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Job Strain and Cognitive Change: the Baltimore Epidemiologic Catchment Area Follow-up Study

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Abstract

Objectives: To investigate the association between job strain and subsequent cognitive change over approximately 11 years, using data from the population-based Baltimore Epidemiologic Catchment Area Follow-up Study.

Methods: The sample ranged from 555 to 563 participants, depending on the outcome, who reported psychosocial characteristics corresponding to the full-time job they held at baseline (1993–1996). Overall cognitive performance was measured by the Mini-Mental State Examination (MMSE), and verbal memory was measured by the Immediate and Delayed Word Recall Tasks (IWRT and DWRT) at baseline and follow-up (2003–2004). Multiple linear regression was used to examine the association between job strain and cognitive change, and inverse probability weighting was used to account for differential attrition.

Results: Participants with high job demands (psychological or physical demands) and/or low job control had greater decrease in the MMSE and memory scores than those with low job demands and high job control. After adjustment for baseline outcome scores, age and sex, the greatest

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CONTRIBUTORSHIP STATEMENT

LD conceived the research question, conducted data analyses and drafted the manuscript. APS, JA and RM contributed to the study design, data interpretation, revision of the manuscript and the final approval. WWE provided the data, and contributed to the study design and the final approval. PJS contributed to revision of the manuscript and the final approval. RM supervised the project.

COMPETING INTERESTS

None.

decrease was observed in participants with high job demands and low job control (MMSE: -0.24 , 95% confidence interval [CI]: -0.36 , -0.11 ; verbal memory scores: -0.26 , 95% CI: -0.44 , -0.07). The differences were partially explained by sociodemographic characteristics, occupational prestige and health factors.

Conclusions: Findings from this prospective study suggest that job strain is associated with, and may be a potential modifiable risk factor for adverse cognitive outcomes.

Keywords

epidemiology; mental health; stress; ageing; public health

INTRODUCTION

In the context of global aging, the increasing burden of late-life cognitive impairment has highlighted the need to identify modifiable early- and mid-life risk factors for adverse cognitive outcomes.¹ The work environment is a major component of adult life that shapes health over the life course.² Individuals' early life cognitive abilities, influenced by genetic heritage and childhood socioeconomic and health status, affect their educational attainment and occupational choice in adulthood.³ Work characteristics determine one's trajectories of health status,⁴⁵ which may in turn influence subsequent work transitions.⁶ In this study, we examined the association of job strain, a potential psychosocial risk factor in the workplace, with later cognitive change in adulthood. We framed the research within the job demand-control model framework.⁷

The job demand-control model is one of the most influential job stress models that has been widely used to study occupational health outcomes.⁸⁹ It proposes two worker-level elements of the psychosocial work environment: job demands, the workload placed on workers; and job control, the degree to which workers are allowed to decide how to meet job demands.⁷ The subdomains of job control are decision authority (degree of freedom in making decisions) and skill discretion (degree of creativity and skill development permitted).⁷ Job strain occurs when stress arising from high job demands and low control over work performance exceeds the body's ability to maintain well-being. Different combinations of demand and control levels form four major types of job-strain categories: high-strain (high demands and low control), low-strain (low demands and high control), active (high demands and high control) and passive (low demands and low control).⁷

The joint impacts of job demands and control may promote positive or negative cognitive outcomes, or affect the timing of workforce exit, which may have its own cognitive consequences. For example, chronic stress from high-strain jobs may dysregulate the hypothalamic-pituitary-adrenal axis, disrupt allostasis and cause disorders of other body systems, thereby affecting cognition directly as a result of functional and structural deficits in the brain, or indirectly through conditions associated with an increased risk of cognitive decline, such as cardiovascular disease and depression.¹⁰¹¹ Second, high job demands combined with a high degree of control (active jobs) produce a cognitively stimulating work environment, which may promote behavior development and increase cognitive performance.⁷¹² In contrast, passive jobs may suppress activities in general, including

problem-solving activities.⁷ Third, job strain is a predictor of early retirement contemplation and work-related disability,^{13,14} which may be associated with poorer late-life cognitive outcomes.¹⁵

