

# Association of Self-Rated Physical Health and Incident Hypertension With O\*NET Factors: Validation Using a Representative National Survey

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**Objective:** To examine the predictive validity of Occupational Information Network (O\*NET)-based constructs with health outcomes. **Methods:** Data from the National Survey of Midlife in the United States (MIDUS) surveys were used to examine associations of self-rated health and incident hypertension with work characteristics. Job control and substantive complexity (SC) scores derived from the O\*NET were imputed to occupation in the MIDUS surveys. Validity was assessed through variance partitioning and regression models contrasting O\*NET and survey-based constructs. **Results:** Congruence between control scores derived from O\*NET and from self-rated scores from MIDUS was good. Shared variance between SC scores and survey-based control was less. All constructs were modest predictors of self-rated health. Substantive complexity was a stronger predictor of incident hypertension (Adjusted Odds Ratio = 1.87). **Conclusions:** Occupational characteristics derived from O\*NET variables performed as well as or better than survey-based job control in describing associations with self-rated health and incident hypertension.

Numerous studies across the past two decades have demonstrated the association between work organization, psychosocial work attributes, and health.<sup>1–17</sup> The principal model used in assessment of psychosocial variables and worker health has been the Demand-Control model of Karasek and colleagues.<sup>12</sup> The constructs of the Demand-Control model were derived from the large-scale Quality of Employment surveys (QES) in the 1960s and early 1970s; the original QES items were augmented with other items to form the Job Content Questionnaire (JCQ) as a survey-based assessment of psychosocial working conditions. Despite its origin in an economy with a substantial jobs base in manufacturing, the JCQ and Demand-Control model have proven to be generalizable to shifts toward a service-based economy and the rise of newer occupations, many based on computers and information technology.

Since the late 1990s more detailed information on psychosocial and physical job attributes has been available through the Occupational Information Network (O\*NET), the successor to the Dictionary of Occupational Titles (DOT). The O\*NET was designed to streamline the prior DOT classification, which in its later editions contained more than 12,000 entries, by grouping occupations using a “content model” that classifies variables according to the characteristics of workers, jobs, organizations, and labor markets.<sup>18,19</sup> This

has resulted in an occupational classification that groups jobs by educational and training requirements as well as relevant skills and demands, with approximately 900 occupations classified.

The potential for the O\*NET classification system to be used in assessing occupational physical and psychosocial exposures and their association with worker health has not escaped the notice of researchers. Investigators have used aggregated O\*NET variables to measure work associations with mental ill health,<sup>20</sup> pregnancy outcomes,<sup>10,21,22</sup> and hospital work exposures and injuries.<sup>11,23,24</sup> Some early studies, assessing the validity of this approach, have tested variables from this database for their association with health risk behaviors in large nationally representative surveys<sup>19</sup> and against JCQ-derived constructs in surveys of health care workers.<sup>11</sup>

Our previous work had used O\*NET measures to establish associations between the work psychosocial environment and adverse birth outcomes including low-birth-weight delivery.<sup>10,22</sup> The most predictive O\*NET construct in these investigations was the *substantive complexity* (SC) of work, a concept derived from the work of Kohn, Schooler, and colleagues<sup>25,26</sup> that encompasses decision latitude, active learning, and ability to use and expand one's abilities at work. Substantive complexity represents a construct similar to, but somewhat more expansive than, control over work. We had chosen to examine its relationship to birth outcomes in our earlier studies, in preference to job control, in part because the factor that emerges from an analysis of the O\*NET database closely corresponds to Kohn and Schooler's construct. The concept of SC and the effects of working conditions on psychological functioning has withstood over two decades of testing, and a consistent body of work has demonstrated its association with improved psychological health in adult life.<sup>2,25–27</sup> The construct may also be a more useful measure of working conditions partly because of the construct's potentially more accurate portrayal of occupational characteristics in a service-based economy, where other types of hazards have been reduced. Nevertheless, the construct has not had the same degree of scrutiny for its effects on physical health. The assumption that O\*NET-derived factors may be useful in assessing the psychosocial work environment, and its relation to ill health, requires additional testing before their use in further research to quantify psychosocial exposures.<sup>28</sup> Likewise, the value of imputation of psychosocial risk levels to specific jobs needs to be examined, as the possibility exists for misclassification of exposure, and subsequent bias, usually understood to be in the direction of no effect. By contrast, however, imputation of job characteristics may have value in reducing the role of other biases introduced by worker survey questionnaires, particularly common-instrument bias in the ascertainment of both exposures and outcomes within the same survey.

