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RESEARCH ARTICLE

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Changes in work characteristics over 12 years: Findings from the 2002-2014 US National NIOSH Quality of Work Life Surveys

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Abstract

Objectives: To assess changes in work characteristics, socioeconomic status inequalities in changes in work characteristics, and whether US workplaces are becoming more stressful.

Methods: We analyzed data from 5361 employed participants from the 2002, 2006, 2010, and 2014 NIOSH Quality of Work Life Surveys, based on representative samples of US workers. We used regression analyses to assess changes in job characteristics, adjusting for age, sex, race/ethnicity, education, work hours, and unemployment rate. For the regression analyses with continuous job characteristics, we created standardized variables allowing for the magnitude of changes to be directly compared between job characteristics.

Results: Over the period 2002-2014, we observed statistically significant increases in job strain (+0.09 standard deviations (SD), $P = 0.02$), low job control (+0.10 SD, $P = 0.03$), and work-family conflict (+0.15 SD, $P = 0.001$). No significant changes were observed for high job demand, low social support, and low reward. The largest increase in low job control was seen among service workers.

Conclusions: The increase in two cardiovascular disease risk factors, job strain, and low job control, might partially explain the slowing of the decline in US heart disease and stroke mortality rates.

KEYWORDS
job control, job strain, job stressors, QWL surveys, work characteristics

1 | INTRODUCTION

Stressful work characteristics are increasingly being studied for their relationships with various adverse health outcomes in the United States.[1,2] and other countries.[3–6] Job strain, a combination of high levels of job demands and low levels of control over one's work,[7] is a risk factor for adverse health effects,[8–12] including cardiovascular disease.[12–15] The job strain (job demands and control) model was introduced in 1979 by Robert Karasek[7,16] and explains how the risk of adverse health outcomes, including cardiovascular disease and its risk factors, can be increased by high work demands and low job control or job decision latitude. The model was later expanded to include support from coworkers and supervisors: the demand-control-support model.[11,17,18] Work conditions with high demands, low decision latitude, and low social support are posited to decrease health. Major technological, political, economic, and labor market changes have likely had an impact on the organization of work and psychosocial job stressors. Whether these changes have been increasing or decreasing sources of stress at work in recent years, and whether all groups of workers are similarly affected, is unclear.

Low socioeconomic status (SES) is associated with many chronic diseases,[19–21] and may modify the association between psychosocial job stressors and ill health. For example, a stronger association was seen among lower (vs higher) SES workers between job strain and high blood pressure[22] and between job strain and coronary heart disease.[23] Therefore, a greater understanding is needed of whether SES inequalities in job stressors are increasing or decreasing.

Using data from representative samples of US workers (1972 and 1977 Quality of Employment Surveys [QES] and 2002 National Institute for Occupational Safety and Health Quality of Work Life [NIOSH QWL] survey), Tausig et al[24] found an increasing linear trend for decision latitude, decreasing linear trends for both job demands and job strain, and curvilinear trends for both job support and job security; decrease (1972 to 1977) and then increase (1977 to 2002). Their findings suggest that work conditions improved (1972 to 2002) and thus working in 2002 was less stressful than it was in 1972. The American Psychological Association (APA) Work and Well-Being Survey,[25] conducted from 2011 to 2017, is based on nationally representative samples of US workers. However, they only span a period of 7 years, do not report statistical significance of changes over time, show a decrease in the proportion of blue-collar workers completing the survey, and have fewer questions on work characteristics than the QWL, especially those linked to risk of chronic diseases.

Therefore, to determine whether work characteristics are becoming more stressful and potentially increasing risk of chronic diseases, including cardiovascular disease, we examined data from the NIOSH QWL surveys over a 12-year period. We hypothesized that the prevalence of stressful psychosocial job and work schedule characteristics has been increasing over this 12-year period. We also hypothesized that the prevalence of stressful psychosocial job and work schedule characteristics has been increasing to a greater extent among workers with low SES compared to those with high SES.

2 | METHODS

2.1 | Study population

We analyzed data from 2002, 2006, 2010, and 2014 NIOSH QWL surveys.[26] In 2002, the 76-item QWL module was first administered as part of the General Social Survey (GSS) in households across the US during a face-to-face, 90-minute interview of a randomly selected sample of noninstitutionalized, English speaking adults age 18 or older. The QWL module was only given to GSS respondents who were used for pay during the week before the survey or temporarily not working due to vacation, sickness, or strike. The 2002 and 2006 QWL modules were identical. The 2010 module was slightly modified to reflect changes in risk factors for worker safety and health. The 2014 module was modified to include a variety of new questions. However, the questions used in the current analysis were present in all four waves of the QWL. Survey sample sizes were 1796 in 2002 (70% response rate), 1734 in 2006 (71% response rate), 1187 in 2010 (70% response rate), and 1249 in 2014 (69% response rate). Occupational and industry codes for the data set were updated to reflect 2010 Census Occupation and 2007 North American Industry Classification System (NAICS) codes.

We restricted the sample for the current analysis to QWL participants used in the labor force for at least 20 h/wk, consistent with other occupational research studies.[2,27] There were 5361 QWL survey participants eligible for analysis: in 2002 (N = 1576), 2006 (N = 1560), 2010 (N = 1075), and 2014 (N = 1150).

