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PSYCHOSOCIAL WORKING CONDITIONS AND ACTIVE LEISURE-TIME PHYSICAL ACTIVITY IN MIDDLE-AGED US WORKERS

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Abstract
Objectives: This study was to examine whether psychosocial work characteristics such as job control, psychological job demands, and their combinations are associated with leisure-time physical activity (LTPA) in US workers. **Materials and Methods:** 2019 workers (age range: 32 to 69) from the National Survey of Midlife Development in the United States (MIDUS) II study (2004–2006) were chosen for this cross-sectional study. Job control and job demands were measured by standard questionnaire items. Active LTPA was defined as "moderate or vigorous" level of physical activity. **Results:** After controlling for covariates (e.g., age, race, education, income, physical effort at work, obesity, and alcohol consumption), high job control was associated with active LTPA. Active jobs (high control and low demands) and low-strain jobs (high control and high demands), compared to passive jobs (low control and low demands), increased the odds for active LTPA. The associations varied by sex and education level. Job demands alone were not associated with active LTPA. **Conclusions:** Having on-the-job learning opportunities and decision authority on their tasks may be conducive to active LTPA in middle-aged US workers.

Key words:
Job control, Job demands, Education, Obesity, MIDUS

INTRODUCTION

Regular physical activity reduces the risk of all-cause mortality, coronary heart disease, high blood pressure, stroke, type 2 diabetes, metabolic syndrome, colon cancer, breast cancer, and depression [1,2]. Thus it has been widely recommended as a key public health policy [1,3,4] in the United States (US): for instance, adults should engage in at least 30 minutes of moderate-intensity physical activity (e.g., brisk walking) on five days of the week. However, according to the recent statistics from the Behavioral Risk Factor Surveillance System (BRFSS) [5], only half of US adults meet the recommended level of physical activity and about 25% of adults do not engage in any physical activity during their leisure time. More importantly, the proportions have not changed

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much during the last fifteen years. The reasons for this situation are not well understood and there may well be important unidentified social and environmental determinants of leisure-time physical activity (LTPA). This study explores the role of psychosocial work characteristics such as job control, psychological job demands, and their combinations as occupational determinants of LTPA in US workers.

Theories: the relationship between work and LTPA

A number of sociologists [6–9] have postulated that work characteristics could affect leisure-time activities of workers and, generally, there would be a similarity rather than an antithesis between work and non-work activities (called "spill-over hypothesis" vs. "compensation hypothesis"). Meissner [7] suggested, in a study on manual workers at a Canadian wood-product manufacturing factory, that "the design of industrial work creates or prevents opportunities for the development or maintenance of discretionary and social skills. When choice of action is suppressed by the spatial, temporal, and functional constraints of the work process, worker capacity for meeting the demands of spare-time activities which require discretion is reduced. They engage less in those activities which necessitated planning, coordination, and purposeful action" (p. 260). In the study, Meissner [7] reported that those who had high job discretion engaged more frequently in sports activities during their leisure time, in contrast, those who had low job discretion engaged more frequently in sedentary activities at home (e.g., going for a drive, TV watching) during their leisure time.

Karasek [6] also proposed a similar, but more sophisticated hypothesis based on the two concepts — job control (opportunities at work for learning and decision making) and psychological job demands (degree of mental work demands). According to the active-passive hypothesis of the demand-control (DC) model [6,10], those who have an "active job" (a combination of high control and high demands) would develop "more skills through the trial/failure/success learning process" [10, p. 93] and an active personality ("feeling of mastery or confidence", p. 98). Thus, they would be most active in leisure activities (e.g., reading books, sports activities, social participation, and political activities), but in contrast, those who have a "passive job" (a combination of low control and low demands), would undergo a process of "skill atrophy and unlearning" [10, p. 94]. This group would be least active in the leisure activities. In addition, those who had "low strain" jobs (a combination of high control and low demands) or "high strain" jobs (a combination of low control and high demands) would have intermediate levels of the leisure activities. In a national Swedish study [6], sports activities during leisure time were more prevalent in those who had high control, high demands, and an active job (vs. passive job).

Other theories have focused on the internal process of how people change behavior [11–13]. These theories posit that for successful adoption of healthy behaviors, a person needs to be highly motivated and also to have skill and ability to actualize a well-conceived plan for the behavior against barriers in reality.

In sum, the above theories imply that job control, psychological job demands, and an active job (vs. passive job) would be associated with LTPA in a working population.