In this study, we used a large national survey with two waves, the National Survey of Midlife in the United States (MIDUS), to examine the convergent validity between O\*NET-based factors, and the survey-based answers to the JCQ provided by subjects in the study. We also examine and contrast the associations of SC and job control with two health outcomes, self-rated health and incident high blood pressure (BP), to determine the predictive validity of SC as a useful construct in research on psychosocial characteristics of work.

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## METHODS

Survey data from the two waves of the MIDUS were obtained and used for the analysis in this investigation. The original MIDUS survey was a study of 7000 American adults aged 25 to 74 years, initiated by the MacArthur Midlife Research Network and designed to investigate behavioral, social, and psychological factors and their association with age-related changes in physical and mental health. Respondents in the initial 1994–1995 survey included a core sample ( $N = 3485$ ), metropolitan over-samples (757), twins (998 pairs), and siblings (951) of core respondents. The second wave of the survey was initiated in 2005 and was designed to assess longitudinal changes in health, occupation, attitudes, and other important attributes of aging. Subject retention across the two waves of the study was in excess of 75%. Sampling weights correcting for selection probability and nonresponse were calculated and provided to match the core survey population to the age, sex, race, and educational profile of the US population. Subjects' work is categorized in both surveys by three-digit occupational and industry codes used for the 1990 census. MIDUS I and II survey data are de-identified and publicly available from the Inter-University Consortium for Political and Social Research at the University of Michigan.<sup>29,30</sup>

Job characteristics were obtained from the O\*NET Resource Center. The most current version of the O\*NET data set (v. 13.0, June 2008) was used and consists of 226 variables used to describe 809 occupations and is available for download from the Web-based O\*NET information resource center.<sup>31</sup>

## Variables and Measures

### Independent Variables; Job Characteristics

**Substantive Complexity.** Factor analysis replicating the methods of Hadden et al<sup>27</sup> was performed on the 226 variables of the O\*NET version 13 with SPSS version 17 (SPSS Inc, Chicago, IL) using principal components analysis extraction and a promax rotation that relaxes the assumption of independence between factors. A three-factor solution was specified and obtained, conforming to prior investigators' work, and composing factors describing *SC*, *people versus things*, and *physical demands*.<sup>10,27,32</sup> Scales for these factors were created using regression methods to create *z* scores (mean of 0 and standard deviation of 1), retaining variables with loadings greater than 0.7. Based on our previous work, the main factor of interest was SC; O\*NET variables with the highest loadings on this factor (all  $> 0.8$ ) were deductive reasoning, inductive reasoning, critical thinking, analyzing data or information, and complex problem solving. Substantive complexity scores were linked via O\*NET job codes to the 1990 census codes used in MIDUS through the use of occupational-code crosswalks.<sup>33</sup>

**Job Demand-Control Characterization.** Both waves of MIDUS include questions drawn from the JCQ<sup>12,15</sup> assessing skill discretion (six items) and decision authority (three items). The two compose the overall nine-item construct termed *job control* (decision latitude). Differing from standard JCQ usage, items in MIDUS were answered on a five-point response scale, with low scores representing higher control. These were reverse-coded for this analysis so that higher scores represented higher control levels, as in standard JCQ scoring, and aggregated according to the methods described by Karasek et al.<sup>15</sup> The individual items were also assessed for internal consistency using confirmatory factor analysis and Cronbach alpha.