2.2 | Work characteristics (dependent variables)

We examined 21 different dependent variables: six primary and 15 secondary work characteristics. A number of these have previously been shown to have associations with adverse health outcomes[1–3,6] and all have appeared in all four QWL surveys. We then combined QWL items consistent with each work characteristic to create scales and assessed internal consistency reliability by Cronbach's α for 5 of our 6 primary work characteristics: high job demand (six items, Cronbach's $\alpha = 0.71$), low job control (five items, Cronbach's $\alpha = 0.66$), low work rewards (five items, Cronbach's $\alpha = 0.72$), low work social support (four items, Cronbach's $\alpha = 0.77$), and work-family conflict (three items, Cronbach's $\alpha = 0.67$). All items in these five scales had a four-point response option, such as ranging from "*strongly disagree*" to "*strongly agree*" (see Table S1 for complete list of items and response options and Table S2 for definition of Cronbach's α in Appendix A, available as an online supplement to this article).

We created an additional primary work characteristic, job strain, by combining high job demand and low job control in two ways: multiplicative (high job demands × low job control) and additive (high job demand + low job control × [6/5]). Multiplying by 6/5 provides equal weight to the job demand (six items) and job control (five items) scales in computing the additive version of job strain. Additionally, exploratory analyses were conducted on the following 15 secondary work characteristics (seven continuous and eight categorical variables); low supervisor support, inadequate resources, lack of opportunities for promotions, can't take time off during work for family, ability to vary starting and quitting times, days per month working extra hours, hours worked per week, must work extra days, night shift, nonstandard work shift, sexual harassment within last year, threatened or harassed on the job within last year, age discrimination, gender discrimination, and race/ethnicity discrimination. For full wording of questions for all secondary work characteristics see Table S2 (Appendix A).

We standardized all continuous variables for the analyses to simplify interpretation of the results because unstandardized scale units for job characteristic scales are not directly comparable to each other. Change over time based on standardized scores means that the magnitude of changes can be more directly compared between job characteristics. For any scale, one can see to what extent (how many SDs) the score changed over time.

2.3 | Additional variables

The independent variable was QWL survey year, with four levels: 2002, 2006, 2010, and 2014. We adjusted for sociodemographic

factors obtained from the GSS, including age, sex, race/ethnicity, educational level (seven categories), and hours worked per week (eight categories). We also adjusted for unemployment rate by using the actual unemployment rate for each year (5.7% for 2002, 4.7% for 2006, 9.8% for 2010, and 6.6% for 2014) obtained from the US Bureau of Labor Statistics (BLS).[28] Four occupational categories were created using the 2010 US census occupation codes: management/professional (0010-3540), service (3600-4650), sales/office (4700-5940), and blue-collar (6000-9750). Full descriptions of all covariates other than unemployment rate are contained in Table 1.

2.4 | Statistical analysis

In the following steps, we modeled, as dependent variables, (1) all continuous primary and secondary work characteristics, such as high job demand, low job control, and work-family conflict, using multiple linear regression and (2) all other secondary outcome (categorical) variables, such as race discrimination and sexual harassment, using multiple logistic regression. First, we compared each of the 3 later years (2006, 2010, and 2014) with the earliest year (model 1). Second, we assessed the significance of the linear trend for year (model 2). Third, we computed the estimated marginal means to graph trends across all four-time periods (model 3). Models 1 and 2 were derived from either the multiple linear regression or the multiple logistic regression models, depending on whether the outcome variable was continuous or categorical. Model 3 was derived only from the multiple linear regression models.

Each of the above steps was conducted twice for each work characteristic; first unadjusted and then adjusted for age, sex, race/ethnicity, education, hours worked per week, and unemployment rate. Finally, we tested for interactions by including a product term of occupational category (as a measure of SES) with all work characteristics, race/ethnicity with race discrimination, and gender with sex discrimination. For interaction between SES and trends in work characteristics, we modeled a product term consisting of four occupational groups and the four-time periods for each work characteristics variable. For interaction of race discrimination by race/ethnicity, we modeled a product term of the four race/ethnic groups with the four-time periods for race discrimination. For interaction of sex discrimination by gender, we modeled a product term of the two gender groups with the four-time periods for sex discrimination.

All statistical analyses were conducted using SPSS v23 Complex Samples with weights to account for the multistage area probability sample of the survey and produce more precise sample estimates. Statistical significance was set at a two-sided α value of 0.05. To determine the goodness-of-fit, we used R^2 for multiple linear regression models and Cox and Snell pseudo-R^2 for multiple logistic regression models. To assess for model validation, we conducted K (10) fold cross-validation for the six primary dependent variables (Appendix B, available as an online supplement to this article). PASS (version 15)[29] was used to assess statistical power post analysis (Appendix B).

TABLE 1 Demographic characteristics and hours worked for employed US National Institute for Occupational Safety and Health Quality of Work Life Survey respondents working 20+ hours per week (n =5361), 2002-2014

	N	Weighted %
Age, weighted mean (range), y	41.92 (18-88)	
Sex		
Female	2743	50.2
Male	2618	49.8
Race/ethnicity		
White	3785	70.7
Black	770	13.1
Asian	210	4.5
Hispanic	575	11.7
Education		
1-8 y	121	2.4
9-11 y	429	7.9
High school graduate	1346	25.6
13-15 y	1627	31.3
Bachelor's degree	986	17.9
Post graduate study or degree	838	14.8
Occupational category		
Management/professional	2100	38.5
Service	942	18.2
Sales/office	1194	22.3
Blue-collar	1125	21.0
Hours worked/week		
Less than 40 h	1267	23.9
40 h	1814	34.0
41-59 h	1556	28.5
60 h or more	724	13.6

Occupational categories defined as follows from 2010 U.S. Census Occupation Codes: codes 0010-3540 were classified as management/professional, 3600-4650 as service, 4700-5940 as sales/office, and 6000-9750 as blue-collar.