Empirical evidence:
psychosocial working conditions and active LTPA

Empirical evidence for these associations has been inconclusive. Some studies have supported the associations for high job control [6,14–18], high psychological job demands [6] and an active job [6,15,19]. But other studies have not supported the associations for high job control [12,20], high psychological job demands [12,14–18,20] and an active job [14,21,22]. In addition, only a few studies [15,16,19,20,22] examined the associations after controlling for possible confounders such as socioeconomic status, physical effort at work, and working hours. Furthermore, to our knowledge, few studies [15] have examined the associations in US workers from diverse occupations and industries.

The aim of this study is to examine whether psychosocial work characteristics are associated with active (moderate or vigorous level) LTPA in middle-aged US workers, using a recent US national dataset.

METHODS

Study population

Data from the National Survey of Midlife Development in the United States (MIDUS) II study [23] were used for this study. Information on physical effort at work and leisure-time physical activity was not available in the MIDUS I study, so it was not possible to perform a longitudinal analysis. From 1995 to 1996, the MacArthur Midlife Research Network carried out a national survey (i.e., MIDUS I study) to investigate the role of behavioral, psychological, and social factors in understanding age-related differences in physical and mental health [23]. In the MIDUS I study, 7108 persons (males, 48% and females, 52%) completed a telephone interview only (N = 783) or both the interview and mailed questionnaires (N = 6325). All of the participants were non-institutionalized, English-speaking adults, aged 25–74, in the US. They were drawn from four subsamples: (a) a national random-digit-dial (RDD) sample (N = 3487); (b) oversamples from five metropolitan areas (N = 757); (c) siblings of individuals from the RDD sample (N = 950); and (d) a national RDD sample of twin pairs (N = 1914). 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 [23]. The sociodemographic 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 black, young (e.g., aged 25 to 34), or had less education (i.e., 12 or less than 12 years of formal education) [23].

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%). There were no significant ($p < 0.01$) differences between the follow-up participants and non-participants in terms of age and gender. However, in the follow-up, less-educated persons and non-whites were relatively more likely to have dropped out of the study. For the MIDUS II study, 4,963 persons (males, 47% and females, 53%) completed a telephone interview only (N = 931) and both the interview and mailed questionnaires (N = 4032). For this analysis, we first restricted study subjects to those (N = 2292) who completed both the interview and mailed questionnaires (N = 4032), were not pregnant (N = 4954), were working a paid-job (at least one hour per week at a main job) in the MIDUS II survey (N = 2469), and were aged less than 70 years (N = 4177). Finally 2019 workers (1001 males and 1018 females) who had valid information on the exposure and outcome variables (see below) were chosen for this analysis.

Main exposures — job control, psychological job demands, and their combinations

Both job control and psychological job demands were assessed by self-administered questionnaire items, similar to the ones of the Job Content Questionnaire (JCQ) [24]. Job control was measured with five items about skill discretion (2 items; e.g., "How often do you learn new things at work?") and decision authority (3 items; e.g., "How often do you have a choice in deciding how you do your tasks at work?"). Psychological job demands were measured with three items about work intensity, workload, and time pressure (e.g., "How often do you have enough time to get everything done?" — reverse scored). More detailed information about the items is available elsewhere [25]. The items had a five-point Likert type of response set: all of the time (1) to never (5) and were summed up for scaling-scoring. The Cronbach alphas of job control and psychological job demands were 0.81 and 0.68, respectively. For analysis, the two scale scores were divided into four groups based on their quartiles. The lowest groups of job control and psychological job demands scale scores were chosen as the reference for analysis (see below).

The four quadrants of the DC model — active, low strain, high strain, and passive jobs — were created by two different methods: a) based on the medians of job control and psychological job demands (hereafter called "four-group

definition"); and b) based on the quartiles of job control and psychological job demands (resulting in 16 possible cells) [26, see Figure 2-e, p. 195] for avoiding potential misclassification of the four quadrants of the DC model around the medians of job control and psychological job demands. The 4 cells in the middle were labeled as "middle group" and the other 12 cells (3 corner cells for each) were labeled as active, low strain, high strain, and passive jobs (hereafter called "five-group definition").

Outcome — active LTPA

Active LTPA was defined by moderate or vigorous level of LTPA which is long enough to work up a sweat, several times a week, during the summer or the winter. It is quite consistent with the contemporary minimum recommendation of physical activity for US adults [1,3,4]: at least 5 days of week for moderate physical activity and at least 3 days per week for vigorous physical activity. In detail, vigorous and moderate LTPA were each assessed with one item [23]: "during your leisure time or free time, how often do you engage in vigorous physical activity that causes your heart to beat so rapidly that you can feel it in your chest and you perform the activity long enough to work up a good sweat and are breathing heavily?"; and "during your leisure time or free time, how often do you engage in moderate physical activity, that is not physically exhausting, but it causes your heart rate to increase slightly and you typically work up a sweat?", respectively.