In addition, a control score was constructed using the five items from the O\*NET that most closely corresponded to those assessed in the JCQ. This O\*NET control score consisted of the variables active learning, making decisions and solving problems, scheduling work and activities, organizing, planning, and prioritizing work, and freedom to make decisions.<sup>23</sup> To facilitate comparisons with the O\*NET measurements, individual job control scores were

rescaled using a *z* score metric with the mean represented by zero and standard deviation of 1.

### Dependent/Outcome Measures

Self-rated physical health was assessed by MIDUS subjects in each wave of the survey on a scale from 1 (poor) to 5 (excellent). This rating was used as an ordinal response variable in analyses. Self-rated health was also coded as a binary variable dichotomizing poor/fair versus good/very good/excellent and used to analyze change in self-rated health across the two surveys. *Incident hypertension* was defined as a subject's having a systolic BP 140 mm Hg or greater and diastolic BP 90 mm Hg or greater in 2005 if the subject had (a) a 1995 BP that was below those cutoffs or (b) no 1995 BP recorded but no notation of treatment for hypertension. Normotensive subjects, for the comparison group, were defined as having 1995 and 2005 BP values below cutoffs and no treatment of hypertension in both 1995 and 2005.

### Independent Variables

**Demographics.** Age, sex, race/ethnicity, current smoking habit (current smoker, former, never), current alcohol use (how many drinks the subject will drink at one time), and body mass index, calculated from subjects' height and weight by the MIDUS survey, were collected in the MIDUS surveys. Educational attainment is measured at both waves in the MIDUS surveys and is categorized as an ordinal variable with discrete categories corresponding to usual metrics of educational attainment (non-high school graduate, high school graduate, some college, college graduate, or further). Data on total household income included spousal income, unemployment benefits, pensions, and other sources, and was expressed in dollar values for the year of the survey.

**Other Independent Variables.** Participants in the 1995 survey rated their health at the age of 16 years according to the same scale as they rated their current physical health; this was used as an independent variable to control for earlier health in cross-sectional analyses. The mean of six items in the MIDUS questionnaire was used to describe negative affectivity, a construct derived from the Center for Epidemiological Studies Depression Scale that may indicate a tendency to view events and features of one's life in an adverse light.<sup>34</sup> The negative affectivity scale was used in the analyses to control for potential confounding whereby participants may rate both working conditions and health pessimistically as part of a more generalized psychological profile. Assessments of current physical activity levels were not made in the MIDUS survey; therefore, three questions relevant to health beliefs and physical activity were used as surrogates (rating physical activity compared to 5 years ago, and agreement as to whether one works hard to stay healthy and can reduce myocardial infarction risk). These measures of self-efficacy and health beliefs have been shown to be acceptable surrogates for physical activity where a specific measure of the latter is not available.<sup>35</sup>

**Analyses.** All analyses were performed using Stata version 11 (Stata Corp, College Station, TX) and SPSS version 17 to account for the sampling design of the MIDUS surveys. Occupational and demographic variables were tabulated and examined (Table 1). To examine convergent validity, the intraclass correlation (ICC) between self-rated job control and the O\*NET-derived factors was computed using linear mixed models, first regressing JCQ-based job control scores on occupation (1990 census codes) used as a random variable. Using these models, the total variance in job control scores can be partitioned and the proportion attributable to differences between occupations estimated. The ICC is then calculated as the ratio between interoccupational variance and the total variance.<sup>11,36</sup> Introduction of scores for O\*NET-derived factors into this model as a fixed variable reduces the interoccupational variance component proportionate to the degree of shared variance between the two