3 | RESULTS

The majority (70.7%) of our sample was white, about half (49.8%) male, and a little more than a third (35.9%) had a high school education or less (Table 1). Their age ranged from 18 to 88 years. Management/professional employees constituted 38.5% of our sample, while 18.2% were in the service occupational category, 22.3% in sales and office, and 21.0% in blue-collar. Approximately 76% of our sample reported working at least 40 hours per week.

3.1 | Trends in work characteristics

Statistically significant increases between 2002 and 2014 were observed for three of six continuous primary work characteristics: job strain (0.09 SD increase), low job control (0.10 SD increase), and work-family conflict (0.15 SD increase) (Table 2). Figures 1 and 2 show the trends in job strain and low job control, from 2002 to 2014, respectively. The 12-year trend in work-family conflict is shown in

TABLE 2 Linear trends for primary work characteristics for employed Americans working 20+ h/wk ($n = 5361$): US National Institute for Occupational Safety and Health Quality of Work Life Surveys, 2002-2014

Work characteristics	Mean unadjusted	*B* (95% CI) standardized unadjusted	*P*	Mean adjusted	B (95% CI) standardized adjusted	*P*	*B* (95% CI) linear trend standardized 2002-2014 unadjusted	*P*	B (95% CI) linear trend standardized 2002-2014 adjusted	*P*
High job demand							0.003 (−0.003, 0.010)	0.33	0.004 (−0.003, 0.012)	0.27
2002	12.831	Reference		12.914	Reference					
2006	12.898	0.022 (−0.056, 0.100)	0.58	12.909	−0.002 (−0.077, 0.073)	0.96				
2010	12.876	0.015 (−0.074, 0.104)	0.74	13.010	0.032 (−0.054, 0.118)	0.47				
2014	12.975	0.048 (−0.038, 0.134)	0.28	13.074	0.053 (−0.031, 0.137)	0.22				
Low job control							**0.007 (0.000, 0.015)**	**0.05**	**0.009 (0.002, 0.017)**	**0.02**
2002	8.632	Reference		8.890	Reference					
2006	8.759	0.048 (−0.039, 0.135)	0.28	9.141	**0.095 (0.012, 0.177)**	**0.03**				
2010	8.728	0.036 (−0.054, 0.126)	0.43	8.984	0.035 (−0.055, 0.125)	0.44				
2014	8.899	**0.101 (0.007, 0.194)**	**0.04**	9.146	**0.097 (0.012, 0.181)**	**0.03**				
Low work social support							0.004 (−0.003, 0.011)	0.30	0.001 (−0.006, 0.009)	0.75
2002	6.734	Reference		7.115	Reference					
2006	6.879	0.057 (−0.032, 0.146)	0.21	7.274	0.063 (−0.028, 0.153)	0.18				
2010	6.938	0.080 (−0.030, 0.191)	0.15	7.316	0.079 (−0.030, 0.188)	0.16				
2014	6.829	0.037 (−0.047, 0.122)	0.39	7.165	0.020 (−0.066, 0.106)	0.65				
Low work reward							0.000 (−0.007, 0.006)	0.92	−0.004 (−0.011, 0.004)	0.33
2002	9.840	Reference		10.037	Reference					
2006	9.745	−0.031 (−0.112, 0.049)	0.44	9.977	−0.020 (−0.101, 0.061)	0.63				
2010	9.962	0.040 (−0.056, 0.137)	0.41	10.150	0.037 (−0.061, 0.135)	0.46				
2014	9.754	−0.028 (−0.108, 0.051)	0.49	9.945	−0.030 (−0.112, 0.052)	0.47				
Work family conflict							**.013 (0.006, 0.019)**	**<0.001**	**0.012 (0.005, 0.019)**	**<0.001**
2002	6.1865	Reference		6.3215	Reference					
2006	6.2551	0.032 (−0.047, 0.112)	0.43	6.3174	−0.002 (−0.078, 0.074)	0.96				
2010	6.4154	**0.108 (0.020, 0.195)**	**0.02**	6.5852	**0.124 (0.038, 0.210)**	**<0.001**				
2014	6.4948	**0.145 (0.066, 0.223)**	**<0.001**	6.6480	**0.153 (0.077, 0.230)**	**<0.001**				
Job strain							**0.008 (0.001, 0.014)**	**0.02**	**0.008 (0.001, 0.015)**	**0.03**
2002	111.657	Reference		115.750	Reference					
2006	112.977	0.027 (−0.046, 0.100)	0.47	118.060	0.047 (−0.027, 0.121)	0.21				
2010	114.169	0.051 (−0.039, 0.142)	0.27	118.560	0.057 (−0.037, 0.151)	0.23				
2014	116.248	**0.094 (0.012, 0.175)**	**0.03**	120.274	**0.092 (0.012, 0.172)**	**0.02**				

(Continues)

TABLE 2 (Continued)