The items were specified further for the summer and the winter, considering a possible seasonable variation of LTPA. They had a 6-frequency based response set (several times a week, once a week, several times a month, once a month, less than once a month, and never). A preliminary analysis revealed little seasonal (summer vs. winter) variation in responses to the vigorous and moderate physical activity items: Spearman correlations were 0.90 and 0.87, respectively. Nonetheless, in this study, we still retained seasonal specificity in the definition of active LTPA (i.e., during the summer *or* the winter) to minimize potential misclassification of the LTPA outcome variable (essentially equivalent to controlling for potential confounding by season).

Covariates

Various potential covariates were considered in the analysis: data sources, socio-demographic measures [4,27–31], other working conditions [6,16,17,22,27,32,33], health conditions [28,34], and health behaviors [28–30]. 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), race (whites vs. 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). Working conditions were measured by questionnaire items: physical effort at work (1 item), coworker (2 items) and immediate supervisor (2 items) support, and no coworkers (2 items) and immediate supervisors (2 items). More detailed information about the items is available elsewhere [25]. In addition, hours of work per week at a main job (≤ 40 hrs and > 40 hrs per week) and other paid jobs (yes vs. no) were also self-reported.

The following health conditions and health behaviors were measured: major depression assessed by the telephone interview, based on the Diagnostic and Statistical Manual of Mental Disorders III-R [35]; 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); obesity (body mass indexes based on self-reported height and weight information, ≥ 30 kg/m^2) [36]; 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 [37] during the past month and heavy drinking — more than moderate drinking vs. no drinking); 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").

Statistical analyses

Descriptive statistics of vigorous and moderate levels of LTPA are presented in Table 1. The bivariate associations of the study variables with active LTPA were examined by chi square tests (Table 2). The associations were then investigated through a series of multivariate logistic regression models (Tables 3 and 4): Model 1 — only two variables (job control and job demands) or the four quadrants of the DC model; Model 2 — additionally with other working conditions; Model 3 — additionally with other working conditions, data sources, and socio-demographic variables; and Model 4 — additionally with other working conditions, data sources, socio-demographic variables, health conditions, and health behavior variables. In addition, the above multivariate analyses were replicated with stratification of the data by sex and education (Table 5) in consideration of potential interactions between sex, education, and the psychosocial work characteristics on active LTPA.

Table 1. Prevalence of vigorous and moderate leisure-time physical activity (LTPA) in 2019 US male and female workers

Level of LTPA	Men N = 1,001 (%)	Women N = 1,018 (%)	Total N = 2,019 (%)
Vigorous	30.8	28.3	29.5
Moderate	38.2	39.8	39.0
Vigorous or moderate	44.8	44.4	44.6

Table 2. Active leisure-time physical activity prevalence in relation to study variables in 2019 US workers

Major variable category	Minor variable category	Subcategory	Frequency (%)	Active LTPA (%)
Data source	Subsamples	National random	41.9	45.8
		City	9.2	47.8
		Siblings	16.3	43.2
		Twin	32.6	42.8
Socio-demographic	Sex	Men	49.6	44.8
		Women	50.4	44.4
	Age (years)	< 40	11.7	49.8[b]
		40–49	34.8	45.9[b]
		50–59	36.5	45.4[b]
		≥ 60	17.0	36.6[b]
	Marital status	Married	73.8	44.6
		Non-married	26.2	44.5
	Race	White	92.7	45.8[c]
		Others	7.3	29.3[c]
	Education	High school or less	25.4	31.4[c]
		Some college	28.8	40.2[c]
		University or more	45.8	54.6[c]
	Annual household income ($)	< 60,000	32.7	37.0[c]
		60,000–99,999	33.1	43.3[c]
		≥ 100,000	34.2	53.1[c]

Table 2. Active leisure-time physical activity prevalence in relation to study variables in 2019 US workers — cont.