Empirical evidence regarding the association between work stress and late-life cognitive function using the job demand-control model is limited and mixed.^{16–21} Although high demands and low control have been generally found to be associated with poorer cognitive function, there are variations across cognitive domains. Moreover, differential attrition may bias the results of studies that use complete-case analysis.²² Both job strain and cognitive decline are associated with increased risks of mortality and study dropout.^{23–25} Restricting the sample to complete cases may lead to biased association between job strain and cognitive changes, when there are unmeasured factors such as previous cognitive change that influence both remaining in the study and subsequent cognitive change.²²

The present study aims to advance our knowledge in two ways. First, we investigate the association between job strain and changes in cognition prospectively over a subsequent eleven-year period in a population-based sample from the Baltimore Epidemiologic Catchment Area (ECA) follow-up study, which included psychopathology assessments based on structured interviews. Second, it accounts for differential attrition using inverse probability weighting to obtain valid estimates. We hypothesized that participants with high-strain or passive jobs would experience greater decrease in cognitive function over 11 years of follow-up, compared with those with low-strain jobs.

METHODS

Study population

The Baltimore ECA follow-up study is a population-based, prospective cohort study designed to investigate life course psychopathology.²⁶ The first interview in the Baltimore ECA study (Wave 1) was conducted in 1981 among 3,481 Baltimore residents. Participants were followed up in 1982 (Wave 2, n=2,768), 1993–1996 (Wave 3, n=1,920) and 2004–2005 (Wave 4, n=1071). The Baltimore ECA follow-up study has been described in more detail elsewhere.²⁶

Wave 3 of the Baltimore ECA constituted the baseline of the present study, and Wave 4 the follow-up. Of the 1,920 participants in Wave 3, 1,252 reported job characteristics of their most recent full-time job. We excluded 436 participants who were not working at the full-time job at the time of the Wave 3 interview. We further excluded 11 participants who had Mini-Mental State Examination (MMSE) scores <24 at Wave 3 (suggesting abnormal cognitive function), and 191 participants who were not in the Wave 4. Of the remaining 614 participants, 563 had baseline and follow-up MMSE scores, and 555 had baseline and follow-up scores of the Immediate Word Recall Task (IWRT) and Delayed Word Recall Task (DWRT). Thus, these totals represent the final sample sizes for each outcome. Participants who did not complete the Wave 4 interview or had missing scores for cognitive measures at Wave 4 were excluded from the final sample but included in the analytical process of generating inverse probability weights to account for potential differential attrition (n=242 for MMSE, n=250 for IWRT and DWRT).

Measures

Cognitive tests.—Global cognition and memory were measured by the MMSE and word recall tests (IWRT and DWRT) respectively at baseline and follow-up. The MMSE, a test widely used in clinical and research settings to detect changes in cognitive function, covers five domains, including orientation, registration, attention and calculation, recall and language.²⁷ MMSE scores range from 0 to 30, with higher scores representing better cognitive function. The IWRT and DWRT measure verbal episodic memory in particular. In the Baltimore ECA, a list of 20 common words was read to participants, and participants were asked to recall as many as they could, immediately after hearing the list (IWRT) and then 20 minutes later (DWRT).²⁸ Possible scores on each task range from 0 to 20, with higher scores indicating better recall.

We standardized the cognitive scores to baseline by converting the raw scores to z scores (supplemental materials).²⁹ A composite measure of memory was generated by averaging the z scores of IWRT and DWRT.²⁹ Cognitive change, the outcome of the present analysis, was considered as change in z scores of the MMSE and the composite measure of memory, and calculated as scores at Wave 4 minus scores at Wave 3. The raw and standardized change scores were approximately normally distributed.

