

Examining Associations Between Job Characteristics and Health: Linking Data From the Occupational Information Network (O*NET) to Two U.S. National Health Surveys

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Objective: To determine whether the Occupational Information Network (O*NET) database can be used to identify job dimensions to serve as proxy measures for psychosocial factors and select environmental factors, and to determine whether these factors could be linked to national health surveys to examine associations with health risk behaviors and outcomes. **Methods:** Job characteristics were obtained from O*NET 98. Health outcomes were obtained from two national surveys. Data were linked using Bureau of Census codes. Multiple logistic regression was used to examine associations between O*NET factors and cardiovascular disease, depression, and health risk factors. **Results:** Seven of nine work organization or psychosocial factors were significantly associated with health risk behaviors in both the National Health and Nutrition Examination Survey III and National Health Interview Survey. **Conclusions:** This study demonstrates a method for linking independently obtained health and job characteristic data based on occupational code. (J Occup Environ Med. 2008;50:1401–1413)

There is a large body of literature examining the association between work organization and health.^{1–9} Much of the literature has focused on identifying underlying work organization variables that are associated with increased risk for cardiovascular disease (CVD).^{10–12} Nevertheless, these approaches often suffer from an over-reliance on self-report measures for both exposure (job characteristics), and outcome (health), as well as the use of relatively small samples. Workplace psychosocial and work organization factors that may impact health have been difficult to define and measure. Primary data collection on these factors can be expensive and time consuming. Employer and union mistrust of investigators and labor-management tensions can make research in this field difficult. As a partial solution, researchers in the United States^{1,13–18} have imputed or linked job characteristics based on occupational title with health outcomes in national surveys or cohort data using the University of Michigan Quality of Employment Surveys.¹⁹ Job characteristics have been also linked to the Position Analysis Questionnaire,²⁰ a worker-oriented job analysis technique.^{21,22}

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Psychosocial characteristics of occupations²³ have been generated from the Dictionary of Occupational Titles (DOT), however, this was last revised in 1991. Because of the changes in work, such as fewer jobs in manufacturing and increases in the

service industry, the Occupational Information Network (O*NET), an extensive revision of the DOT, was developed.²⁴ The O*NET was piloted in five states in 1996 to 1997 and contains several hundred variables representing descriptors of work and worker characteristics designed to be used by employers, policymakers, and educators. The O*NET provides a common language for defining work attributes and work content to form a classification system that can be applied across occupational groups.²⁵

A contextualized historical view of our study within the tradition of psychosocial work environment measures will help us gain a better understanding of the importance of the O*NET. In the last three decades, the DOT²⁶ has been used to generate measures of the psychosocial characteristics of occupations^{27–33} These measures, such as “substantive complexity,” “perceptual and motor skills,” and “physical demands and hazards,”³⁴ have not only been useful in the sociology of work, occupations, and organizations^{35–37} but in social epidemiology as well.^{34,38–40} Moreover, the DOT measures have inspired the design of other direct measures (eg, job demands and control over work scales⁴¹) that have become standard instruments in social epidemiology⁴². The DOT was created in the 1930s with major revisions in 1949, 1965, 1977, and 1991. It contained, in addition to titles and descriptions, a large number of quantitative variables that described occupations. It is these variables that have been used by social scientists.⁴³ The concept of occupation in the DOT was quite specific; the fourth edition contained over 12,000 entries, too many for practical statistical applications. In the late 1970s, the Bureau of Labor Statistics (BLS), Bureau of the Census and other federal statistical agencies attempted to standardize the production and presentation of occupational statistics with a Standard Occupational Classification⁴⁴ Standardiza-

tion, however, was incomplete; different data systems continued to report occupational statistics with incomparable categories, and by the early 1990s, government officials and their advisory committees saw changes in work and occupations attributed to deindustrialization, globalization, and advancing technology as justification for an extensive revision of the DOT and the standardized occupation codes (SOC).^{45–47} Initially, these revisions were developed separately.

The revision of the DOT is the database system called the Occupation Information Network, or the O*NET.⁴⁸ This system is a major advance in occupational data and in making the content of the system available and relevant to users. The quality of the content is also much improved, or, at least, that is the promise as current versions become finalized. In coming years, O*NET data will continue to be updated, refined, and be made available to the general public.^{49,50} There are three major innovations in the O*NET. First, the number of occupations is much reduced and they are more broadly defined. Many of the occupational titles in the old DOT describe particular jobs; the occupations in the O*NET are intended to group many jobs according to the type of work and amount of education, skills, or training and were partly defined by grouping titles with similar characteristics in the DOT and the BLS_Occupational Employment Statistics system. Compared with over 12,000 entries in the 1991 revision of the DOT, there are 900 occupations described in the current version of the O*NET. Second, the selection and definition of the occupational descriptors has been guided by an extensive review of the progress in occupational analysis since the introduction of the DOT.^{49,51–53} The result of the review is a “content model” that classifies variables according to the characteristics of workers, jobs, organizations, and labor markets with variables defined to