Major variable category	Minor variable category	Subcategory	Frequency (%)	Active LTPA (%)
Working conditions	Job control	Lowest group	21.5	36.2[c]
		2nd lowest group	28.2	42.5[c]
		2nd highest group	24.6	45.4[c]
		Highest group	25.8	53.1[c]
	Quantitative job demands	Lowest group	23.9	44.2
		2nd lowest group	18.9	43.6
		2nd highest group	35.7	43.8
		Highest group	21.6	47.2
	Four groups of the DC combinations	Passive	21.7	39.5[c]
		High strain	28.0	40.0[c]
		Low strain	21.1	48.5[c]
		Active	29.3	49.9[c]
	Five groups of the DC combinations	Passive	16.5	36.9[c]
		High strain	17.5	39.5[c]
		Middle	29.2	42.8[c]
		Low strain	15.9	51.4[c]
		Active	20.9	52.1[c]
	Supervisor support	Low	41.6	42.8
		High	42.8	45.3
		No immediate supervisors	15.6	47.3
	Coworker support	Low	47.3	43.3
		High	43.1	46.4
		No coworkers	9.6	42.8
	Hours of work per week at a main job	40 or less	62.8	43.6
		> 40	37.2	46.1
	Any other (second) paid jobs	No	84.8	43.8[a]
		Yes	15.2	49.0[a]
	Physical effort at work	Low	56.4	47.6[b]
		Middle	23.6	40.7[b]
		High	20.0	40.7[b]
Health conditions	Any chronic diseases	No	48.5	46.5[a]
		Yes	51.5	42.7[a]
	Major depression	No	92.2	45.0
		Yes	7.8	39.9
	Obesity (BMI ≥ 30 kg/m^2)	No	72.3	48.1[c]
		Yes	27.7	35.4[c]
Health behaviors	Stress-induced overeating	No	70.9	45.0
		Yes	29.1	43.5
	Current smoker	No	84.4	48.4[c]
		Yes	15.6	24.1[c]
	Alcohol consumption	No	33.5	36.1[c]
		Moderate	64.2	49.2[c]
		Heavy	2.3	38.3[c]

DC — demand-control, BMI — body mass index.
[a] $p < 0.10$, [b] $p < 0.01$, [c] $p < 0.001$ at chi-square tests.

Table 3. Odds ratios and their 95% confidence intervals of the study variables (including job control and high psychological job demands) for active leisure-time physical activity in US workers (N = 2019)

Variables	Model 1	Model 2	Model 3	Model 4
Job control				
Lowest	1.00	1.00	1.00	1.00
2nd lowest	1.32 (1.02–1.71)	1.25 (0.96–1.63)	1.14 (0.87–1.13)	1.09 (0.83–1.44)
2nd highest	1.48 (1.13–1.92)	1.39 (1.06–1.83)	1.20 (0.90–1.60)	1.18 (0.88–1.57)
Highest	2.01 (1.55–2.61)	1.93 (1.46–2.57)	1.55 (1.16–2.08)	1.60 (1.18–2.16)
Job demands				
Lowest	1.00	1.00	1.00	1.00
2nd lowest	0.93 (0.70–1.22)	0.95 (0.72–1.25)	0.85 (0.64–1.13)	0.84 (0.63–1.13)
2nd highest	0.95 (0.75–1.20)	0.98 (0.77–1.24)	0.89 (0.69–1.14)	0.87 (0.70–1.12)
Hhighest	1.10 (0.85–1.43)	1.13 (0.85–1.49)	0.99 (0.72–1.28)	0.92 (0.68–1.24)
Supervisor support				
Low		0.96 (0.78–1.18)	0.91 (0.73–1.12)	0.92 (0.74–1.14)
No immediate supervisor		1.05 (0.75–1.45)	1.03 (0.73–1.45)	0.98 (0.69–1.38)
Coworker support				
Low		0.96 (0.79–1.17)	0.99 (0.81–1.21)	1.02 (0.83–1.25)
No coworkers		0.78 (0.53–1.15)	0.92 (0.61–1.37)	0.95 (0.63–1.43)
Working hours (> 40)		1.01 (0.83–1.22)	0.91 (0.74–1.12)	0.94 (0.76–1.16)
Any other (second) paid jobs		1.27 (0.99–1.62)	1.23 (0.95–1.58)	1.20 (0.93–1.56)
Physical effort at work				
Middle		0.76 (0.61–0.95)	0.94 (0.74–1.18)	0.96 (0.76–1.21)
High		0.77 (0.61–0.98)	1.07 (0.83–1.39)	1.12 (0.86–1.46)
Women (vs. men)			1.05 (0.86–1.27)	1.06 (0.86–1.30)
Subsample				
Siblings			0.85 (0.65–1.11)	0.84 (0.64–1.10)
Twin			0.90 (0.72–1.11)	0.88 (0.71–1.10)
City			1.03 (0.74–1.44)	1.03 (0.73–1.45)
Age (years)				
40–49			0.88 (0.64–1.19)	0.85 (0.62–1.17)
50–59			0.83 (0.61–1.13)	0.80 (0.59–1.10)
≥ 60			0.63 (0.44–0.90)	0.60 (0.41–0.87)
Non-married			1.30 (1.03–1.64)	1.39 (1.09–1.76)
Race (non-white)			0.47 (0.32–0.69)	0.51 (0.35–0.76)
Education				
Middle			0.63 (0.51–0.79)	0.72 (0.57–0.90)
Low			0.46 (0.36–0.59)	0.56 (0.44–0.73)
Annual household income				
Low			0.61 (0.47–0.79)	0.69 (0.53–0.90)
Middle			0.80 (0.64–1.01)	0.86 (0.68–1.09)
Stress-induced overeating				1.01 (0.81–1.26)
Smoking				0.38 (0.29–0.51)
Alcohol consumption				
Moderate				1.42 (1.16–1.75)
Heavy				0.97 (0.51–1.86)
Any chronic diseases				1.02 (0.84–1.24)
Major depression				0.87 (0.61–1.26)
Obesity				0.64 (0.51–0.80)