Job strain.—The questions on job characteristics in the Baltimore ECA Wave 3 that we used to categorize job strain were adapted from the Quality of Employment Surveys, which was used for developing the job demand-control model.^{7,30} Factor analysis has been conducted in the Baltimore ECA study to validate the job demand-control model,³⁰ according to which, we formed scales of physical job demands, psychological job demands, decision authority and skill discretion (Table S1). Total scores for the four job scales were generated by summing the response values of each dimension,³⁰ and were approximately normally distributed in the study sample.

We constructed the job strain variable using the four job dimensions: physical job demands, psychological job demands, decision authority and skill discretion.³⁰ The correlation of job dimensions was low between physical demands and psychological demands ($r=0.14$), but high between decision authority and skill discretion ($r=0.60$). High demands was defined as either high physical demands or high psychological demands in the main analysis, and examined separately in the sensitivity analysis. Job control was characterized by combining measures of decision authority and skill discretion, yielding a single scale with good internal consistency (Cronbach $\alpha=0.83$). We dichotomized variables for high demand and low control based on a median split, and classified participants into four job categories: high-strain, active, passive and low-strain.

Demographic characteristics.—Participants' age, sex (male, female), race (White, non-White) and education (below high school, high school, above high school) were obtained at baseline. The Black and other race categories were combined due to the small sample size of participants who were neither White nor Black ($n=19$, 3.4%).

Health factors.—Participants' self-rated health status (excellent, good, fair or poor), lifetime mental disorders (yes, no), smoking status (never smoker, past smoker, current

smoker) and were assessed at baseline. The fair and poor categories of self-rated health status were combined due to the small sample size of participants reporting poor health (n=4, 0.9%). Lifetime depressive syndrome (major and minor depressive disorders excluding spells due to bereavement) and alcohol abuse/dependence were assessed using the Diagnostic Interview Schedule.³¹

Occupational prestige.—Occupational prestige of jobs reported at baseline was measured by the Nam-Powers-Terrie Occupational Status Scores (NAM index), which was generated based on occupation-associated educational requirements and income.^{32,33} It ranges from 0 to 100, with higher scores representing higher socioeconomic position.

Statistical analysis

We examined participant characteristics at baseline by job strain classification using Pearson's chi-square tests for categorical variables and Kruskal-Wallis tests for continuous variables, and compared the study sample with participants who were excluded due to either loss to follow-up or missing cognitive measures at follow-up.

We examined cognitive change during the study period by age and job strain categories. We used multiple linear regression models to examine the association of the composite job strain measure and each dichotomized job dimension at baseline with cognitive change over the follow-up period. We tested three models for each of the two cognitive outcomes, with low-strain jobs as the reference group. Model 1 adjusted for standardized cognitive score at baseline, age and sex. Model 2 additionally adjusted for race/ethnicity, education and occupational prestige. Model 3 adjusted for Model 2 covariates, self-rated health status and smoking status at baseline. Spline terms were used to model the non-linear association of the outcome scores with age and the NAM index. The coefficients of these models represented differences in the outcome scores for each category of predictors compared with the reference category for categorical predictors, or differences in the outcome scores for each unit change of continuous predictors. To account for the impact of differential attrition on the association of interest, we applied inverse probability weights to the models described above to reflect the full sample by up-weighting study participants who were similar to those not included (Supplemental materials).

Two sensitivity analyses were conducted. In the first, we additionally adjusted for lifetime depressive syndrome and alcohol abuse/dependence that may have influence on occupational choice. In the second, we separated physical demands from psychological demands and examined job strain respectively.

All significance tests were two-sided with alpha set at the level of 0.05. Statistical analyses were conducted using statistical software Stata version 14.2 (Stata Corp., College Station, TX). The Baltimore ECA follow-up study was approved by the Institutional Review Board of the Johns Hopkins Bloomberg School of Public Health.