measure significant aspects of these domains. Third, whereas in the old DOT the data were based upon ratings by expert job evaluators, in the O*NET expert evaluations are being largely supplanted by variables measured in surveys of workers. In the version of the O*NET98, the data are still ratings of occupational analysts, but in the future, the data on abilities will be updated with new ratings and the data on skills, generalized work activities, work context, and knowledge will be updated with data from a survey of employees.^{54,55} The survey will cover approximately 300 jobs per year, taking about 3 years to update the entire database.^{54,55} To make the data representative, probability sampling will be used, but the design for the survey is complex. A sample of business establishments stratified on industry, size, and the number of incumbents in target occupations will be selected. This sample will be augmented with employees drawn from association or other occupational group membership lists to more efficiently find persons in some smaller occupations. It is expected that a minimum of 15 respondents will be found for each questionnaire for each occupation. During the same years that the O*NET was being designed to replace the DOT, the SOC was being revised by a committee with members from many federal statistical agencies. After a period of public discussion and development,^{56,57} the revision was completed in 1998. The occupations defined in the SOC are not identical to those defined in the O*NET, but the new SOC is being used in the O*NET and for 2000 Census data and will be used in other data systems presenting statistics by occupation.^{58,59} The new SOC, like its predecessors, was constructed along pragmatic lines in an effort to meet multiple, conflicting objectives. These included facilitating the compilation of useful data by several statistical agencies that reflect the changes in the American workforce and yet can be compared over time

and across nations. The fundamental approach in the new SOC, as in the 1980 SOC, defines occupations by the type of work done, that is by categorizing job titles; however, in the new SOC greater attention has been paid to identifying skill level and to making the system hierarchical. In the new SOC, there are 822 detailed occupations at the fourth and lowest level of a hierarchy with these detailed occupations grouped into 452 broad occupations, 98 minor groups, and 23 major groups. There are guidelines for condensing these groups further into 11 or 6 categories.⁵⁷ It is also possible for users to add even more detail for specific applications by subdividing occupations. This is what has been done in the O*NET, which aims to provide data on 974 occupations.⁵⁸ Previous attempts at creating summary indices have used factor analysis or similar methods of data reduction. Parcel and Mueller²⁹ report an exploratory factor analysis (EFA) of data from the third edition DOT aggregate to 1970 Census of occupations. Roos and Treiman³⁰ aggregated data from the DOT fourth edition to 1970 Census occupations and then did an EFA. Cain and Treiman²⁷ did an EFA of a 10% sample of the titles in the fourth edition of the DOT. England and Kilbourne²⁸ updated the Roos and Treiman³⁰ analysis for 1980 Census occupations. Muntaner et al³⁹ linked the DOT to a probability sample from U.S. metropolitan areas and did an EFA of the DOT data with person as the unit of analysis, comparing the results to Karasek scales. Shu et al³¹ developed comparable scales for 1960, 1970, and 1980 Census occupations with a confirmatory factor analysis. These analyses have produced fairly consistent results, but all authors acknowledge that the data in the DOT are not well documented and are not as reliable, valid, or complete in their content as they might be.²⁷

We build on these previous studies to generate a set of measures of the psychosocial characteristics of work

for occupations using the O*NET. We show that it is useful to link these measures to data sets with records of individuals whose occupation has been coded. These measures can be used in occupational health research to address critical questions on the consequences of occupation where individual occupational characteristics have not been measured or have been assessed with subjective self-reports.^{35,60} After the O*NET developers, we performed an EFA of O*NET occupational characteristics for which data was complete.⁶¹ EFA is an appropriate statistical tool to summarize O*NET indicators of occupational characteristics because, even though the indicators were collected under the O*NET conceptual model, that model does not clearly define relationships among the dimensions of its various categories and domains (see Ref. ⁶¹).

After the earlier considerations, the main purpose of our study is, thus, to determine whether the O*NET can be used to identify job dimensions that would serve as proxy measures for workplace psychosocial factors, work organization, and select environmental factors similar to those found in the population health literature. To fulfill this goal, we sought to empirically derive scales within the conceptual framework of the O*NET that could be linked to national health surveys to examine associations with health risk

behaviors and outcomes, including CVD-related variables and depression.

Methods

Job characteristics were obtained from the O*NET 98, the first version of the O*NET.²⁵ The database contains variables describing job characteristics for O*NET occupation codes, with crosswalks to Bureau of Census codes, and Standard Occupational Codes (SOC). Ratings came from job analysis experts and students. The O*NET 98 is based on a “Content Model” that delineates variables describing characteristics and requirements of both the job and the worker (Table 1). The model contains six broad domains; three domains focus on variables pertaining to the job and three pertain to the worker. These major conceptual domains and subdomains of the O*NET content model are shown in Table 1. Within several of the domains and subdomains, the O*NET content model lists a number of variables, which we have not shown here. For instance, the 52 variables that measure abilities are grouped in the O*NET content model into subdomains like cognitive and psychomotor abilities and scales like verbal or quantitative abilities and fine manipulative or control movement abilities.^{49,62} The variables in the O*NET domains of work activity, ability, knowledge, and skills are measured on more than one dimen-

TABLE 1
Content Model for O*NET 98

Occupation	Worker
Occupational requirements	Worker characteristics
Generalized work activities	Abilities
Work context	Interests
Organizational context	Occupational values
Occupational-specific requirements	Work styles
Occupational knowledge	Worker requirements
Occupational skills	Basic and cross functional skills
Tasks	General knowledge
Machine, tools, and equipments	Education
Occupational characteristics	Experience requirements
Labor market information	Training
Occupational outlook	Experience
Wages	Licensing

sion. For instance, abilities are measured both for the level of ability and the importance of the ability. These level and importance measures are highly correlated.