**TABLE 1.** Demographic Characteristics, MIDUS I (Main Sample, n = 1879)

Age—mean (SD)	44 (11)
Male sex (%)	988 (52.6)
Educational level (%)	
Non—high school graduate	108 (5.7)
High school graduate/GED	517 (27.5)
College: Less than bachelors degree	591 (31.5)
College graduate and above (>15 yr)	661 (35.2)
Unknown/missing	2 (0.1)
Race/ethnicity (%)	
White non-Hispanic	1633 (86.9)
Black	121 (6.4)
Hispanic	50 (2.7)
Other/unclassified/missing	75 (4.0)
Tobacco use (%)	
Current	425 (22.6)
Past user, not current	1016 (54.1)
Never	437 (23.3)
Unknown	1 (0.1)
Body mass index (Median)	26
Total household income (1995 dollars; median)	60,000
Major industry sectors (%)	
Executive, administrative, and managerial	392 (21.0)
Professional, scientific, and technical	375 (20.0)
Technicians and related support	73 (3.9)
Sales	181 (9.6)
Administrative support and clerical	288 (15.3)
Service	170 (9.0)
Farming, forestry, and fishing	34 (1.8)
Precision product, craft, and repair	188 (10.0)
Machine operators, assemblers, and inspectors	83 (4.4)
Transportation and material moving	51 (2.7)
Handlers, equipment cleaners, helpers, and laborers	44 (2.3)
Self-rated health (%)	
Excellent	311 (16.6)
Very good	718 (38.2)
Good	658 (35.0)
Fair	168 (8.9)
Poor	24 (1.3)

GED indicates General Equivalency Diploma; MIDUS, National Survey of Midlife in the United States.

constructs. The degree of agreement is quantified by the reduction in the ICC following introduction of the O\*NET fixed variable score. Mean O\*NET- and survey-derived scores for occupational characteristics were also examined for the extent of agreement by constructing a Bland-Altman plot, which portrays the difference between the two scores as a function of the mean value of both.<sup>37</sup>

The prevalence risk for a change in one category of self-rated health (ranging from poor to excellent) for each unit (one standard deviation) in occupational characteristics scores was estimated using a generalized linear model with a multinomial distribution and a cumulative log-log link function. Robust (Huber-White) variance estimates were used to adjust for the clustering of scores by occupation.<sup>38</sup> Similar regression models with a binomial distribution and logit link were used to examine the odds of worsening self-rated health (ie, moving from the dichotomized category of good/very good/excellent health to fair/poor health) across the 10 years between the two surveys, and for the odds of incident hypertension between the 1995

and 2005 surveys. Initial models were constructed controlling for age, smoking, race/ethnicity, education, and self-reported health at the age of 16 years; models examining the association of health with work characteristics in 2005 were additionally adjusted for self-rated health in 1995. Additional models were constructed by controlling for negative affectivity and household income to examine whether associations with occupation were substantially altered or confounded by these variables. Models examining the association of hypertension with occupational characteristics were controlled for age, sex, current smoking, current alcohol use, race/ethnicity, education, and body mass index, with a second model additionally adjusted for self-assessment of physical activity and the health efficacy variable noted earlier; 95% confidence intervals were calculated for estimates of effect. Approval for this study was obtained from the institutional review board of the University of Connecticut Health Center.

## RESULTS

Demographic characteristics of the employed sample from the 1995 MIDUS I survey are shown in Table 1. There were slightly more males and lower proportions of black and Hispanic workers than in the general population. Employment in administrative, technical, white-collar and other service occupations comprised 78.8% of the sample, while 19.4% were employed in manufacturing and transportation sectors, and 1.8% in agriculture and fishing. Overall, employed survey participants considered themselves in good health at the baseline 1995 survey, with only 10.2% rating their health either fair or poor.

Factor analysis of the 14 questions from the JCQ used in the MIDUS I survey confirmed a three-factor solution, with the constructs of decision authority and skill discretion (the traditional components of decision latitude or job control) emerging as distinct factors, along with the third factor of job demands. The smallest loading for the variables composing the control factor was 0.64; most were greater than 0.8. Likewise, the single factor structure of the five-item control score derived from the O\*NET was confirmed, with a Cronbach alpha of 0.84 and variable loadings ranging from 0.65 (for “freedom to make decisions”) to 0.85 (“making decisions and solving problems”)