RESULTS

Sample characteristics at baseline

Among 563 study participants with complete MMSE measures, the mean age at baseline was 43.7 years (standard deviation [SD]: 8.0); 56.5% were female; 61.6% were non-Hispanic Whites; 17.2% had an education level below high school; and 13.9% rated their health as fair or poor (data not shown). The mean follow-up period was 10.8 years (SD: 0.6; range: 9.3–12.1). In terms of job strain classification, 156 participants (27.7%) had low-strain jobs, 54 (9.6%) had passive jobs, 242 (43.0%) had active jobs and 111 (19.7%) had high-strain jobs (Table 1). Among the four groups, participants with high-strain jobs had the lowest average z scores on the MMSE and the composite measure for memory at baseline, the highest proportion of participants being non-White and reporting fair or poor health status, and the lowest occupational prestige (all $P<0.050$). The mean occupational prestige was highest among participants with low-strain jobs, followed by active jobs, passive jobs and high-strain jobs ($P<0.001$).

We found that the 242 participants who were excluded due to loss to follow-up ($n=191$) or missing the MMSE scores at Wave 4 ($n=51$) did not significantly differ from the study sample in sex, race, baseline self-rated health, baseline memory, lifetime depressive syndrome and alcohol abuse/dependence (Table S3). However, those excluded were older, had lower educational attainment, lower baseline MMSE, higher physical job demands, lower skill discretion and lower occupational prestige, and were more likely to smoke at baseline. Compared to participants with low-strain jobs, those with other types of jobs were more likely to drop out, and the difference was statistically significant for high strain jobs ($P<0.050$).

Association between baseline job strain and cognitive change

Decrease in IWRT scores was observed in all age groups, with older participants experiencing greater decrease (Figure S1, Table S4). Each one-year increase in age was associated with about 0.03 points decline in IWRT. There were significant decreases in the MMSE, IWRT and DWRT scores among participants with passive jobs and high strain jobs, and among those aged between 40 and 55 (Table S4). Compared to participants with low-strain jobs, people in all other job groups experienced greater decrease in the MMSE and memory scores (Table 2). High strain and passive jobs were associated with the greatest decrease in the MMSE (effect size as measured by Cohen's d: passive jobs: 0.40; active jobs: 0.02; high strain jobs: 0.25) and memory scores (Cohen's d: passive jobs: 0.13; active jobs: 0.04; high strain jobs: 0.08). The differences were partially explained by baseline cognitive scores, age, sex, race, education, occupational prestige, self-rated health status and smoking status at baseline.

The spline terms of age were statistically significant in the models of the MMSE scores. After adjustment for baseline MMSE scores and sex, each one-year increase in age was associated with 0.01 points decrease in the MMSE among participants aged below 55, and 0.05 points decrease in the MMSE among participants aged above 55. Among participants aged below 55, the effects of high-strain jobs, passive jobs and active jobs were equivalent to

the effect of 24.3, 22.9 and 10.3 years older age, respectively. Among participants aged 55 and above, the effects of high-strain jobs, passive jobs and active jobs were equivalent to the effect of 4.6, 4.4 and 2.0 years older age, respectively.

Overall, the results of the complete-case analysis were consistent with the main analysis (Table S5). Nevertheless, after accounting for attrition, the decrease in cognitive scores associated with passive and active jobs were attenuated in terms of magnitude and significance, but the decrease associated with high strain jobs were strengthened slightly.

The above findings remained after additional adjustment for mental disorders in the sensitivity analyses (Table S6). In the separate analysis for physical demands, the results consistently suggested similar trends as in the main analysis (Table S7). When considering psychological demands, active jobs did not differ from low strain jobs in the MMSE scores, and no statistically significant differences were observed in the memory scores (Table S7).

DISCUSSION

This study examined the association between job strain and cognitive change later in life using a population-based sample from the Baltimore ECA study. Results showed that low strain jobs were associated with significantly less decrease in cognitive scores than other job groups over an approximately eleven-year period.