After the recommendation of O*NET developers,⁶¹ we focused on two domains, Occupational Requirements and Worker Characteristics, as these represent cross-job variables and workplace psychosocial factors that research suggests may be associated with health.

Health outcomes (CVD and depression), along with health risk behaviors were obtained from two national surveys, each representative of the civilian, noninstitutionalized population of the United States. A brief description of each survey is provided.

National Health and Nutrition Examination Survey III

The third National Health and Nutrition Examination Survey (NHANES III) (1988 to 1994) used a cross-sectional, stratified, multistage probability sampling design to collect health and nutrition data through personal interview, physical examination, and laboratory analysis.^{26,63} For NHANES III, 20,050 respondents aged 17 and older completed adult interviews. Respondents in our study were excluded: 1) 2345 had no depression information; 2) 410 respondents were age 17 and did not match the adult population in the National Health Interview Survey (NHIS) (ages 18 and older); 3) 7844 did not work at a job during the past 2 weeks; and 4) 82 lacked valid occupation and education information. The final sample included 9369 respondents.

National Health Interview Survey

The National Health Interview Survey (NHIS) is a multipurpose health survey conducted as a household interview.^{27,28,64,65} Adult data from years 2001 to 2003 were selected for this study. There were 95,222 participants of ages 18 and

older. Exclusions for our study included 35,706 respondents who did not have a job during the previous week; and 2361 missing valid occupation and education information. The final sample consisted of 57,155 respondents.

Health Outcome Variables and Confounders

Cardiovascular Diseases. In both surveys, respondents who answered “yes” to the question “Have you ever been told by a doctor or other health professional that you had hypertension, also called high blood pressure?” were defined as having hypertension. Coronary heart disease and angina were defined in the NHIS by questions “Have you ever been told by a doctor or other health professional that you had coronary heart disease?” This was repeated for angina. Questions in NHANES III limited coronary heart disease to those for whom a physician told them that they had a heart attack. Having a heart attack is not comparable to having coronary heart disease, and therefore this question from NHANES III was excluded and only the NHIS questions are presented.

Health Behaviors. In NHANES III, current smokers are those who answered “yes” to the question “Do you smoke cigarettes now?” Non-smokers included those who responded “no” to the above question or answered “no” to the question “Have you smoked at least 100 cigarettes during your entire life?” In NHIS 2001 to 2003, current smokers included respondents who answered “every day” or “some days” to the question “Do you now smoke cigarettes every day, some days, or not at all?” Heavy drinkers included those who indicated that they had five or more drinks per day and drank at least for 60 days in the past 12 months. Overweight was defined by a body mass index ≥ 25 kg/m².

Depression. Depression was measured differently in each survey. In NHANES III, respondents who answered “yes” to the question, “In

your lifetime, have you ever had 2 weeks or more during which you felt sad, blue, depressed, or when you lost all interest and pleasure in things that you usually cared about or enjoyed?” were defined as having had a depressive episode. Depression questions in NHANES III were only asked of those aged 18 to 39 years. In the NHIS, four questions (based on the National Comorbidity Survey^{29,66} were used to define current depressive symptoms and for comparison purposes, this variable is presented two ways: restricted to those ages 18 to 39 years, and then for all adults. These questions were during the past 30 days, how often did you feel: so sad that nothing can cheer you up; hopeless, everything was an effort, worthless? Depression was dichotomized based on population prevalence of 10%.^{29,66}

Covariates. Demographic variables were measured similarly in both surveys. Age, gender, race/ethnicity, and education were included in the models. Age was treated as a continuous variable, and race and ethnicity were combined into four groups: Non-Hispanic white, Non-Hispanic black, Mexican-American, and other. Education was grouped according to the highest year of school completed.

Statistical Analysis

Factor analyses were performed on job descriptors in three subdomains of the O*NET 98 thought to be more relevant to health outcomes based on the work organization and health literature. Subdomains included are generalized work activities, work context, and occupational values. In doing so, we followed the domains that the O*NET developers recommended in Ref. ⁶¹, and we performed factor analyses for job characteristics in those domains and subdomains. Data were not available for “Karasek type” indicators of psychological demands, control over work and workplace social support in the early version of the O*NET. Those variables that would best fit

TABLE 2

Items, Factor Loadings, and Cronbach's Alpha Included in Factors of Generalized Work Activities, Work Context, and Occupational Values Subdomains, O*NET 98