Work characteristics	Mean unadjusted	*B* (95% CI) standardized unadjusted	*P*	Mean adjusted	*B* (95% CI) standardized adjusted	*P*	*B* (95% CI) linear trend standardized 2002-2014 unadjusted	*P*	*B* (95% CI) linear trend standardized 2002-2014 adjusted	*P*
Job strain2							**0.008 (0.001, 0.014)**	**0.03**	**0.009 (0.002, 0.017)**	**0.02**
2002	23.176	Reference		23.574	Reference					
2006	23.399	0.048 (−0.028, 0.123)	0.22	23.871	0.063 (−0.014, 0.141)	0.11				
2010	23.375	0.043 (−0.047, 0.132)	0.35	23.810	0.050 (−0.042, 0.143)	0.29				
2014	23.657	**0.103 (0.019, 0.187)**	**0.02**	24.057	**0.103 (0.020, 0.187)**	**0.02**				

Abbreviation: CI, confidence interval.
Adjusted: controlled for age, sex, race/ethnicity, educational attainment, hours worked per week, and unemployment rate.
Job strain: product of job demand and low control.
Job strain 2: sum of job demand and low control × (6/5).
Statistical analysis: multiple linear regression:
Model 1: comparison of each of the 3 later years (2006, 2010, and 2014) with the earliest year (2002). *B* represents the mean difference in the job characteristic between 2 survey years.
Model 2: assessment of the significance of the linear trend for year. *B* represents the slope of the trend line across all four-time periods.
Bold rows: indicate statistical significance at $P < 0.05$.

Figure S1 (Appendix A). We found no significant change for high job demand, low social support, and low reward.

Tables 2, 3AA and B, and 4 present results for the six primary work characteristics and the seven continuous and eight binary secondary work characteristics, respectively. In adjusted multiple logistic regression models, statistically significant decreases were observed for two of 15 secondary work characteristics: race/ethnicity discrimination and sexual harassment (Appendix B). We found no significant changes for the other 13 secondary work characteristics.

Adjusted cross-validation for each level of the predictor variable reported mean square errors (MSE) close to 1.00. Across predictor variable levels, cross-validated MSE measures ranged between 0.990 and 1.016. These results indicate no overfitting problem and thus provide supporting evidence for reproducibility of the models fitted and tested in our study. Power calculations revealed that our study was well-powered (>99%) to detect small effects.

3.2 | Tests of interaction

We found one statistically significant interaction with SES; low job control differed by occupational category ($P = 0.03$) in the adjusted multiple linear regression model. Figure 2 shows that low job control trends varied by occupational category, with the largest increase from 2002 to 2014 observed in service workers, smaller increases in the sales/office and management/professional groups, and very little change in the blue-collar group. No other psychosocial job or work schedule characteristics varied by SES. We also found a statistically significant interaction with race/ethnicity; perceptions of race/ethnicity discrimination differed by race/ethnicity group ($P = 0.048$) in an adjusted multiple logistic regression model. Figure S2 (Appendix A) shows that the perceptions of race/ethnicity discrimination trends varied by race/ethnicity, with the largest decrease from 2002 to 2014 observed for black workers.

4 | DISCUSSION

To our knowledge, this is the first study to assess changes in work characteristics from 2002 to 2014 using the NIOSH QWL surveys, nationally representative samples of US workers. Our major finding is that job strain, low job control, and work-family conflict revealed statistically significant increases both before and after adjustment for covariates (since job strain is defined as the combination of high job demands and low job control, these two variables are not completely independent of each other). This finding partly supports our first hypothesis that the prevalence of psychosocial job stressors has been increasing over this 12-year period. In contrast, three other primary work characteristics did not significantly change over the same time span.

An extensive literature has documented the link between stressful work characteristics, such as job strain and low job control, and cardiovascular disease.[12,13,15] Theorell et al conducted a systematic review of original empirical articles published between

TABLE 3A Linear trends for secondary work characteristics (ordinal scale) for employed Americans working 20+ h/wk (*n* =5361): US National Institute for Occupational Safety and Health Quality of Work Life Surveys, 2002-2014