Table 4. Odds ratios (OR) and their 95% confidence intervals (CI) of the combinations of job control and psychological job demands for active leisure-time physical activity in US workers (N = 2019)

Number of groups	Variables	Model 1 OR (95% CI)	Model 2[a] OR (95% CI)	Model 3[b] OR (95% CI)	Model 4[c] OR (95% CI)
4	Passive job	1.00	1.00	1.00	1.00
	High strain	1.02 (0.79–1.32)	1.05 (0.81–1.36)	0.95 (0.73–1.25)	0.94 (0.71–1.24)
	Low strain	1.44 (1.10–1.89)	1.39 (1.06–1.84)	1.18 (0.89–1.57)	1.23 (0.92–1.65)
	Active job	1.53 (1.19–1.96)	1.50 (1.16–1.95)	1.22 (0.93–1.60)	1.22 (0.93–1.61)
5	Passive job	1.00	1.00	1.00	1.00
	High strain	1.12 (0.82–1.52)	1.17 (0.85–1.61)	1.06 (0.77–1.47)	1.07 (0.77–1.50)
	Middle	1.28 (0.97–1.68)	1.27 (0.96–1.68)	1.09 (0.81–1.45)	1.27 (0.96–1.68)
	Low strain	1.81 (1.32–2.47)	1.78 (1.29–2.45)	1.50 (1.08–2.09)	1.60 (1.14–2.25)
	Active job	1.86 (1.39–2.49)	1.86 (1.37–2.53)	1.43 (1.04–1.97)	1.46 (1.06–2.03)

[a] Other working conditions (supervisor and coworker support, hours of work per week at a major job, any other paid jobs, and physical effort at work) were controlled for.
[b] Covariates in Model 2 plus sources of subsamples and socio-demographic variables (age, sex, marital status, race, education, and annual household income) were controlled for.
[c] Covariates in Model 3 plus health behaviors (stress-induced overeating, current smoker, and alcohol consumption) and health conditions (any chronic diseases, major depression, and obesity) were controlled for.

RESULTS

Descriptive statistics of active LTPA

The prevalence of vigorous and moderate levels of LTPA was 29.5% and 39.0%, respectively in the study sample. Twenty four per cent (24.0%) of the study sample engaged in both vigorous and moderate LTPA; 15.1% only in moderate LTPA; and 5.5% only in vigorous LTPA. Thus, 44.6 % of the study sample engaged in active LTPA (i.e., moderate or vigorous LTPA). There was little difference in LTPA between men and women (Table 1).

Bivariate associations with active LTPA

In bivariate analyses, higher levels of job control were significantly ($p < 0.001$) associated with active LTPA (Table 2) in US male and female workers. Active LTPA was also slightly higher among workers in the highest quartile of psychological job demands; however, this association was not statistically significant. Active LTPA was most prevalent in active jobs, while it was least prevalent in passive jobs, although the differences were small between passive and high strain jobs and between active and low strain jobs, reflecting the lack of a significant association between psychological job demands and active LTPA. The difference in prevalence of active LTPA between active and passive jobs became slightly larger when the five-group definition of the DC model was used than when the four-group definition was used.

Age (younger workers), race (whites), high levels of education and annual household income, low physical effort at work, being non-obese, non-smokers, and moderate level of alcohol consumption were strongly ($p < 0.01$) associated with active LTPA. Data-source subsamples, sex, marital status, supervisor support at work, hours of work per week, major depression, and stress-related overeating were not associated with active LTPA. Having a chronic disease and a second job were marginally ($p < 0.10$) associated with active LTPA.