Generalized Work Activities (Level Scale) (n = 42)		Work Context (Scales Vary)		Occupational Values (Extent Scale)	
Gaining knowledge and information processing (n = 17; Cronbach's $\alpha = 0.98$)		Hazardous work exposures (n = 18; Cronbach's $\alpha = 0.95$)		Psychosocial work environment (n = 10; Cronbach's $\alpha = 0.97$)	
Processing information	94	Very hot	86	Ability utilization	98
Analyzing data or information	94	Outdoors	85	Autonomy	96
Updating and using job-relevant knowledge	94	Keeping or regaining balance	84	Creativity	93
Identifying objects, actions, and events	88	Kneeling, crouching or crawling	83	Responsibility	92
Getting information needed to do the job	86	Extremely bright or inadequate lighting	81	Recognition	91
Interacting with computers	84	Bending or twisting the body	81	Achievement	88
Evaluating info. against standards	83	Indoors – reversed	79	Social status	86
Documenting/recording information	83	Cramped work space, awkward positions	78	Variety	75
Making decisions and solving problems	81	Climbing ladders, scaffolds, poles, etc.	76	Compensation	74
Interpreting meaning of info. to others	80	Sitting*	73	Good working conditions	67
Judging qualities of things, services, people	76	Standing	66		
Implementing ideas, programs, etc.	75	High places	65		
Monitor processes, material, surroundings	69	Contaminants	64		
Estimating needed characteristics	68	Sounds, noise levels are distracting, etc.	64		
Provide consultation and advice to others	63	Hazardous situations	63		
Thinking creatively	58	Whole body vibration	58		
Communicating with other workers	57	Common protective or safety attire	56		
		Hazardous conditions	52		
Interpersonal relationship, assisting, guiding work of others (n = 13; Cronbach's $\alpha = 0.96$)		Dealing with people, diversity of tasks (n = 15; Cronbach's $\alpha = 0.93$)		Working with others (n = 3; Cronbach's $\alpha = 0.77$)	
Developing and building teams	93	Job-required social interaction	86	Independence*	95
Guiding, directing, motivating subordinates	91	Deal with unpleasant/angry people	84	Co-workers	80
Coaching and developing others	89	Deal with external customers	80	Social service	69
Staffing organizational units	88	Frequency in conflict situations	80		
Coordinating work and activities of others	87	Persuade someone to a course of action	78		
Scheduling work and activities	83	Objective or subjective information	73		
Resolving conflict, negotiating w/others	78	Provide a service to others	69		
Monitoring and controlling resources	76	Using hands on objects, tools, controls*	68		
Establishing and maintaining relationships	68	Pace determined by speed of equipment*	66		
Teaching others	65	Take a position opposed to others	63		
Selling or influencing others	59	Coordinate or lead others	61		
Performing administrative activities	56	Making repetitive motions*	58		
Assisting and caring for others	46	Deal with physically aggressive people	56		
		Importance of repeating same tasks*	53		
		Supervise, coach, train others	52		
Physical activities, repairing and maintaining equipment (n = 5; Cronbach's $\alpha = 0.81$)		Competitive work context, importance of being precise (n = 4; Cronbach's $\alpha = 0.82$)		Worker and management relations (n = 3; Cronbach's $\alpha = 0.86$)	
Inspecting equipment, structures, material	79	Consequence of error	80	Company policies and practices	89
Repairing and maintaining mechanical equipment	74	Importance of being sure all is done	71		
Controlling machines and processes	73	Importance of being exact or accurate	69	Supervision, human relations	88
Handling and moving objects	55	Frustrating circumstances	53	Advancement	72
Repairing and maintaining electrical equipment	52				

*Descriptor was reverse coded.

the standard work organization were in the work context subdomain, but these were released slowly on small numbers of occupations (see www.onetcenter.org). The study had been funded and while we waited a year to see if those data on those variables would become available, they did not (with sufficient number of occupations).

Principal factor analysis using SAS 9.1^{30,67} was performed within each subdomain, maintaining the taxonomic system of the O*NET. Promax rotations relaxed the orthogonal constraint to allow for correlated factors. Descriptors were included if Cronbach's alpha was >0.7 .³¹ Values of each extracted factor were assigned factor-based scores, representing the mean of the values for selected descriptors. Table 2 shows the results from factor analysis of the O*NET. Cronbach's alpha for the subscales ranged from 0.77 to 0.98.

The O*NET 98 was linked to NHANES III (1988 to 1994) and NHIS (2001 to 2003) using occupational titles provided by NCHS. Each respondent in NHANES III and NHIS was assigned a mean descriptor value for each of the nine factors from the O*NET (Fig. 1).

Logistic Regression. Multiple logistic regression was used to examine associations between O*NET factors and CVD, depression, and health risk behaviors, with adjustment for age, gender, race, ethnicity, and education. Logistic regression models for hypertension, angina, and coronary heart disease also included smoking and body mass index as confounders. Each O*NET factor was dichotomized into a binary variable at the median for ease of interpretation; binary variables were included in the models. Quadratic terms for age were included when significant. SUDAAN 8.0 was used to take into account the complex survey designs.^{32,68} Data for NHANES III were weighted using the examined sample final weight. The final weight for NHIS (2001 to 2003) was calculated by dividing the sample adult