Work characteristics	Mean unadjusted	B (95% CI) standardized unadjusted	*P*	Mean adjusted	B (95% CI) standardized adjusted	*P*	B (95% CI) linear trend standardized 2002-2014 unadjusted	*P*	B (95% CI) linear trend standardized 2002-2014 adjusted	*P*
Low supervisor support							0.000 (−0.007, 0.007)	0.93	−0.003 (−0.011, 0.005)	0.43
2002	3.442	Reference		3.636	Reference					
2006	3.481	0.024 (−0.062, 0.110)	0.58	3.686	0.031 (−0.057, 0.119)	0.49				
2010	3.513	0.044 (−0.060, 0.147)	0.41	3.697	0.038 (−0.065, 0.140)	0.47				
2014	3.420	−0.014 (−0.102, 0.075)	0.76	3.582	−0.033 (−0.123, 0.056)	0.46				
Inadequate resources							−0.002 (−0.008, 0.005)	0.66	0.000 (−0.008, 0.007)	0.91
2002	3.188	Reference		3.286	Reference					
2006	3.272	0.067 (−0.005, 0.138)	0.07	3.361	0.059 (−0.013, 0.131)	0.11				
2010	3.217	0.023 (−0.067, 0.113)	0.62	3.318	0.026 (−0.063, 0.115)	0.57				
2014	3.174	−0.011 (−0.098, 0.076)	0.80	3.275	−0.009 (−0.095, 0.078)	0.85				
Promotions							0.004 (−0.003, 0.011)	0.27	**0.008 (0.001, 0.016)**	**0.04**
2002	5.448	Reference		5.433	Reference					
2006	5.523	0.042 (−0.040, 0.124)	0.31	5.485	0.030 (−0.051, 0.111)	0.47				
2010	5.419	−0.017 (−0.106, 0.073)	0.71	5.439	0.003 (−0.088, 0.095)	0.94				
2014	5.573	0.071 (−0.014, 0.155)	0.10	5.586	0.087 (0.002, 0.173)	0.05				
Can't take time off during work for family							**0.013 (0.006, 0.020)**	**<0.001**	**0.013 (0.005, 0.020)**	**<0.001**
2002	1.88	Reference		2.02	Reference					
2006	1.97	**0.093 (0.009, 0.178)**	**0.03**	2.11	**0.083 (0.002, 0.164)**	**0.05**				
2010	2.01	**0.129 (0.041, 0.217)**	**<0.001**	2.17	**0.142 (0.055, 0.229)**	**<0.001**				
2014	2.03	**0.154 (0.067, 0.241)**	**<0.001**	2.18	**0.153 (0.070, 0.237)**	**<0.001**				
Ability to vary starting and quitting times							0.002 (−0.006, 0.009)	0.67	0.001 (−0.006, 0.008)	0.81
2002	2.43	Reference		2.56	Reference					
2006	2.43	0.001 (−0.095, 0.096)	0.99	2.61	0.038 (−0.045, 0.120)	0.37				
2010	2.49	0.044 (−0.049, 0.138)	0.35	2.64	0.061 (−0.022, 0.144)	0.15				
2014	2.44	0.006 (−0.089, 0.101)	0.90	2.58	0.016 (−0.066, 0.098)	0.70				

TABLE 3B Linear trends for secondary work characteristics (ordinal scale, unstandardized) for employed Americans working 20+ h/wk (*n*=5361): US National Institute for Occupational Safety and Health Quality of Work Life Surveys, 2002-2014

Work characteristics	Mean unadjusted	B (95% CI) unstandardized unadjusted	*P*	Mean adjusted	B (95% CI) unstandardized adjusted	*P*	B (95% CI) linear trend unstandardized 2002-2014 unadjusted	*P*	B (95% CI) linear trend unstandardized 2002-2014 adjusted	*P*
Days/month working extra hours							0.001 (−0.055, 0.056)	0.99	0.011 (−0.047, 0.069)	0.71
2002	5.69	Reference		5.38	Reference					
2006	6.48	**0.792 (0.164, 1.419)**	**0.01**	5.82	0.439 (−0.125, 1.003)	0.13				
2010	6.11	0.425 (−0.259, 1.109)	0.22	5.99	**0.615 (0.011, 1.219)**	**0.05**				
2014	5.76	0.067 (−0.633, 0.767)	0.85	5.55	0.174 (−0.470, 0.818)	0.60				
Hours worked/week							−0.038 (−0.125, 0.050)	0.40	0.036 (−0.055, 0.128)	0.79
2002	43.39	Reference		42.01	Reference					
2006	44.58	**1.192 (0.112, 2.271)**	**0.03**	43.01	1.006 (−0.004, 2.016)	0.05				
2010	42.99	−0.402 (−1.510, 0.706)	0.48	41.69	−0.314 (−1.333, 0.706)	0.55				
2014	43.35	−0.041 (−1.146, 1.064)	0.94	42.21	0.201 (−0.815, 1.217)	0.70				

Abbreviation: CI, confidence interval.
Adjusted: controlled for age, sex, race/ethnicity, educational attainment, hours worked per week, and unemployment rate.
Statistical analysis: multiple linear regression.
Model 1: comparison of each of the 3 later years (2006, 2010, and 2014) with the earliest year (2002). *B* represents the mean difference in the job characteristic between 2 years.
Model 2: assessment of the significance of the linear trend for year. *B* represents the slope of the trend line across all four-time periods.
Bold rows: indicate statistical significance at $P < 0.05$.

1985 and 2014 and found that workers who reported exposure to job stressors such as job strain and low job control had an increased incidence of ischemic heart disease. Since job strain and low job control are work-related risk factors for CVD, our analysis provides one possible explanation of why the declines in CVD incidence and mortality appear to have slowed in recent years, and "may even be showing early signs of a reversal in some population groups".[30, p. 366]

Contrary to our findings, the American Psychological Association (APA) 2017 Work and Well-Being Survey showed an apparent increase in job control (62% in 2011 to 65% in 2014 and 70% in 2017) in the US measured by affirmative response to the statement "overall, I am satisfied with the amount of control and involvement I have at work". However, the APA's single question does not ask directly about job control, as the QWL does, rather a more subjective question about "satisfaction" with amount of job control.[31] Also, in contrast to our findings, two Canadian national surveys conducted in 2002 and 2012 revealed decreases in psychological demands in both base and adjusted models; skill discretion and decision authority (components of job control) improved over time in base models, although those improvements were attenuated toward the null in adjusted models.[32] The European Working Conditions Surveys (EWCS) also found *increased* job decision latitude (or job control) from 2005 to 2015.[33] Our finding for work-family conflict is consistent with trends reported in the APA 2017 Work and Well-Being Survey.[31] The APA used two questions to measure work-life (or family) conflict and showed that, since 2012, there has been a steady increase in affirmative response to the statement "my home and family responsibilities interfere with my ability to perform my job well" and an overall increase, with slight fluctuations, in affirmative response to "the demands of my job interfere with my ability to fulfill family or home responsibilities". Perhaps the increasing burdens,[34,35] ranging from work time commitment[35,36] to difficulty in finding the affordable child and elder care arrangements,[37] that working families in the US have been experiencing, help explain the increasing trend we observed for work-family conflict.