Multivariate associations with active LTPA

Controlling for other working conditions such as social support at work, hours of work, second job, and physical effort at work had little effect on the association between job control and active LTPA (Table 3). However, the association was attenuated to some extent by socio-demographic variables (particularly education and annual household income). Nonetheless, the highest level (vs. the lowest level) of job control was still significantly associated with

Table 5. Odds ratios and their 95% confidence intervals of the combinations of job control and psychological job demands for active leisure-time physical activity in US workers by gender and education

Variables	Men				Women			
	model 1	model 2[a]	model 3[b]	model 4[c]	model 1	model 2[a]	model 3[b]	model 4[c]
	high education (N = 761)				high education (N = 746)			
Job control								
Lowest	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2nd lowest	1.20 (0.76–1.90)	1.12 (0.70–1.80)	1.08 (0.66–1.75)	1.08 (0.65–1.77)	1.35 (0.88-2.06)	1.35 (0.87–2.07)	1.39 (0.89–2.18)	1.25 (0.79–1.98)
2nd highest	1.56 (0.99–2.45)	1.47 (0.91–2.36)	1.43 (0.88–2.33)	1.44 (0.87–2.38)	1.27 (0.82–1.96)	1.26 (0.80–1.98)	1.15 (0.72–1.84)	1.05 (0.65–1.70)
Highest	2.11 (1.35–3.30)	2.08 (1.26–3.44)	1.89 (1.13–3.16)	1.88 (1.10–3.21)	2.06 (1.31–3.22)	1.97 (1.23–3.18)	1.76 (1.08–2.89)	1.76 (1.06–2.92)
Passive	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Strain								
High	1.63 (0.93–2.86)	1.62 (0.92–2.87)	1.38 (0.77–2.49)	1.55 (0.84–2.86)	0.84 (0.51–1.39)	0.84 (0.50–1.41)	0.75 (0.44–1.30)	0.80 (0.46–1.39)
Middle	1.59 (0.96–2.62)	1.51 (0.90–2.52)	1.37 (0.81–2.32)	1.53 (0.89–2.63)	0.98 (0.63–1.51)	0.97 (0.62–1.51)	0.89 (0.57–1.41)	0.88 (0.55–1.40)
Low	2.73 (1.59–4.69)	2.75 (1.55–4.86)	2.54 (1.42–4.55)	2.81 (1.54–5.15)	1.16 (0.70–1.93)	1.12 (0.67–1.88)	0.98 (0.57–1.68)	1.03 (0.59–1.78)
Active job	2.42 (1.45–4.05)	2.31 (1.34–4.00)	1.95 (1.10–3.44)	2.08 (1.16–3.74)	1.58 (0.98–2.55)	1.53 (0.93–2.52)	1.24 (0.74–2.07)	1.26 (0.74–2.13)
	low education (N = 240)				low education (N = 272)			
Job control								
Lowest	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2nd lowest	1.10 (0.54–2.63)	1.09 (0.51–2.30)	1.00 (0.45–2.24)	1.13 (0.48–2.62)	1.25 (0.64–2.46)	1.14 (0.56–2.32)	1.25 (0.59–2.68)	1.19 (0.55–2.59)
2nd highest	1.20 (0.55–2.63)	1.21 (0.52–2.82)	1.01 (0.41–2.51)	1.14 (0.43–3.05)	1.04 (0.48–2.27)	1.00 (0.44–2.27)	1.12 (0.46–2.71)	1.15 (0.46–2.87)
Highest	0.58 (0.26–1.28)	0.57 (0.24–1.37)	0.40 (0.16–1.02)	0.43 (0.16–1.13)	2.67 (1.27–5.64)	2.77 (1.26–6.10)	2.60 (1.09–6.21)	2.67 (1.09–6.55)
Passive	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Strain								
High	0.87 (0.37–2.02)	1.01 (0.41–2.48)	1.10 (0.42–2.87)	0.90 (0.33–2.46)	1.32 (0.61–2.83)	1.37 (0.59–3.15)	1.35 (0.56–3.28)	1.38 (0.55–3.41)
Middle	1.14 (0.51–2.56)	1.30 (0.56–3.03)	1.24 (0.51–3.03)	1.27 (0.50–3.24)	1.19 (0.55–2.53)	1.13 (0.51–2.49)	1.06 (0.46–2.48)	0.96 (0.40–2.31)
Low	0.79 (0.29–2.14)	0.88 (0.30–2.55)	0.65 (0.21–2.02)	0.53 (0.16–1.76)	2.49 (1.06–5.86)	2.63 (1.10–6.31)	3.17 (1.18–8.51)	3.69 (1.27–10.71)
Active job	0.64 (0.26–1.59)	0.73 (0.28–1.91)	0.61 (0.22–1.65)	0.58 (0.20–1.63)	2.30 (0.95–5.54)	2.49 (0.97–6.38)	2.27 (0.84–6.16)	2.06 (0.72–5.87)

[a] Other working conditions (supervisor and coworker support, hours of work per week at a major job, any other paid jobs, and physical effort at work) were controlled for. [b] Covariates in Model 2 plus sources of subsamples and socio-demographic variables (age, marital status, race, education, and annual household income) were controlled for. [c] Covariates in Model 3 plus health behaviors (stress-induced overeating, current smoker, and alcohol consumption) and health conditions (any chronic diseases, major depression, and obesity) were controlled for.

active LTPA in the final model in which health conditions and health behaviors were also controlled for (Table 3), with an odds ratio (OR) (95% confidence interval (CI)) of 1.60 (1.18–2.16). Psychological job demands were not associated with active LTPA, as in the bivariate analysis.