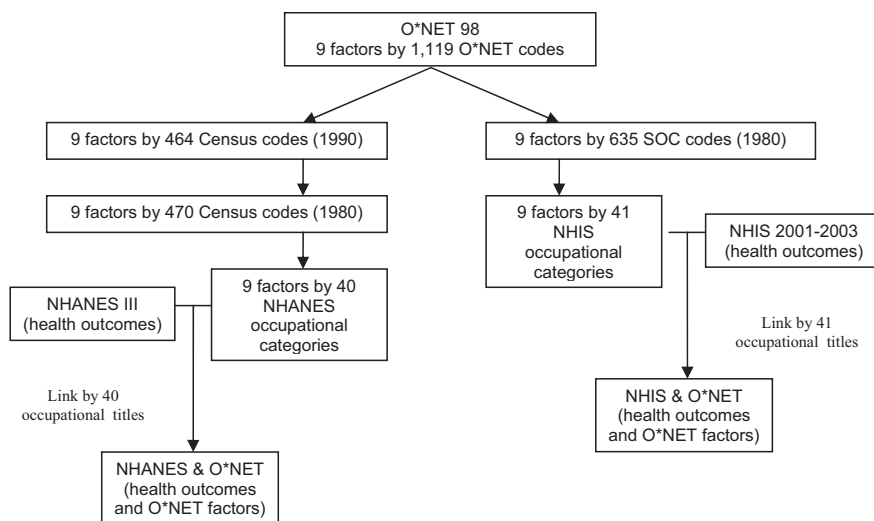


Fig. 1. Procedure for linkage of O*NET to NHANES III and NHIS.

weight by 3. Variance estimates were made with replacement sampling.

Results

Prevalence estimates for demographic characteristics, risk factors,

and health outcomes for NHANES III and NHIS respondents are presented in Table 3. Although the surveys were taken approximately 8 years apart, demographic characteristics of working participants in the

TABLE 3

Weighted Prevalence Estimates* for Demographic Characteristics, CVD Risk Factors, and Health Outcomes for NHANES III (1988–1994) and NHIS (2001–2003)

Characteristic	NHANES III (1988–1994) N = 9369	NHIS (2001–2003) N = 57,155
Characteristic Total		
Gender		
Men	54.7	53.6
Women	45.3	46.4
Race/ethnicity		
Non-Hispanic White	77.7	73.3
Non-Hispanic Black	10.1	10.8
Hispanic	4.9	11.4
Others	7.3	4.4
Education		
0–8 yr	6.4	3.6
9–12 yr	46.3	36.4
13–16 yr	36.7	50.1
17+ yr	10.5	9.8
Age (mean yr)	38.3	40.3
Risk factors and health outcomes		
Current smoker	29.9	23.6
Heavy drinking	8.1	3.7
Overweight (BMI \geq 25)	52.1	59.8
Hypertension	17.4	17.6
Depression	36.5†	10.7† 9.6‡
Coronary heart disease	–§	1.6
Angina	–§	1.1

Data are presented in percentage.

*Data were weighted according to weights provided by NCHS.

†The subpopulation is adults ages 18 to 39.

‡Population is adults ages 18 and older.

§Information is not comparable in NHANES III.

NHIS and NHANES III are similar, with the exception that the NHIS estimated a higher percentage of Hispanics and respondents who were overweight. NHANES III showed higher prevalence estimates for current smoking, heavy drinking, and depression. The distribution of job titles was similar between the two surveys (not shown).

Table 4 shows results of logistic regression analyses of the NHANES III with health risk behaviors and health outcomes as the dependent variables, and dichotomized subscales resulting from factor analyses of the O*NET as the independent variables of interest. All models were adjusted for age, gender, race, and education. Gaining knowledge and information processing was a protective factor for being a current smoker, engaging in heavy drinking, and having suffered a depressive episode. Having a job that involved more interaction and assisting and guiding the work of others was a risk

factor for being overweight. Working at a job that involves physical activity and repairing and maintaining equipment, and a job having hazardous work exposures were risk factors for smoking and drinking behaviors. Dealing with people and having a diversity of tasks was protective against being a current smoker and heavy drinking, and a risk factor for being overweight and having hypertension. Having a positive psychosocial work environment and working with others were protective for being a current smoker and heavy alcohol intake. Having good worker management relations was protective for being a current smoker, heavy drinking, and hypertension in NHANES III.

Table 5 presents results of logistic regression analyses of the NHIS. Gaining knowledge and information processing was a protective factor for current smoking, heavy drinking, and depression. Having a job that involved assisting and guiding the

work of others was also protective for current smoking, heavy drinking, depression, and hypertension. Jobs that involved physical activity, and repairing and maintaining equipment and involving hazardous work exposures were associated with current smoking, heavy drinking, and depressive symptoms for adults of all ages. Dealing with people and having a diversity of tasks was protective for current smoking and heavy drinking, but a risk factor for being overweight. Having a job that involved a competitive work context, being precise and experiencing frustration, was protective for current smoking, heavy drinking, and depression. A positive psychosocial environment was protective for current smoking, heavy drinking, being overweight, angina, hypertension, and depressive symptoms. Having a job that involved working with others was protective for current smoking, heavy drinking, hypertension, and depressive symptoms. Good worker management

TABLE 4

Adjusted Odds Ratios and 95% Confidence Intervals for Job Characteristics in O*NET 98 and Health Risk Behaviors and Outcomes in NHANES III