Our exploratory analyses revealed two significant trends from 2002 to 2014, a decline in the perception of racial or ethnic discrimination and a decline in the perception of sexual harassment, both warranting further research. The sixth EWCS did not report trends for discrimination or harassment. However, it identified subgroups that reported higher levels of discrimination, including "workers with nonpermanent contracts".[33] Such temporary or contingent workers, if working less than 20 h/wk, were excluded from our sample. Thus, the exclusion of survey participants who worked less than 20 hours weekly might partly explain the decreasing trend for race/ethnicity discrimination we observed.

We observed two significant interactions between work characteristics and other factors from 2002 to 2014. The increasing trend for low job control varied by occupational category and the decreasing trend for the perceptions of race/ethnicity discrimination varied by race/ethnicity group. The greatest increase in low job control was observed in service workers (eg, auto mechanics, house cleaners, and hairdressers), followed by management/professional

TABLE 4 Linear trends for secondary work characteristics (binary scale) for employed americans working 20+ h/wk ($n = 5361$): US National Institute for Occupational Safety and Health Quality of Work Life Surveys, 2002-2014

Work characteristics	Weighted %	OR (95% CI) unadjusted	*P*	OR (95% CI) adjusted	*P*	OR (95% CI) for each 4 y change assuming a linear trend, 2002-2014 Unadjusted	*P*	OR (95% CI) for each 4 y change assuming a linear trend, 2002-2014 Adjusted	*P*
Must work extra days						1.005 (0.990, 1.020)		1.005 (0.987, 1.023)	
2002	26.5	Reference		Reference			0.55		0.59
2006	26.5	0.996 (0.830, 1.196)	0.97	1.008 (0.834, 1.217)	0.94				
2010	28.1	1.084 (0.890, 1.319)	0.42	1.120 (0.908, 1.382)	0.29				
2014	27.2	1.032 (0.855, 1.247)	0.74	1.078 (0.882, 1.318)	0.46				
Night shift						0.984 (0.951, 1.019)		0.997 (0.960, 1.035)	
2002	7.2	Reference		Reference			0.36		0.86
2006	5.8	0.796 (0.552, 1.149)	0.22	0.840 (0.583, 1.209)	0.35				
2010	5.0	0.685 (0.445, 1.053)	0.08	.720 (0.466, 1.114)	0.14				
2014	6.3	0.875 (0.587, 1.303)	0.51	0.939 (0.632, 1.394)	0.75				
Nonstandard work shift						0.999 (0.983, 1.014)		1.004 (0.986, 1.022)	
2002	28.3	Reference		Reference			0.85		0.68
2006	25.9	0.885 (0.734, 1.068)	0.20	0.876 (0.727, 1.055)	0.16				
2010	24.2	**0.811 (0.660, 0.996)**	**0.05**	.818 (0.659, 1.014)	0.07				
2014	28.7	1.021 (0.843, 1.237)	0.83	1.025 (0.841, 1.250)	0.81				
Sexually harassed (within last year)						**0.952 (0.917, 0.988)**		0.958 (0.917, 1.001)	
2002	4.2	Reference		Reference			**0.01**		0.05
2006	3.0	0.707 (0.462, 1.079)	0.11	.720 (0.471, 1.100)	0.13				
2010	2.5	**0.580 (0.367, 0.916)**	**0.02**	**0.613 (0.383, 0.982)**	**0.04**				
2014	2.5	**0.585 (0.372, 0.919)**	**0.02**	**0.621 (0.394, 0.979)**	**0.04**				
Threatened or harassed on the job (within last year)						0.983 (0.960, 1.006)		0.975 (0.948, 1.003)	
2002	10.1	Reference		Reference			0.14		0.08
2006	7.7	**0.744 (0.575, 0.963)**	**0.03**	**0.738 (0.569, 0.958)**	**0.02**				
2010	8.6	0.829 (0.614, 1.120)	0.22	0.834 (0.613, 1.134)	0.25				
2014	8.2	0.786 (0.592, 1.044)	0.10	0.777 (0.578, 1.046)	0.10				
Age discrimination						**0.972 (0.948, 0.997)**		0.979 (0.951, 1.009)	
2002	8.2	Reference		Reference			**0.03**		0.17
2006	8.9	1.083 (0.808, 1.453)	0.59	1.097 (0.813, 1.480)	0.54				
2010	7.0	0.839 (0.600, 1.173)	0.30	.863 9.608, 1.224)	0.41				
2014	6.1	0.728 (0.522, 1.015)	0.06	.746 (0.525, 1.059)	0.10				
Gender discrimination						**0.962 (0.933, 0.992)**		0.969 (0.934, 1.005)	
2002	7.0	Reference		Reference			**0.01**		0.09
2006	6.5	0.928 (0.694, 1.243)	0.62	0.889 (0.657, 1.203)	0.45				
2010	4.6	**0.648 (0.447, 0.939)**	**0.02**	**0.646 (0.440, 0.950)**	**0.03**				
2014	4.8	**0.674 (0.455, 0.997)**	**0.05**	0.666 (0.443, 1.001)	.05				