We found differential attrition over the follow-up period according to baseline cognitive function, educational attainment, occupational prestige and baseline job characteristics, particularly among participants with high strain jobs. After accounting for attrition using inverse probability weighting, the decrease in cognitive function associated with high strain jobs was strengthened. This finding is consistent with the notion that complete-case analysis can induce a downward bias in the association,²² when there are unmeasured factors such as initial cognitive ability that reduce the probability of remaining in the sample but increase the risk of cognitive decline.

The findings are consistent with the hypothesis that high job strain is associated with adverse health outcomes in general.⁸ Work stress may influence cognitive health through physiological and psychological pathways. Normally, stress responses help individuals deal with urgent situations by activating the hypothalamus-pituitary-adrenal axis and raising cortisol levels.³⁴ However, when stressors become chronic, persistent activation of the stress response may cause structural brain changes, such as hippocampal atrophy,³⁴ and disorders of the human body systems that confer an increased risk of cognitive impairment.¹¹ As a result, workers with high strain jobs may experience unfavorable labor-force outcomes, such as early retirement, disability and switching to low-demand jobs due to adverse health consequences. Retirement and sick leave have also been shown to be associated with lower cognitive function in later life.^{15,35} Moreover, sense of control is a determinant of health behaviors that promotes cognitive performance.³⁶ Because a sense of low control is associated with high psychological stress, people with low job control bear higher risks of cognitive decline when facing high job demands.

We also found that passive jobs were significantly associated with greater decrease in cognitive function compared to low strain jobs, particularly for the MMSE. According to the “use it or lose it” hypothesis, engaging in mental activities that exercise the brain protects individuals against cognitive decline in later life.¹² Passive jobs such as delivery jobs that put less demand on cognitive and problem-solving activities may provide less cognitive protection conferred by mentally stimulating work activities.⁷ Moreover, initial cognitive ability has been proposed as a determinant of mental activity level in working life.¹² Individuals with low cognitive abilities are more likely to obtain low education and have unskilled jobs that fall in the passive category, and may therefore be predisposed to lower levels of mental activity in the workplace. In the present study, less than one tenth of the participants reported passive jobs at Wave 3, and they were more likely to be older non-White females with lower educational attainment. They may not fully represent adults with passive jobs, as participants with lower cognitive function may have dropped out of the study during the period between Wave 1 and Wave 3. It is not known if those who remained in the study entered into passive jobs in the first place due to lower levels of initial cognitive abilities, causing selection bias; or transitioned to passive jobs due to cognitive decline in later life, which may represent inverse causation. Our adjustment for age, sex, race, education and occupational prestige led to attenuated associations of passive jobs with cognitive change. Education is not only an indicator of socioeconomic status that closely relates to health and wellbeing,³⁷ but can also be a proxy for initial cognitive abilities and cognitive reserve that indicates the individuals’ capacity to sustain cognitive performance.³⁸ Nevertheless, using complete cases at Wave 3 without data on initial cognitive abilities and previous cognitive decline may have induced a downward bias and underestimated the association between passive jobs and cognitive changes.²² Similarly, active jobs were found to be associated with greater decline than low-strain jobs. Consistent with previous research,¹⁷¹⁹ we observed that the decrease in cognitive scores associated with active jobs tended to be less than that of passive and high-strain jobs; however, the differences remained significant after adjustment for sociodemographic and health factors. Further research is needed to investigate contributing factors to the differences between active and low-strain jobs in cognitive health.

High-strain, passive and active jobs are characterized by either high job demands and/or low job control. Our findings on the relationship between individual job dimension and cognitive change showed that high physical demands and low decision authority were particularly associated with decrease in cognitive function. These factors may have separate and joint impacts on cognitive function. They may also be proxies of the psychosocial work environment or socioeconomic status, as the association was attenuated after adjustment for race, education and occupational prestige.