O*NET Factors	Health Risk Behaviors			Health Outcomes	
	Current Smoker ^a	Heavy Drinking ^b	Overweight ^a	Hypertension ^c	Depressive Episode ^d
Generalized work activities					
Gaining knowledge and information processing	0.77** (0.68–0.88)	0.55** (0.42–0.72)	1.16 (0.99–1.36)	1.09 (0.88–1.34)	0.78* (0.63–0.96)
Interpersonal relationship, assisting, guiding work of others	0.87 (0.75–1.02)	0.85 (0.67–1.08)	1.21* (1.04–1.42)	1.18 (0.95–1.46)	0.81 (0.65–1.01)
Physical activity, repairing and maintaining equipment	1.30** (1.13–1.49)	1.39* (1.06–1.83)	0.88 (0.76–1.01)	0.85 (0.71–1.01)	1.11 (0.90–1.38)
Work context					
Hazardous work exposures	1.32** (1.14–1.51)	1.48* (1.18–1.87)	1.02 (0.87–1.18)	0.85 (0.68–1.05)	1.08 (0.86–1.36)
Dealing with people, diversity of tasks	0.79* (0.69–0.91)	0.74* (0.57–0.95)	1.17* (1.02–1.35)	1.23* (1.00–1.51)	0.88 (0.70–1.10)
Competitive work context accuracy and frustration	0.98 (0.82–1.16)	0.89 (0.70–1.13)	1.02 (0.92–1.13)	0.92 (0.78–1.08)	0.87 (0.69–1.09)
Occupational values					
Psychosocial work environment (positive)	0.83* (0.70–0.98)	0.57** (0.44–0.73)	1.15 (0.96–1.39)	1.08 (0.92–1.28)	0.84 (0.68–1.03)
Working with others	0.79* (0.68–0.92)	0.78* (0.63–0.97)	1.10 (0.92–1.31)	1.20 (0.94–1.53)	0.80 (0.59–1.07)
Worker management relations policy, supervision, advancement (positive)	0.86* (0.76–0.98)	0.68* (0.52–0.90)	1.05 (0.94–1.19)	0.83* (0.71–0.98)	0.86 (0.68–1.08)

* $P < 0.05$; ** $P < 0.01$.

^aModels are adjusted for gender, race/ethnicity, education, and linear and quadratic terms for age.

^bModels are adjusted for gender, race/ethnicity, education, and linear terms for age.

^cModels are adjusted for, gender, race/ethnicity, education, smoking, and linear terms for age and BMI.

^dDepressive episode is restricted to those ages 18–39; models are adjusted, for gender, race/ethnicity, education, and the linear term for age.

TABLE 5
Adjusted Odds Ratios and 95% Confidence Intervals for Job Characteristics in O*NET 98 and Health Risk Behaviors and Outcomes in NHIS (2001–2003)

O*NET Factors	Health Risk Behaviors				Health Outcomes			
	Current smoking ^a	Heavy drinking ^a	Overweight ^a	Hypertension ^b	Angina ^c	Coronary Heart Disease ^d	Depressive symptoms ^a	Depressive symptoms ^e
Generalized work activities	0.70** (0.66–0.73)	0.59** (0.52–0.66)	1.05 (1.00–1.10)	0.96 (0.90–1.03)	0.85 (0.68–1.06)	1.08 (0.89–1.30)	0.77** (0.72–0.83)	0.85* (0.77–0.95)
Gaining knowledge and information processing	0.91* (0.86–0.97)	0.85* (0.75–0.96)	1.01 (0.95–1.07)	0.89* (0.83–0.96)	0.84 (0.66–1.06)	0.92 (0.75–1.13)	0.86** (0.79–0.94)	0.87* (0.77–0.98)
Interpersonal relationship, assisting, guiding work of others	1.26** (1.19–1.33)	1.42** (1.26–1.59)	1.00 (0.95–1.05)	1.02 (0.95–1.09)	0.98 (0.79–1.22)	0.88 (0.73–1.06)	1.12** (1.04–1.22)	1.06 (0.95–1.18)
Physical activity, repairing and maintaining equipment								
Work context								
Hazard work exposures	1.27** (1.20–1.35)	1.43** (1.27–1.62)	1.05 (1.00–1.11)	0.99 (0.93–1.06)	1.05 (0.84–1.31)	0.87 (0.72–1.06)	1.18** (1.09–1.28)	1.02 (0.91–1.14)
Dealing with people, diversity of tasks	0.81** (0.77–0.86)	0.70** (0.62–0.78)	1.07* (1.02–1.13)	0.96 (0.90–1.03)	0.84 (0.68–1.04)	1.01 (0.84–1.23)	0.93 (0.86–1.01)	0.96 (0.86–1.07)
Competitive work context accuracy and frustration	0.94* (0.89–0.98)	0.88* (0.79–0.98)	1.03 (0.98–1.07)	0.99 (0.94–1.05)	1.18 (0.97–1.42)	1.05 (0.89–1.24)	0.76** (0.71–0.82)	0.8* (0.74–0.89)
Occupational Values								
Healthy psychosocial work environment	0.71** (0.67–0.74)	0.62** (0.55–0.69)	0.94* (0.90–0.99)	0.92* (0.87–0.99)	0.78* (0.63–0.96)	1.01 (0.84–1.21)	0.72** (0.67–0.78)	0.80** (0.72–0.88)
Working with others	0.90** (0.85–0.95)	0.87* (0.78–0.98)	0.96 (0.91–1.01)	0.88** (0.82–0.94)	0.89 (0.70–1.11)	1.06 (0.87–1.29)	0.85** (0.78–0.92)	0.86* (0.77–0.97)
Good worker management relations policy, supervision, advancement	0.82** (0.78–0.86)	0.72** (0.65–0.81)	1.01 (0.97–1.06)	0.98 (0.92–1.04)	0.77* (0.63–0.94)	1.13 (0.96–1.34)	0.88** (0.82–0.94)	0.96 (0.87–1.06)

* $P < 0.05$; ** $P < 0.01$.