(Continues)

TABLE 4 (Continued)

Work characteristics	Weighted %	OR (95% CI) unadjusted	P	OR (95% CI) adjusted	P	OR (95% CI) for each 4 y change assuming a linear trend, 2002-2014 Unadjusted	P	OR (95% CI) for each 4 y change assuming a linear trend, 2002-2014 Adjusted	P
Race discrimination						0.981 (0.950, 1.014)	0.26	**0.954 (0.919, 0.990)**	**0.01**
2002	5.0	Reference		Reference					
2006	4.8	0.958 (0.640, 1.434)	0.84	0.873 (0.590, 1.292)	0.50				
2010	4.9	0.979 (0.655, 1.463)	0.92	0.829 (0.562, 1.225)	0.35				
2014	3.8	0.756 (0.489, 1.170)	0.21	**0.580 (0.378, 0.891)**	**0.01**				

Abbreviations: CI, confidence interval; OR, odds ratio.
Adjusted: controlled for age, sex, race/ethnicity, educational attainment, hours worked per week, and unemployment rate.
Statistical analysis: multiple logistic regression:
Model 1: comparison of each of the 3 later years (2006, 2010, and 2014) with the earliest year (2002).
Model 2: assessment of the significance of the linear trend for year.
Bold rows: indicate statistical significance at $P < 0.05$.

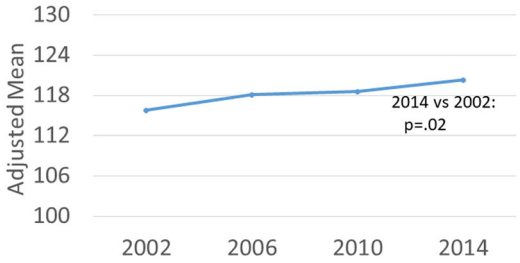

FIGURE 1 Trend in job strain, 2002-2014: NIOSH QWL surveys adjusted means are the estimated marginal means derived from multiple linear regression analysis with continuous variable job strain by all four-time periods, adjusted for all covariates (model 3). Significance of increase, 2014 vs 2002: $P = 0.02$, was also derived from model 3. Linear trend significance $P = 0.03$ was derived from multiple linear regression analysis of job strain with year (model 2). NIOSH, National Institute for Occupational Safety and Health; QWL, Quality of Work Life [Color figure can be viewed at wileyonlinelibrary.com]

(eg, administrative mangers, health professionals, and teaching professionals) and sales/office workers (eg, retail sales workers, customer service, and cashiers). We observed a slight decline in low job control for blue-collar workers (eg, construction workers, police officers, and subway operators). Overall, low job control remained at relatively low levels for the management/professional group and at high levels for the service, sales/office, and blue-collar groups. We did not observe the increase in job control that Tausig et al observed between 1972 and 2002. However, we did observe a similar socioeconomic inequality in job control found by Tausig et al between 1972 and 2002.

We also observed that, for perceptions of race/ethnicity discrimination, the greatest decline was observed among blacks, although levels of race/ethnicity discrimination remained lowest among whites. We are unaware of other studies that have tracked such perceptions by race/ethnic group over time.

Overall, our interaction findings demonstrate some socioeconomic and racial/ethnic inequalities in work characteristics, but do not support our second hypothesis that the prevalence of psycho-

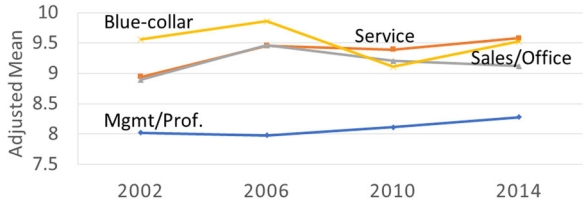

FIGURE 2 Trend in low job control with variation by occupation, NIOSH QWL surveys adjusted means are the estimated marginal means derived from multiple linear regression analysis with continuous variable low job control by all four-time periods, adjusted for all covariates (model 3). Significance of increase, 2014 vs 2002: $P = 0.03$ was also derived from model 3. Significance of year by occupation category interaction $P = 0.03$ was derived from multiple linear regression analysis of low job control by a product term of all four-time periods and all four occupational groups. NIOSH, National Institute for Occupational Safety and Health; QWL, Quality of Work Life [Color figure can be viewed at wileyonlinelibrary.com]

social job stressors has been increasing to a greater extent among low SES workers than among high SES workers. We did not examine trends in work characteristics by sex. We found no significant change in high job demand, low social support, low reward, and the other secondary work characteristics.

The APA Work and Well-Being Survey also showed an apparent increase in "job insecurity" (33% in 2011 to 38% in 2014).[31] In contrast, our measure of low reward, which includes "job insecurity", did not significantly change from 2002 to 2014. We measured social support by combining 2 QWL items each for coworker support and supervisor support and found no statistically significant change from 2002 to 2014. In comparison, the APA measured social support using two questions, "I have a positive relationship with my coworker" and "I have a positive relationship with my boss or supervisor" and found little change from 2011 to 2017. Similarly, the APA found little change for job demand measured by "too heavy a workload" and "unrealistic job expectations", whereas we found no statistically significant change when measured by seven QWL items. Further research is needed to better understand factors contributing to increases in some stressful work characteristics, and to no change or declines in others.

