.4***
		Yes	46.6	50.5	33.9**	31.3**	39.3***	49.9***
	Depression	No	94.1	87.1	29.5	25.3*	33.3	40.3*
		Yes	5.9	12.9	19.6	35.0*	26.8	51.2*
	Anxiety	No	93.5	83.8	29.0	26.3	32.7	41.6
		Yes	6.5	16.2	27.4	27.7	35.5	42.6
Health behaviors	Leisure-time physical activity	Non-active	55.2	55.4	33.2**	32.1***	38.1***	49.6***
		Active	44.8	44.6	23.6**	19.7***	26.4***	31.9***
	Stress-induced overeating	No	80.5	61.2	22.8***	17.3***	28.0***	30.8***
		Yes	19.5	38.8	54.3***	41.2***	53.2***	59.0***
	Current smoker	No	85.8	83.4	29.1	28.2**	33.6	42.3
		Yes	14.2	16.6	27.9	18.2**	28.7	39.0
	Alcohol consumption	No	30.1	35.9	35.2**	37.0***	39.4**	51.9***
		Moderate	67.2	62.4	26.8**	20.8***	30.5**	36.0***
		Heavy	2.7	1.7	11.5**	18.8***	19.2**	37.5***
Obesity	Total obesity (BMI, $\geq$ 30 kg/m^2)		28.9	26.6				
	Central obesity (WC)		32.9	41.7				

Note. BMI = body mass index. WC = waist circumference, > 40 inches for men and >35 inches for women. *p < 0.05, **p < 0.01, and ***p < 0.001 at chi-square tests.

Table 2. Odds ratios of sedentary work for total obesity (BMI, ≥ 30 kg/m^2) in US male (n=955) and female (n=956) workers

Sex	Variables	Model 1	Model 2[a]	Model 3[b]
Men	Sedentary work (middle)	1.18 (0.81-1.73)	1.32 (0.89-1.97)	1.60 (1.05-2.45)
	Sedentary work (high)	1.18 (0.85-1.63)	1.53 (1.07-2.20)	1.53 (1.04-2.24)
	Education (middle)		1.65 (1.14-2.37)	1.69 (1.15-2.50)
	Education (low)		2.16 (1.47-3.17)	2.32 (1.52-3.53)
	Any chronic diseases			1.56 (1.14-2.14)
	Depression			0.44 (0.20-0.95)
	Active leisure-time physical activity			0.66 (0.48-0.91)
	Stress-induced overeating			4.83 (3.32-7.03)
	Moderate alcohol consumption			0.71 (0.51-0.99)
	Heavy alcohol consumption			0.27 (0.07-0.95)
Women	Sedentary work (middle)	0.81 (0.54-1.22)	0.85 (0.55-1.31)	0.98 (0.62-1.55)
	Sedentary work (high)	1.28 (0.93-1.77)	1.23 (0.87-1.75)	1.28 (0.87-1.87)
	Job control (low)		1.28 (0.94-1.76)	1.01 (0.72-1.41)
	Coworker support (low)		1.68 (1.21-2.33)	1.66 (1.16-2.36)
	Working hours (> 40 hrs per week)		1.44 (1.04-2.01)	1.49 (1.04-2.13)
	Race (non-whites)		2.54 (1.54-4.17)	2.78 (1.61-4.81)
	Education (middle)		1.51 (1.04-2.18)	1.63 (1.09-2.43)
	Education (low)		1.61 (1.09-2.39)	1.69 (1.09-2.62)
	Any chronic diseases			1.81 (1.30-2.54)
	Depression			1.25 (0.75-2.07)
	Active leisure-time physical activity			0.59 (0.42-0.82)
	Stress-induced overeating			3.19 (2.29-4.43)
	Smoking			0.40 (0.24-0.65)
	Moderate alcohol consumption			0.46 (0.33-0.65)
	Heavy alcohol consumption			0.52 (0.13-2.06)

[a]Sources of subsamples, socio-demographic variables, and working conditions were controlled for. [b]Covariates in Model 2 plus health status and health behaviors were additionally controlled for. Due to space limitations, the odds ratios in the multivariate analyses were presented only for the covariates which were significant ($p < 0.05$) in the univariate analyses or in Model 3.