^aModels are adjusted for gender, race/ethnicity, education, and linear and quadratic terms for age.

^bModels are adjusted for gender, race/ethnicity, education, smoking, the linear term for age, and linear and quadratic terms for BMI.

^cModels are adjusted for gender, race/ethnicity, education, smoking, and linear terms of age and BMI.

^dModels are adjusted for gender, race/ethnicity, education, smoking, linear and quadratic terms for age, and the linear term for BMI.

^eDepression is restricted to those ages 18–39 for comparison with NHANES; models are adjusted for gender, race/ethnicity, education, and the linear term for age.

relations involving company policies, supervision, and opportunities for advancement was protective for current smoking, heavy drinking, angina, and depressive symptoms for adults.

A summary of the statistically significant adjusted associations between job characteristics in the O*NET and health risk behaviors and outcomes in both the NHANES III and the NHIS are presented in Table 6. A minus sign indicates a negative association, and a plus sign indicates a positive association. Seven of the nine factors were significantly associated with health risk behaviors in both surveys, but only one of the nine factors (gaining knowledge and information processing) was significant for a health outcome (depression) in both surveys.

Discussion

This study demonstrates that psychosocial, work organization, and environmental job characteristics derived from the O*NET can successfully be linked to large-scale surveys to examine associations with health behaviors and outcomes. Although the surveys were conducted at different points in time (ie, 8 or more years apart), with the exception of hypertension, associations between the factors in O*NET 98 and health behaviors and outcomes were quite similar.

In both surveys, health risk behaviors (current smoking and heavy drinking) were associated with psychosocial and work organization factors. Current smoking, heavy drinking, and depression were negatively associated with gaining knowledge and information processing. Health risk behaviors were positively associated with jobs involving physical activity, repairing equipment, and hazardous work exposures. Current smokers and heavy drinkers were more likely to be blue-collar workers. We attempted to control for socioeconomic position by including education in the models. Being overweight and having hypertension

TABLE 6

Summary Table of Statistically Significant Adjusted Associations for Job Characteristics in O*NET 98 and Health Risk Behaviors and Outcomes in NHANES III (1988–1994) and NHIS (2001–2003)*

O*NET Factors	Health Risk Behaviors						Health Outcomes			
	Current Smoking†		Heavy Drinking†		Overweight‡		Hypertension‡		Depression§ (Ages 18–39)	
	NHANES	NHIS	NHANES	NHIS	NHANES	NHIS	NHANES	NHIS	NHANES	NHIS
Generalized work activities										
Gaining knowledge and information processing	–	–	–	–					–	–
Interpersonal relationship, assisting, guiding work of others		–		–	–			–		–
Physical activities, repairing and maintaining equipment	+	+	+	+						
Work context										
Hazard work exposures	+	+	+	+						
Dealing with people, diversity of tasks	–	–	–	–	+	+	+			
Competitive work context		–		–						–
Occupational values										
Healthy psychosocial work environment	–	–	–	–		–		–		–
Working with others	–	–	–	–				–		–
Good worker management relations	–	–	–	–			–			

*Plus signs (+) represent a risk factor and minus signs (–) represent a protective factor.

†Models are adjusted for gender, race/ethnicity, education, and linear and quadratic terms for age.

‡Models are adjusted for gender, race/ethnicity, education, smoking, the linear term for age, and linear and quadratic terms for BMI.

§Depression is restricted to those ages 18–39 for comparison with NHANES, models are adjusted for gender, race/ethnicity, education, and the linear term for age.

showed fewer significant associations with psychosocial and work organization factors. Hypertension was negatively associated with factors derived under Occupational Values⁶⁹ in the NHIS and was negatively associated with good-worker-management-relations in NHANES III.

These factors differ from the job demand, job control, social support, effort reward, and emotional labor^{41,70,71} variables often reported in the literature^{1,2} but do describe aspects of the psychosocial work environment that intuitively would be expected to have an impact on mental health and therefore health behaviors and outcomes. Although a direct assessment of the relation between O*NET domains and the standard Karasek dimensions of the psychosocial work environment (job demands and control over work/decision latitude) is not avail-

able, indirect evidence from factor analytical studies of the O* NET’s precursor the DOT suggest a substantial overlap with these two dimensions *plus* some additional dimensions not covered by the demand/control model. Thus, in a series of exploratory and confirmatory factor analyses of DOT rating and Karasek self-report scales in the United States,^{23,39} there was a very high correlation between DOT’s substantive complexity and demands and Karasek’s control and demands respectively. Recently, Hadden et al⁷² conducted a factor analysis of all the indicators present in the O*NET 4.0 version obtaining the traditional DOT factors of Substantive Complexity, People versus Data, Physical Demands, and a new O*NET specific factor that was labeled “Bureaucracy.” This new factor tapped into the hierarchical and regulatory aspects of work organiza-

tion such as organizational policies and practices.