4.1 | Study limitations and strengths

This analysis has several limitations. First, the QWL has incomplete scales (compared to earlier surveys such as the Job Content Questionnaire) to measure psychosocial job stressors. This likely resulted in the somewhat reduced scale internal consistency reliability, random measurement error, and a bias toward the null value. However, since one of the goals of the QWL survey is to track trends and emerging problems, it's design does provide a comprehensive view of the workplace (a wide range of work characteristics, stressors, and outcomes). The trade-off to this advantage is having scales with fewer variables than standard job demand, job control, job support, job reward, or job insecurity scales.

Although the QWL surveys contain information on additional work characteristics, such as job insecurity, job autonomy, skill utilization, inadequate staffing, and participation in job decision making, we were unable to assess their trends across the four-time periods either because they were not measured in all four surveys or the scales to measure them had low internal consistency reliability for two-item scales. Second, the study was based on self-reported information from the QWL surveys, thus subject to self-report bias. There was no opportunity to validate respondents' responses against job records. Third, respondents were asked to recall information on certain work characteristics, some as far back as 12 months. This may result in recall bias as respondents may be more or less likely to remember and report certain work characteristics depending on the extent they were personally impacted by them. We have no reason to believe that these information biases led to differential misclassification. Thus, their likely effect was to increase random error and bias results towards the null value. In general, survey response rates appear to be lower among workers exposed to more stressful working conditions than their counterparts.[38] However, it is unknown whether such survey nonresponse due to stressful work has been increasing. If it has, and if job stressors have in fact been increasing, then this would also bias our results towards the null value.

Fourth, for the 2002 QWL survey, non-English speaking workers were underrepresented as interviews were only conducted in English. This excludes some immigrant workers who have jobs more stressful than national averages.[39,40] The proportion of non-English speaking workers in the labor force has increased from 2002 to 2014 with Spanish the predominant non-English language spoken.[41–43] The proportion of Spanish speaking farm workers in US workplaces has also been increasing compared to their English speaking counterparts.[44] Fortunately, beginning in 2006, all QWL surveys are conducted in English and in Spanish (for Spanish-speakers).

Finally, we used standardized continuous variables in the regression analyses to better interpret and compare the results internally. This may limit comparability of results and thus accumulation of knowledge from other publications, such as when comparing results across studies and when using results in a systematic review or a meta-analysis. Furthermore, some recently published papers have discouraged standardization of variables in the regression.[45,46] There are several advantages of simple, unstandardized effect sizes over standardized effect sizes, such as being easier to compute and more robust. However, when comparing conceptually similar effects using different units of measurement,[45] which is the case in our study, standardized effect sizes may be preferable to simple unstandardized effect sizes. In addition, unstandardized regression coefficients for job characteristics scale scores (reflecting associations with a one-unit change in the independent variable) are not easily interpretable. "Whether standardized or unstandardized effect sizes are reported is less important than reporting effect sizes in a way that effectively communicates the essential findings of the study." [46,p209]

The main strengths of our analysis are that it was based on large nationally representative samples of US working adults. The QWL survey, unlike the National Health Interview Survey, National Health and Nutrition Examination Survey, and Multi-Ethnic Study of Atherosclerosis, includes detailed measures of a large group of psychosocial job stressors and work schedule characteristics. Thus, the QWL survey is an important source of data for occupational safety and health research and provides a unique opportunity to assess trends in workers' exposure to a larger group of work characteristics.

4.2 | Conclusions

Our study shows the importance of analyzing data from ongoing national surveys of the US working population, which allow us to track changes in reports of psychosocial job stressors and work schedule characteristics. Subsequently, stakeholders can identify job stressors of concern as well as groups at risk in their own organizations, and develop programs, policies, and legislation and regulation aimed at improving the quality of the work environment, especially for more vulnerable groups of workers.[11,47]

For future QWL survey data collection, we recommend: (1) addition of more items to allow for complete scales to measure constructs such as demands, control, reward, and support, (2) inclusion of variables for health-related behaviors, such as diet, physical activity, and smoking to assess the associations between work characteristics and such behaviors, and (3) addition of more questions on new systems of work organizations, such as lean production and new public management to better understand changes in stressful work characteristics in light of changing workplaces, workers and economy.

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CONFLICT OF INTERESTS

The authors declare that there are no conflict of interests.

DISCLOSURE BY AJIM EDITOR OF RECORD

Rodney Ehrlich declares that he has no conflict of interest in the review and publication decision regarding this article.

AUTHOR CONTRIBUTIONS

Dr SM completed the analyses contained in this manuscript as part of her DrPH dissertation at the SUNY-Downstate School of Public Health. She conceived of the idea for the research, conducted the data analyses, and wrote the dissertation, including this manuscript. Dr PL was chair of Dr Myers' dissertation committee. He provided guidance on the ideas for the dissertation, on the data set to be used, on the data analyses, interpretation of data and preparation of manuscripts. Dr MJ and Dr UG were members of Dr Myers' dissertation committee. They reviewed, provided guidance on and approved both the dissertation proposal and the final dissertation. They also reviewed, provided guidance on and approved this manuscript.

ETHICS APPROVAL AND INFORMED CONSENT

Work was approved by the Institutional Review Board of the State University of New York-Downstate Medical Center.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

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