The study has several potential limitations. First, selection bias may exist due to our lack of information on early-life risk factors that may confound the association between midlife job characteristics and cognitive decline later in life, such as early-life cognitive abilities, health and socioeconomic status. Second, leisure-time activities off the job also influence cognitive function.³⁹ However, data on participants’ cognitively stimulating activities outside of the workplace were not available. Third, the cognitive measures were not sufficiently detailed to account for different domains of cognitive function. Statistically significant differences in

the cognitive scores may not have clinically meaningful implications. The results should be considered hypothesis generating, and larger studies with comprehensive cognitive measures should seek to replicate the findings. Fourth, with only two assessments, longer trajectories of cognitive decline could not be studied.

Despite these limitations, this study's results support the hypothesis that high job strain is associated with cognitive decline later in life. The workplace is an important setting in which to implement public health interventions that may influence the cognitive health of the population. To the extent possible, job redesign or reorganization that reduces job demands and/or increases job control may help promote cognitive health in mid- and late life. Further research is needed to investigate the pathways between job strain and cognitive change, and to determine whether interventions that target potential mediators alter the negative impacts of job strain on cognitive health. Implementing these programs through the workplace may facilitate their dissemination.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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What is already known about this subject?

Job strain is associated with adverse health outcomes in general.

What are the new findings?

Using population-based data, the present study suggests that jobs with high demands and/or low controls are associated with adverse cognitive outcomes after adjustment for sociodemographic characteristics, occupational prestige and health factors.

Job strain may be a potential modifiable risk factor for adverse cognitive outcomes.

How might this impact on policy or clinical practice in the foreseeable future?

The workplace is an important setting in which to implement public health interventions that may influence the cognitive health of the population.

To the extent possible, job redesign or reorganization that reduces job demands and/or increases job control may help promote cognitive health in mid- and late life. Further research is needed to investigate the pathways between job strain and cognitive change, and to identify effective interventions.

Table 1.

Baseline sample characteristics by job strain classification, the Baltimore Epidemiologic Catchment Area Follow-up Study, 1993–2004.

Characteristics at baseline	High strain (n=111)			Active (n=242)			Passive (n=54)			Low strain (n=156)			P value
	%	Mean	SD	%	Mean	SD	%	Mean	SD	%	Mean	SD	
Age (continuous)		44.6	7.9		42.8	7.6		47.1	8.8		43.4	8.3	0.003
Age (categorical)													0.019
<40	25.2			37.6			18.5			37.8			
40–55	64.9			54.1			63.0			52.6			
>55	9.9			8.3			18.5			9.6			
Sex													0.047
Male	37.8			45.9			29.6			48.7			
Female	62.2			54.1			70.4			51.3			
Race													0.010
White	50.5			62.8			55.6			69.9			
Non-White	49.6			37.2			44.4			30.1			
Education													0.009
Below high school	22.5			15.3			27.8			12.8			
High school	29.7			36.4			46.3			34.0			
Above high school	47.8			48.4			25.9			53.2			
Self-rated health										37.2			
Excellent	18.0			30.6			22.2						0.003
Good	60.4			55.0			63.0			55.8			
Fair or poor	21.6			14.5			14.8			7.1			
Smoking status													0.132
Never smoker	27.9			35.1			29.6			37.8			
Past smoker	29.7			31.0			29.6			36.5			
Current smoker	42.3			33.9			40.7			25.6			
Lifetime depressive syndrome													0.944
Yes	14.4			16.5			14.8			14.7			
No	85.6			83.5			85.2			85.3			
Lifetime alcohol abuse/dependence													0.366