Table 2 outlines the results of the variance-partitioning model for self-rated job control scores from the JCQ in the MIDUS I survey. The ICC coefficient for the unconditional model was 25.6%, indicating that one quarter of the overall variance in self-rated job control was attributable to differences between occupations, with the remainder ascribable to within-occupation (between-subject) variability. When the five-item O\*NET control score was added to the model as a fixed effect, the ICC was reduced by greater than 75%, indicating, once between-subject variability is partitioned, considerable congruence between job control scores derived from the O\*NET and self-rated scores from the survey. By contrast, the degree of shared variance between the O\*NET SC factor score and survey job control was considerably lower: the ICC was reduced by slightly over one third (37.7%).

Estimates of the association of survey- and O\*NET-derived factors with self-rated health are shown in Table 3. Modest associations of all three factors with self-rated health in 1995 are evident. Job factors were somewhat stronger predictors of health in 2005, controlling for 1995 self-rated health and job factors. All three work-characteristic factors were robust to possible confounders entered in the models. Associations of health with self-rated job control were more sensitive to adjustment for negative affectivity, while associations with O\*NET-derived factors were mildly attenuated when adjusted for household income.

Table 4 presents longitudinal analyses for self-rated health and new-onset hypertension across the 10-year period between the two surveys. All three job-characteristics measures emerged as modest predictors of a decline in self-rated health between the two surveys,

**TABLE 2.** Partitioning of Variance for Job Control Scores From MIDUS I Survey (*Unconditional Model*) and Reduction in ICC Coefficient With Inclusion of O\*NET Factors as Fixed Effects

Unconditional Model			Model With O*NET SC Factor as Fixed Effect			
Within Occupation Variability	Between Occupation Variability	ICC	Within Occupation Variability	Between Occupation Variability	ICC	% Reduction in ICC
0.791	0.272	25.6%	0.784	0.149	16.0%	37.7%
<b>Model With 5-item CONTROL by O*NET as Fixed Effect</b>						
0.791	0.272	25.6%	0.787	0.045	5.5%	78.7%

ICC indicates intraclass correlation; MIDUS, National Survey of Midlife in the United States; O\*NET, Occupational Information Network; SC, substantive complexity.

**TABLE 3.** Prevalence Risk Ratios for Association of Substantive Complexity of Work or Job Control With Self-Rated Health; 1995 MIDUS I and 2005 MIDUS II Surveys\*

	Self-Rated Physical Health 1995			Self-Rated Physical Health 2005		
	Substantive Complexity	Job Control (JCQ)	Job Control (O*NET)	Substantive Complexity	Job Control (JCQ)	Job Control (O*NET)
Model 1	1.12(1.04–1.20)	1.15(1.07–1.23)	1.09(1.02–1.17)	1.31(1.15–1.49)	1.23(1.09–1.40)	1.28(1.13–1.46)
Model 2	1.13(1.05–1.21)	1.12(1.04–1.20)	1.11(1.03–1.19)	1.30(1.14–1.48)	1.21(1.07–1.38)	1.28(1.12–1.46)
Model 3	1.10(1.02–1.18)	1.11(1.03–1.19)	1.09(1.01–1.17)	1.30(1.13–1.49)	1.21(1.07–1.38)	1.27(1.11–1.45)

JCQ indicates Job Content Questionnaire; MIDUS, National Survey of Midlife in the United States; O\*NET, Occupational Information Network.

\*Prevalence risk ratios represent the odds of a one-level change in self-rated health for a 1 standard deviation change in job characteristic. Model 1 is adjusted for age, sex, current smoking, race/ethnicity, education, and self-reported health at the age of 16 years. Model 2 is additionally adjusted for negative affectivity. Model 3 is further adjusted for total household income (natural logarithm). Analyses for self-rated health in 2005 are additionally adjusted in all models for self-rated health in 1995 as well as at the age of 16 years, and for substantive complexity or job control in 1995.