Active job (vs. passive job) based on the four group definition was significantly associated with active LTPA, after controlling for other working conditions: OR (95% CI) = 1.50 (1.16–1.95). However, the association was non-significant when additionally controlling for socio-demographic variables (particularly education and annual household income) (Table 4). However, active job (vs. passive job) based on the five-group definition, was significantly associated with active LTPA, even after controlling for all of the covariates (Table 4), an OR (95% CI) = 1.46 (1.06–2.03). Low strain job (vs. passive job) was also associated with active LTPA: OR (95% CI) = 1.60 (1.14–2.25).

As in the bivariate analysis, age (younger workers), race (whites), high levels of education and annual household income, being non-obese, non-smokers, and moderate level of alcohol consumption were associated with active LTPA in the multivariate analyses. The one exception was low physical effort at work. It was not a significant contributor when controlling for socio-demographic variables (particularly education and annual household income) (Model 3 in Table 3).

Multivariate associations with active LTPA by gender and education

We replicated the above multivariate analyses after stratifying the data by sex and education. For a simpler analysis, we combined together the high and middle education groups (called higher education group). So four sub-samples were created for the higher/low education groups in each of men and women (see Table 5).

There were no statistically significant interactions between sex, education, and psychological job demands on active LTPA (data not shown here). The highest level of job control was associated with active LTPA in three of the four subsamples. However, this was not the case in a subsample of male workers with low education (N = 240).

The associations of active job and low strain job (vs. passive job) and LTPA based on the five-group definition in two subsamples (male higher education and female low education groups) were similar to those in the whole sample. However, the combinations of job control and psychological job demands were not associated with active LTPA in the other two subsamples: male low education and female higher education groups. In the male low education group, longer work hours (> 40 hours/week) and the low and middle levels of annual household income were associated with less active LTPA: OR (95% CI) = 0.46 (0.23–0.92); 0.20 (0.08–0.54); and 0.38 (0.16–0.89), respectively, in Model 4. On the other hand, in the female higher education group, high physical effort at work was marginally (p = 0.06) associated with active LTPA: OR (95% CI) = 1.57 (0.98–2.50) in Model 4.

DISCUSSION

This study examined the associations between psychosocial work characteristics and leisure-time physical activity in middle-aged US workers, using a recent US national (MIDUS II) dataset. In this study, high job control and its combinations with psychological job demands (active jobs) were identified as possible facilitators of active LTPA in the US workers. However, some discrepancies in this pattern of results were observed in stratified analyses by sex and education level. Particularly, in a subsample of male workers with only high school or lower education, work hours greater than 40 hours per week and annual household income less than $100 000 were associated with less active LTPA, while psychosocial work characteristics were not associated with active LTPA. Psychological job demands alone were not associated with active LTPA. These results, if confirmed in prospective analyses, would indicate a new avenue for promoting active LTPA in middle-aged US workers, i.e., increasing workers' on-the-job learning opportunities and workers authority on their tasks. However, the lack of a beneficial effect of high job control on men with lower levels of education needs to be explored further.

Comparisons with other studies

The results of this study were similar to those of the only other previous US study [15] from 32 worksites in Minnesota, that is job control and active jobs were associated with LTPA, but psychological job demands were not associated with LTPA. Our study has some advantages over the previous study. First, this study was based on a national US survey, thus its results could be more generalizable to the US working population. Second, this study addressed as its main outcome specifically the contemporary recommended minimum level of physical activity for US adults [3,4]. In addition, this study revealed that associations could be gender- and social status-specific. Thus its results would be more informative in evaluating and establishing public health policies for US adults.

The results of this study for job control and psychological job demands and LTPA are also consistent with those of the majority of non-US studies. Five studies [6,14–18] supported the association between job control and LTPA at least in either men or women. Although one Japanese study [20] in 12 rural communities generally did not support the association, it also reported a significant association between job control and LTPA in a subsample with female workers (farming and forestry, and fisheries). One study [12] from the United Kingdom did not support the association, but limited variation in job control existed among its study subjects, which might make it harder to detect an association. Only one study [6] reported a bivariate association between high psychological job demands and LTPA. However, none of the other studies [12,14, 16–18,20] supported such an association. Even one Swedish study [16] reported that a high level of psychological job demands (hectic job and psychologically demanding job) was a risk factor for sedentary LTPA in women.