Characteristics at baseline	High strain (n=111)			Active (n=242)			Passive (n=54)			Low strain (n=156)			P value
	%	Mean	SD	%	Mean	SD	%	Mean	SD	%	Mean	SD	
Yes	12.6			16.5			11.1			19.2			
No	87.4			83.5			88.9			80.8			
Overall cognitive performance													
MMSE (raw scores)		28.8	1.3		28.9	1.4		28.9	1.4		29.2	1.0	0.020
MMSE (z scores)		0.3	0.5		0.4	0.5		0.4	0.5		0.5	0.4	0.020
Verbal memory													
IWRT (raw scores)		7.9	2.8		8.1	2.6		7.8	2.3		8.9	2.5	0.003
DWRT (raw scores)		6.2	2.7		6.5	2.6		6.3	2.4		7.0	2.6	0.047
Overall verbal memory (composite z scores)		0.2	0.9		0.3	0.8		0.2	0.8		0.5	0.8	0.011
Job characteristics													
Physical demands		18.6	2.9		18.4	3.2		15.3	1.5		15.2	1.7	<0.001
Psychological demands		8.0	1.3		8.1	1.5		6.5	0.6		6.3	0.7	<0.001
Decision authority		7.2	1.3		9.7	1.3		7.3	1.4		9.7	1.2	<0.001
Skill discretion		12.9	1.8		16.2	2.0		12.5	1.7		16.0	1.7	<0.001
Occupational prestige (NAM) ^a		46.7	22.3		61.3	22.9		50.3	23.5		64.7	21.0	<0.001

Note. DWRT, Delayed Word Recall Task; IWRT, Immediate Word Recall Task; MMSE, Mini-Mental State Examination; NAM, the Nam-Powers-Terrie Occupational Status Scores; SD, standard deviation. The study sample included 563 participants with complete measures on the MMSE. Pearson's chi-square tests were used for categorical variables and Kruskal-Wallis tests were used for continuous variables.

Table 2.

Multiple linear regression models of the association between job strain and cognitive change, the Baltimore Epidemiologic Catchment Area Follow-up Study, 1993–2004.

	Model 1		Model 2		Model 3	
	Coefficient	95% CI	Coefficient	95% CI	Coefficient	95% CI
Overall cognitive performance (MMSE) (n=563)						
Job strain classification						
Low strain	Reference	-	Reference	-	Reference	-
Passive	-0.22 [*]	-0.40, -0.05	-0.19 [*]	-0.37, -0.00	-0.18 [*]	-0.36, -0.00
Active	-0.10 [*]	-0.19, -0.01	-0.09 [†]	-0.19, 0.00	-0.09 [†]	-0.18, 0.01
High strain	-0.24 ^{***}	-0.36, -0.11	-0.20 ^{**}	-0.33, -0.07	-0.20 ^{**}	-0.33, -0.06
Verbal memory (IWRT and DWRT) (n=555)						
Job strain classification						
Low strain	Reference	-	Reference	-	Reference	-
Passive	-0.23 [†]	-0.46, 0.00	-0.15	-0.38, 0.09	-0.15	-0.39, 0.09
Active	-0.17 [*]	-0.32, -0.03	-0.15 [*]	-0.29, -0.01	-0.15 [*]	-0.29, -0.01
High strain	-0.26 ^{**}	-0.44, -0.07	-0.17 [†]	-0.36, 0.03	-0.16 [†]	-0.36, 0.03

Note. 95% CI, 95% confidence interval; DWRT, Delayed Word Recall Task; IWRT, Immediate Word Recall Task; MMSE, mini-mental state examination.

Inverse probability weights were applied to all models to adjust for differential attrition. Overall cognitive performance was based on z scores of the MMSE, and memory was based on composite z scores of the Immediate and Delayed Word Recall Tasks. Model 1 adjusted for baseline cognitive score, age and sex. Model 2 adjusted for Model 1 covariates, race, education and occupational prestige. Model 3 adjusted for Model 2 covariates, self-rated health and smoking status at baseline. The sample sizes were the same in the three models for MMSE and verbal memory. For the MMSE score, the 563 participants consisted of 111 with high strain jobs, 242 with active jobs, 54 with passive jobs and 156 with low strain jobs. For the memory score, the 555 participants consisted of 108 with high strain jobs, 240 with active jobs, 51 with passive jobs and 156 with low strain jobs. Low strain: low psychological and physical demands, high control; High strain: high psychological and physical demands, low control; Active: high psychological or physical demands, high control; Passive: low psychological and physical demands, low control.

[†] $P < 0.10$

^{*} $P < 0.05$

^{**} $P < 0.01$

^{***} $P < 0.001$