**TABLE 4.** Odds Ratios for Association of 1995 Job Characteristics With (a) Decline in Self-Rated Health and (b) Incident Hypertension, Between 1995 and 2005 Surveys\*

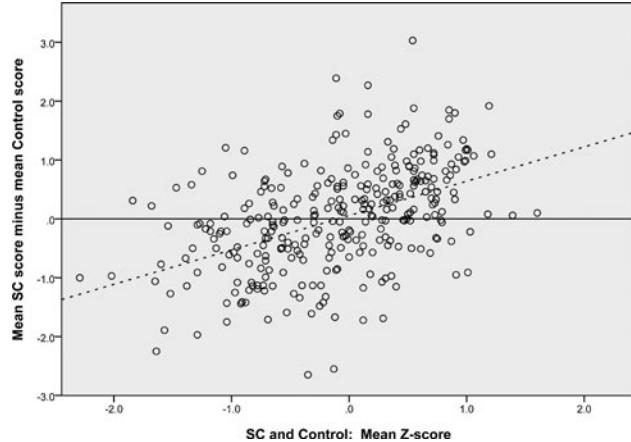
	Substantive Complexity	Job Control (JCQ)	Job Control (O*NET)
<b>Decline in Self-Rated Health</b>			
Model 1	1.46 (1.09–1.94)	1.47 (1.13–1.93)	1.39 (1.06–1.93)
Model 2	1.37 (0.97–1.92)	1.35 (1.00–1.81)	1.41 (1.00–1.98)
Model 3	1.31 (0.93–1.87)	1.31 (0.98–1.77)	1.37 (0.97–1.93)
<b>Incident Hypertension</b>			
Model 1	1.76 (0.99–3.12)	1.23 (0.77–1.96)	1.55 (0.85–2.83)
Model 2	1.87 (1.03–3.40)	1.23 (0.76–1.98)	1.59 (0.87–2.90)

JCQ indicates Job Content Questionnaire; O\*NET, Occupational Information Network.

\*For self-rated health, models are adjusted as shown in Table 3. For hypertension, Model 1 is adjusted for age, sex, current smoking, current alcohol use, race/ethnicity, education, income, and body mass index and Model 2 is additionally adjusted for self-assessment of physical activity and health beliefs.

with borderline statistical significance after adjustment. Substantive complexity, however, emerged as a much stronger predictor of new hypertension in employed subjects between 1995 and 2005.

A Bland-Altman plot displaying agreement between mean z scores for survey-based job control and O\*NET SC scores by job title in the 1995 survey is shown in Fig. 1. The graph indicates considerable variability between the two measures, while a positive slope to the scatterplot suggests that differences between the two measures progressively increase with distance from the mean. Moreover, this positive trend indicates that O\*NET-based SC scores are, overall, more extreme than the mean scores for job control obtained from the MIDUS surveys. The same trend is apparent when O\*NET-derived

**FIGURE 1.** Bland-Altman plot illustrating degree of agreement between substantive complexity (SC) scores and mean job control (JCQ) scores by occupation (1990 census code). Figure represents the difference between SC and mean job control score by occupation (y axis) as a function of the mean of both scores (Bland and Altman<sup>37</sup>). Solid line: Mean score difference; Broken line: regression line fitted to scatterplot.

job control scores are contrasted with JCQ job control scores (not shown). This suggests (as do the high degree of intraoccupational variability and lower ICC shown in Table 2) that job-specific mean scores for self-rated control in surveys using the JCQ may cluster closer toward the overall mean for most occupations, thereby reducing the extent of outlying values, and possibly the range of exposure measurement when mean JCQ scores are used to examine occupational exposure.