In this study, although the association between active jobs (vs. passive jobs) and active LTPA was supported in the whole sample, it was not supported in two out of the four subsamples. Similarly, the association has been inconsistent across the other studies or between men and women [6,14,15,21,22,38]. A recent prospective analysis [39] from the Whitehall II study reported that "passive jobs" (vs. all non–passive jobs) is a risk factor for low LTPA in men, but not in women. However, the study did not provide information about any variation in LTPA among the three non-active jobs (active, high strain, and low strain), which would be useful for more fully exploring the active-passive hypothesis of the DC model for active LTPA.

Implications for theories and policies

Strictly speaking, this study did not support the active-passive hypothesis in that the prevalence of active LTPA was greater in low strain jobs than in active jobs, which is a deviation from the predicted gradient of LTPA along the active-passive axis. In other studies, LTPA was also most prevalent in low strain jobs among the four quadrants of the DC model [14,18,22], although this was not always the case [15,21].

These findings indicate that not only the active-passive hypothesis, but also the "strain" hypothesis (a low strain job would be least stressful while a high strain job would be most stressful to workers) of the DC model may play a role in active LTPA of workers. That is, the accumulation of strain in a high strain job could inhibit workers from engaging in LTPA. Landsbergis et al. [40, Figure 1] illustrated how the two distinct hypotheses could explain the same health behavior via different mechanisms (work strain vs. learned passivity) in workers. If the two mechanisms work together in reality and the relative importance of each mechanism could be determined in context, it might be difficult to expect a clear gradient of LTPA along the active-passive axis of the DC model in empirical studies. Future longitudinal epidemiological studies in which qualitative methods [41] are also employed to investigate the two mechanisms in detail would be needed for testing the above speculation.

On the other hand, this study implies that other work-related factors such as longer work hours and low annual household income are important occupational determinants of LTPA and may be more important than the psychosocial work characteristics in less-educated male workers. The importance of time and money [8] as material resources for off-the-job participation should not be ignored. Overtime, along with shift work and second job,

was reported by blue-collar workers as a main barrier to their participation in a workplace health promotion program [42]. Low income has been a well-documented risk factor for LTPA [31]. It may have additional meanings for less-educated male workers for LTPA, although we cannot rule out the possibility of a residual socioeconomic status effect of income.

This study suggests that job control may be an important occupational determinant of active LTPA in middle-aged US workers. Jaffee and Rex [43] noted one common feature of female workers who were not actively engaged in physical activity: "it is possible that women who were not active have never been active and don't know how to start or how to implement an exercise plan" (p. 27). Having on-the-job learning opportunities and decision authority on their tasks, known to be beneficial to preventing common mental disorders [44] and cardiovascular diseases [45], could be also conductive to active LTPA in US workers. However, unfortunately, psychosocial work characteristics have been disregarded in recent literature reviews [31,46] on social and environmental determinants of LTPA. In order to promote LTPA in US workers, we need to seriously take into consideration psychosocial work characteristics as a new avenue, which is philosophically consistent with an ecological health promotion model [47].

Limitations

This study has several limitations. First, despite the consistency with other studies, we cannot draw causal inferences about the association between psychosocial work characteristics on active LTPA in US workers based on this secondary analysis of cross-sectional data. Although we cannot rule out the possibility of reverse causation, we believe that the directionality of the association would be likely to be forward rather than backward since most people cannot choose or change working conditions as easily as they can do LTPA [48]. 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 entire US working population. The dataset underrepresents certain racial and ethnic groups (e.g., blacks) and people with low level of education. Thus, interpretations of the study results should be made in consideration of the "selective" characteristics of study subjects. Third, self-reported measures of psychosocial work characteristics and active LTPA could be vulnerable to self-report bias. However, the measures of job control and psychological job demands in this study were quite similar to those of the JCQ, which has been extensively validated in several working populations including the US [49]. Although the meanings of some items of the JCQ psychological job demands scale (work fast and work hard items) [49,50] could be interpreted differently by social status (white collar vs. blue collar), our psychological job demands measure did not include such items. In addition, we minimized this possibility via a stratified analysis by education level and adjustment for physical effort at work. In addition, the information from single items based on either a sweat episode or heart rate/breathing [30,51,52], very similar to the physical activity items in this study, were validated against the information from long physical activity questionnaires or a physical activity monitor in US adults. So we do not believe that such self-report bias, if any, would significantly bias our results.

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