A related issue is the limitations of expert ratings as used in the O*NET vis-a-vis subjective assessments as in Karasek’s popular demand control model.^{73,74} Although in population surveys these measures tend to correlate in single occupation studies and small samples in a single organization their association is weaker suggesting that both methods tap into different risk factors linked to work environment.⁷⁵ The healthy worker effect may have affected our results if those who have heart attacks or angina are less likely to remain in the workforce.

In both surveys among those ages 18 to 39 years, depression was only significantly associated with Gaining Knowledge and Information Processing. Nevertheless, although not statistically significant, the associa-

tions for depression were in the same direction for all factors. The lack of statistical significance could be because of the restriction of questions examining depression in the NHANES to those ages 18 to 39 years. When examining all ages in the NHIS, for depression, eight of the nine factors showed statistically significant associations. Depression among workers ages 27 to 35 years was associated with job attributes in a study linking the O*NET 3.1 to the National Longitudinal Study of Youth.^{36,73}

Our study has a number of limitations. Data used from both the NHIS and NHANES III were self-reported, with the exception of height and weight in NHANES III, which were measured during the home interview. Participants may under-report their amount of drinking and smoking due to social desirability concerns. Although the two surveys measure recent job in slightly different ways, working at a job during the past week in NHANES III, and 2 weeks in the NHIS, it is unlikely that this would bias our results. Both measure recent job. The O*NET 98 relied on expert ratings of job characteristics that may differ from incumbent ratings. In addition, the primary purpose for the development of the O*NET was to enable professionals to better match people to jobs. Linkage of job characteristics by job title assumes that jobs with the same title are similar. Nevertheless, these jobs may occur in a variety of environments and involve complexities that cannot be assumed to be identical. Imputation results in the loss of within-occupation variability in work characteristics.⁷⁵

Although, in the absence of specific occupational exposure data, job title is often used as a surrogate for exposure by occupational epidemiologists, caution is urged when attributing characteristics based on job title alone. In both surveys, there may be misclassification of exposure due to the categorization of occupations into only 40 to 41 categories. In addition,

because of the cross-sectional nature of the data, no assumptions about causality can be made. It is unclear whether workers with certain health behaviors or conditions self-select into occupations. Because many individuals are unaware of their condition, hypertension is likely to be under-reported. In addition, the psychosocial and work organization descriptors in this study fail to capture the hierarchical effects of the workplace, bullying/mobbing, racial and gender discrimination, and perceived managerial justice.^{76–80} Other factors such as self-access to health care were not measured in the current study but may moderate associations between job characteristics and health. Additional job and sociodemographic characteristics should be considered in future research. Examples of these are contingent work, shift work, job security, under-employment, over-employment (as in forced overtime), and lack of mobility.

Strengths of the present study include objective measurement of work characteristics^{81–83} decreasing the potential impact of self-report bias in job measurement,⁷⁴ and avoidance of common method variance due to covariance between the predictor and criterion variable when provided by the same respondent.⁸⁴ In our study, job characteristics are measured independently from health. The O*NET has the advantage of being more recent than the Quality of Employment Surveys, and thus more likely to take into account current exposures. A previously published factor analysis of the O*NET 3.0 found similar factors involving cognitive elements, physical effort, and interpersonal relationships.⁷³

The development of the O*NET provides an exciting tool for occupational health researchers. This study has demonstrated the utility of using the O*NET to provide various job descriptors for use in surveys and other health data sets where information on these characteristics is not available. Further use of the O*NET

for research purposes is encouraged. At the time of this analysis, data for descriptors related to job demand and control, social support, effort-reward imbalance, and emotional labor were not available. Data related to these constructs and theories can now be found in the Organizational and Work Context Domains. Several different versions of the O*NET have been released since we began our analyses. Changes have included conversion to SOC and adding ratings derived from incumbents. O*NET 12.0 contains 780 occupations for most domains with a mixture of analyst and incumbent ratings.

Knowledge gained from examination of the associations between job descriptors or factors derived from linkage of the O*NET and health behaviors can be used in the development of healthy workplace initiatives and health promotion activities. For example, unhealthy behaviors may be reduced by providing opportunities for workers to gain knowledge and process information, perhaps through training or support for educational endeavors. For example, Sorensen et al⁸⁵ have developed a social-contextual model among blue-collar workers where organizational factors are incorporated into health promotion programs to reduce tobacco use. Linkage of health data to the O*NET provides a rich source of information that can be used by occupational health researchers, health promotion specialists, and organization development experts to increase the efficacy of healthy workplace initiatives, interventions, and the design of healthier workplaces.

This article describes a data linkage method and demonstrates that psychosocial, work organization, and environmental job characteristics derived from the O*NET can successfully be linked to large-scale surveys to examine associations of work characteristics with health behaviors and outcomes. This data linkage method will provide researchers with job descriptors for use in research,

surveillance, and workplace redesign when information on these characteristics is not available.

If the methods and use of psychosocial factors derived from the O*NET are supported by further research, then occupational health and organizational specialists may be able to use these to design and evaluate potential healthy workplace initiatives and interventions in the workplace. Linkage of health data to the O*NET can provide surveillance data to monitor the changing associations between working conditions and specific disorders for workers in different occupations.

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