## DISCUSSION

Our study provides a useful extension of current evidence for the use of O\*NET variables in describing the psychosocial characteristics of work and their association with the health of workers, as well as providing additional validation of their imputation to specific occupations in survey data. Cifuentes and colleagues<sup>11</sup> found equivalent reductions in ICC (73.5%) to those seen here for job control when O\*NET factors were contrasted with JCQ scores for decision latitude in health care–specific hospital jobs, although this reduction was much smaller (15.2%) for generic jobs in health care settings. The differential in the ICC reduction between the two sets of jobs in that study may arise from the undifferentiated nature of the generic jobs, whereas a broader range of more specifically defined jobs outside health care was available in the MIDUS data sets. The same investigators found that lower levels of decision latitude (job control) based on a composite O\*NET score were a significant predictor of injury in health care workers, with these workplace exposures substantially attenuating socioeconomic gradients in injuries.<sup>23</sup> Similarly, Alterman and colleagues<sup>19</sup> recently showed associations between a ten-item O\*NET score chosen to describe a healthy psychosocial work environment (with the highest factor loadings on ability utilization and autonomy) and reductions in both health risk behaviors (smoking, heavy drinking, and overweight) and self-reported health outcomes including hypertension, angina, and depressive symptoms.

The concept of SC of work is derived from the long-standing investigations of Kohn, Schooler, and colleagues<sup>25,26</sup> that describe the positive effects of work encompassing intellectual challenge and self-direction on psychological functioning, and subsequently on cognitive and intellectual functioning with aging. Work SC was initially quantified through self-rating job surveys and subsequently through scoring based on work characteristics in the DOT, which were primarily observer-determined. More recently, as the O\*NET supplanted the DOT, an equivalent construct has been obtained through factor analyses.<sup>27,32</sup> The construct has, however, not had a formal definition of its components, which may make comparisons between studies difficult. Schooler and coinvestigators provide a definition of SC as entailing complex problem solving involving substantial degree of insight, originality, or thought.<sup>26</sup> Grzywacz and Butler,<sup>32</sup> somewhat by contrast, view SC as encompassing data handling and high levels of training, with decision authority encompassed as well. While the problems in defining theoretical constructs by means of factor-analytic methods are well-described,<sup>39</sup> our replication of prior methods and validation of the resultant SC factor suggests that this construct does encompass such variables as inductive and deductive reasoning. Overlap between the constructs of job control (skill discretion and decision authority) developed by Karasek and colleagues and SC has been noted previously, when scales from the DOT or O\*NET were used and compared with those obtained from the Quality of Employment Surveys.<sup>2,10,12</sup> That the two constructs (job control and SC) would correlate strongly is not surprising. Some investigators have suggested that SC represents a more expansive concept than job control and may be more useful in assessing work as a service economy supplants manufacturing and industrial jobs.<sup>2</sup> Before SC could be used with confidence in the prediction of health effects arising from work characteristics, two questions remained, however. The first was the extent to which imputed SC scores would correlate with those from surveys using the well-validated JCQ, with a secondary concern the comparison of the predictive validity of the two. A second question, more general, concerns the extent to which imputation of job characteristic scores would be predictive of health outcomes, in contrast to individual survey-based scores. Traditionally, the use of proxy or average scores for occupational or other exposures, in place of individual job characteristic assessments, has been considered to result in attenuation of

extremes of exposure assessment, misclassification, and consequent bias toward the null or findings of no effect.<sup>40</sup> Although our results are somewhat mixed, they suggest, as do Cifuentes and colleagues<sup>11</sup> that imputed constructs derived from the O\*NET perform as well as those from individual survey instruments. The substantial reduction in the ICC seen, when O\*NET-based job control scores are contrasted with JCQ scores (Table 2), provides additional evidence that the two are not far apart in measuring job characteristics. The O\*NET may thus provide a useful metric for many job characteristics, one equivalent to JCQ or other measures once interindividual variation is “wrung out” of the exposure measurement. By contrast, the ICC reduction, when SC scores were added to the mixed covariance parameter model, was less than half that seen for the O\*NET-based job control score. This indicates that, while the SC contains variables similar to job control items, it contains additional dimensions that differ sufficiently from the components of job control to consider it a distinct and separate construct. High factor loadings on variables that describe inductive and deductive reasoning and critical thinking<sup>27</sup> may differentiate SC from the JCQ constructs of skill discretion and decision authority that compose job control (decision latitude); these additional variables may be more relevant to a service-sector economy. Although a frequent critique of the classification of work characteristics in this manner emphasizes a correlation with income and thus indicates that this and similar schemata represent surrogates for income or wealth, our results are robust to the inclusion of household income, and indicate that SC and job control are distinct from other constructs used to describe socioeconomic status. In addition, the graphic display of mean scores by occupation (Fig. 1) suggests that the use of O\*NET measures as proxies may increase variability in exposure metrics while the effect of aggregation of survey-based measures may be a tendency to cluster closer to the overall mean, particularly as numbers of subjects within an occupation increase. While this does not militate against the use of individual assessments of work characteristics in survey-based approaches, there is an implication from this contrast that the use of proxy measures, when carefully assessed using both worker and expert appraisal as in the O\*NET methodology, need not result in the nondifferential misclassification of exposure that would tend to move estimates of effect closer to the null.