Table 3. Odds ratios of sedentary work for central obesity (waist circumference, > 40 inches for men and >35 inches for women) in US male (n=955) and female (n=956) workers

Sex	Variables	Model 1	Model 2[a]	Model 3[b]
Men	Sedentary work (middle)	1.30 (0.90-1.88)	1.46 (0.98-2.15)	1.68 (1.11-2.53)
	Sedentary work (high)	1.44 (1.05-1.97)	1.94 (1.36-2.76)	1.97 (1.36-2.85)
	Marital status (vs. married)		0.65 (0.45-0.96)	0.67 (0.44-1.01)
	Race (others vs. white)		1.68 (0.97-2.90)	1.77 (0.99-3.18)
	Education (middle)		1.76 (1.23-2.51)	1.78 (1.22-2.58)
	Education (low)		1.96 (1.34-2.86)	2.03 (1.36-3.04)
	Any chronic diseases			1.61 (1.19-2.18)
	Active leisure-time physical activity			0.60 (0.44-0.81)
	Stress-induced overeating			3.26 (2.26-4.70)
	Smoking			0.69 (0.44-1.10)
	Moderate alcohol consumption			0.74 (0.54-1.02)
	Heavy alcohol consumption			0.40 (0.14-1.18)
Women	Sedentary work (middle)	0.70 (0.49-1.00)	0.76 (0.52-1.11)	0.82 (0.55-1.23)
	Sedentary work (high)	1.06 (0.80-1.42)	1.12 (0.82-1.53)	1.18 (0.84-1.66)
	Job control (low)		1.31 (0.99-1.72)	1.06 (0.79-1.44)
	No immediate supervisors		0.45 (0.25-0.83)	0.52 (0.27-1.00)
	Race (others vs. white)		1.99 (1.22-3.24)	2.12 (1.25-3.60)
	Income (middle)		1.50 (1.06-2.12)	1.44 (0.99-2.11)
	Income (low)		1.34 (0.91-1.98)	1.22 (0.80-1.87)
	Education (middle)		1.30 (0.94-1.80)	1.32 (0.92-1.89)
	Education (low)		1.52 (1.07-2.16)	1.48 (1.00-2.18)
	Any chronic diseases			2.10 (1.56-2.83)
	Depression			1.35 (0.85-2.15)
	Active leisure-time physical activity			0.53 (0.40-0.72)
	Stress-induced overeating			3.19 (2.36-4.29)
	Smoking			0.63 (0.42-0.96)
	Moderate alcohol consumption			0.61 (0.45-0.83)
	Heavy alcohol consumption			0.77 (0.24-2.42)

[a]Sources of subsamples, socio-demographic variables, and working conditions were controlled for. [b]Covariates in Model 2 plus health status and health behaviors were additionally controlled for. Due to space limitations, the odds ratios in the multivariate analyses were presented only for the covariates which were significant ($p < 0.05$) in the univariate analyses or Model 3.

Table 4 Odds ratios of sedentary work, physical job demands, and physical inactivity at work for total (body mass index) and central obesity (waist circumference, > 40 inches for men and >35 inches for women) in US male (n=572) workers who worked more than 40 hours per week.

		Frequency (%)	Total obesity	Central obesity
Sex	Variables		Model 3[a]	Model 3[a]
Men	Sedentary work (low)	29.9	1.00	1.00
	Sedentary work (middle)	24.3	2.09 (1.18-3.71)	1.72 (0.99-2.99)
	Sedentary work (high)	45.8	1.83 (1.06-3.13)	2.17 (1.30-3.63)
	Physical job demand (low)	55.6	1.00	1.00
	Physical job demand (middle)	24.3	1.19 (0.71-1.99)	0.75 (0.45-1.25)
	Physical job demand (high)	20.1	0.64 (0.34-1.22)	0.32 (0.17-0.62)
	Physical inactivity at work (low)	12.6	1.00	1.00
	Physical inactivity at work (middle)	50.2	2.41 (1.17-4.98)	3.35 (1.57-7.15)
	Physical inactivity at work (high)	37.2	2.20 (0.98-4.92)	4.39 (1.93-10.01)

[a]Sources of subsamples, socio-demographic variables, working conditions, health status, and health behaviors were controlled for.

Appendix A : Psychosocial working condition variables

Skill discretion (2 items, response set: all of the time (1) to never (5))

- How often does your job provide you with a variety of things that interest you?
- How often do you learn new things at work?

Decision authority (3 items, response set: all of the time (1) to never (5))

- How often do you have a choice in deciding how you do your tasks at work?
- How often do you have a choice in deciding what tasks you do at work?
- How often do you have a say in decisions about your work?

Job control = skill discretion + decision authority

Quantitative job demands (3 items, response set: all of the time (1) to never (5))

- How often do you have to work very intensively -- that is, you are very busy trying to get things done?
- (How often) you have too many demands made on you.
- (How often) you have enough time to get everything done. (Reversed for scoring)

Coworker support (2 items, all of the time (1) to never (5))

- How often do you get help and support from your coworkers?
- How often are your coworkers willing to listen to your work-related problems?

No coworker ('does not apply' response in the below 2 items)

- How often do you get help and support from your coworkers?
- How often are your coworkers willing to listen to your work-related problems?

Immediate supervisor support (2 items, all of the time (1) to never (5))

- How often do you get help and support from your immediate supervisor?
- How often is your immediate supervisor willing to listen to your work-related problems?

No immediate supervisor support ('does not apply' response in the below 2 items)

- How often do you get help and support from your immediate supervisor?
- How often is your immediate supervisor willing to listen to your work-related problems?