Finally our results are indicative of the need to carefully specify outcomes when testing the associations of work characteristics with health and disorders. All three work characteristic constructs were equivalent but modest predictors of declines in self-rated health across the 10-year period of the two surveys. Substantive complexity, and to a lesser extent, the O\*NET-derived job control score, was a much better predictor of new-onset hypertension than was the control score from the JCQ. Self-rated health may be susceptible to a number of both extraneous and endogenous influences, in which case one might expect to see weaker associations when testing associations with a specified exposure. By contrast, when the outcome is more specific and objectively measured, both measurement variability and extraneous influences upon the outcome are reduced, which may result in the more robust associations seen here between SC and incident hypertension, which exceed those found in these data between job control and hypertension, a well-described finding.<sup>3</sup> It is possible that the association could be strengthened by the inclusion of job psychological demands, as in the two-construct demand-control model.<sup>7</sup> The omission of job demands here is a result of the failure of the O\*NET factor analysis solution to provide a construct equivalent to job demands, or one that could be reasonably contrasted with the demands factor from the JCQ.

The results we present here are subject to several limitations. The lack of a questionnaire-based metric for assessing physical demands in the survey participants excludes a potentially important occupational factor affecting health. Although the MIDUS surveys provided a physical demands score for subjects' jobs, these scores

were drawn from the DOT, and hence they cannot be contrasted with a survey-based assessment. Likewise, this score was highly correlated with the physical demands score from the O\*NET, which limits its usefulness in a comparative study such as this one. Covariation has been noted between scores for job control and psychological demands and those for work's physical demands, which suggests that these constructs may arise from more fundamental workplace organizational factors<sup>16</sup>. Although other investigations have noted that associations between job control and health outcomes remain robust to the inclusion of workplace physical factors,<sup>10</sup> the probability that high-control or high-SC work may represent work that is low in deleterious physical demands or hazards should not be neglected. A second limitation is the possibility of differential losses to follow-up between the first and second surveys, which may bias results if either nonparticipation or retirement by the time of the second survey is based on subjects' work characteristics or conditions. However, when we analyzed job characteristics in responders versus nonresponders between the two surveys, we found little significant difference between groups. The mean control z score in the 1995 survey was 0.04 in those subjects who were still working in 2005 versus 0.01 in those who retired ( $P = 0.058$ ); those who dropped out or did not respond in the 2005 survey had a mean control z score of 0.0 versus 0.05 in responders to both surveys, although both retirees and dropouts had, proportionately, significantly poorer self-rated health in the 1995 survey ( $P$  values by chi-squared test 0.01 and 0.07, respectively).

In summary, we find that occupational characteristics derived from O\*NET variables, in particular using the construct of SC, perform as well as or better than JCQ job control in describing associations with self-rated health and the incidence of hypertension in working subjects in two surveys across 10 years. Our results add to the recent evidence provided by other investigators that descriptive dimensions of work derived from the O\*NET may be successfully used to examine associations of work with health and the development of chronic health conditions<sup>28</sup> and thereby provide insight into the facets of work that promote or impair health across a working lifetime.

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