Classifying U.S. Army Military Occupational Specialties Using the Occupational Information Network

Anne M. Gadermann, PhD; Steven G. Heeringa, PhD†; Murray B. Stein, MD, MPH‡§||; Col Robert J. Ursano, USAF (Ret.)¶; CAPT Lisa J. Colpe, USPHS**; Carol S. Fullerton, PhD¶; Stephen E. Gilman, ScD††‡‡; Michael J. Gruber, MS§§; Matthew K. Nock, PhD||||; Anthony J. Rosellini, PhD§§; Nancy A. Sampson, BA§§; Michael Schoenbaum, PhD¶¶; Alan M. Zaslavsky, PhD§§; Ronald C. Kessler, PhD§§; On behalf of the Army STARRS Collaborators.*

ABSTRACT Objectives: To derive job condition scales for future studies of the effects of job conditions on soldier health and job functioning across Army Military Occupation Specialties (MOSs) and Areas of Concentration (AOCs) using Department of Labor (DoL) Occupational Information Network (O*NET) ratings. Methods: A consolidated administrative dataset was created for the "Army Study to Assess Risk and Resilience in Servicemembers" (Army STARRS) containing all soldiers on active duty between 2004 and 2009. A crosswalk between civilian occupations and MOS/AOCs (created by DoL and the Defense Manpower Data Center) was augmented to assign scores on all 246 O*NET dimensions to each soldier in the dataset. Principal components analysis was used to summarize these dimensions. Results: Three correlated components explained the majority of O*NET dimension variance: "physical demands" (20.9% of variance), "interpersonal complexity" (17.5%), and "substantive complexity" (15.0%). Although broadly consistent with civilian studies, several discrepancies were found with civilian results reflecting potentially important differences in the structure of job conditions in the Army versus the civilian labor force. Conclusions: Principal components scores for these scales provide a parsimonious characterization of key job conditions that can be used in future studies of the effects of MOS/AOC job conditions on diverse outcomes.

INTRODUCTION

A long tradition of research in organizational psychology and related disciplines has examined occupational differences in worker's health,[1,2] job satisfaction,[1,3] and work performance.[1] These studies have documented such things as low rates of job satisfaction among workers with jobs featuring a combination of high demands and low autonomy,[4,5] low work performance among workers exposed to high-intensity artificial lighting,[6] high rates of hypertension among emergency respondents,[7,8] and high rates of suicide among farmers.[9]

Although few comparable studies have been carried out in the military, research has documented significant differences across military occupations in rates of job satisfaction,[10] injury,[11] disability,[12] and suicide.[13,14] A limitation of these military occupational studies is that the denominator population is too small to generate stable outcome estimates for most individual occupations, whereas broadly defined occupational groups, such as two-digit Department of Defense-wide occupation codes, are not designed to define a meaningful

*Centre for Health Evaluation and Outcome Sciences, St. Paul's Hospital, University of British Columbia, 620B-1081 Burrard Street, Vancouver, BC V6Z 1Y6.

†Institute for Social Research, University of Michigan, 426 Thompson Street, Ann Arbor, MI 48104.

‡Department of Psychiatry, University of California San Diego, 9500 Gilman Drive, MC: 0603, La Jolla, CA 92093-0603.

§Department of Family and Preventive Medicine, University of California San Diego, 9500 Gilman Drive, MC: 0603, La Jolla, CA 92093-0603.

||VA San Diego Healthcare System, 3350 La Jolla Village Drive, San Diego, CA 92161.

¶Department of Psychiatry, Center for the Study of Traumatic Stress, Uniformed Services University School of Medicine, 4301 Jones Bridge Road, Bethesda, MD 20814.

**Division of Services and Intervention Research, National Institute of Mental Health, 6001 Executive Boulevard, Bethesda, MD 20892.

††Department of Social and Behavioral Sciences, Harvard School of Public Health, 677 Huntington Avenue, Boston, MA 02115.

‡‡Department of Epidemiology, Harvard School of Public Health, 677 Huntington Avenue, Boston, MA 02115.

§§Department of Health Care Policy, Harvard Medical School, 180 Longwood Avenue, Boston, MA 02115.

||||Department of Psychology, Harvard University, 33 Kirkland Street, Cambridge, MA 02138.

¶¶Office of Science Policy, Planning and Communications, National Institute of Mental Health, 6001 Executive Boulevard, Bethesda, MD 20892.

Kessler has been a consultant for Eli Lilly & Company, Glaxo, Inc., Integrated Benefits Institute, Ortho-McNeil Janssen Scientific Affairs, Pfizer Inc., Sanofi-Aventis Groupe, Shire US Inc., and Transcept Pharmaceuticals Inc. and has served on advisory boards for Johnson & Johnson. Kessler has had research support for his epidemiological studies over this time period from Eli Lilly & Company, EPI-Q, GlaxoSmithKline, Ortho-McNeil Janssen Scientific Affairs, Sanofi-Aventis Groupe, Shire US, Inc., and Walgreens Co. Kessler owns a 25% share in DataStat, Inc. Stein been a consultant for Care Management Technologies, received payment for his editorial work from UpToDate and Depression and Anxiety, and had research support for pharmacological imaging studies from Janssen. The remaining authors report no competing interests.

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dimension in predicting a diverse range of outcomes. One way to address these limitations is to use a conceptual scheme to classify military occupations into a small number of categories using objective ratings of job conditions based on the Occupational Information Network (O*NET) system.[15] O*NET is a system created by the U.S. Department of Labor (DoL) to standardize reporting of occupational statistics based on objective ratings of diverse job requirement and work characteristics across the labor force.[16] The job requirements (knowledge, skills, abilities, education) and work characteristics (activities, tasks, settings) dimensions used in O*NET were selected from dimensions found important in the occupational analysis literature.[16–18] O*NET version 15,[19] which was used in the current report, contains 853 occupational groups rated on 246 different descriptive dimensions.

O*NET has been used to examine effects of job conditions on a variety of outcomes in the civilian labor force.[20–23] However, the complexity and overlap among the 246 O*NET dimensions make it difficult to distinguish clear effects of particular job characteristics.[15] Principal components analysis (PCA) and exploratory factor analyses (EFA) have consequently been used to derive composite measures of multivariate O*NET item profiles.[20,21,24–26] A number of stable components/factors have been found in these studies. It is not clear, though, whether the same components/factors adequately characterize military occupations, as not all DoD occupation codes have direct equivalents to civilian occupations.

The goal of the current report is to derive O*NET-based summary dimensions of military occupations for use in future research on associations between occupational characteristics and soldier outcomes. To accomplish this, we generated O*NET dimension scores for roughly one-third of Army occupations that do not currently have direct equivalents in the O*NET system. We then carried out PCAs across all Army occupations. Our immediate purpose in generating these scores was to use them in the "Army Study to Assess Risk and Resilience in Servicemembers" (Army STARRS; www.armystarrs.org), an epidemiological and neurobiological study of risk and resilience factors for Army suicides. However, the resulting component scores can be used in the study of other topics.[20,26–28] To that end, an appendix accompanying this article provides a public use file of derived scores for each Army occupation on each component scale generated in the analyses reported here (available at http://www.hcp.med.harvard.edu/ncs/ftpdir/ONET_Methods_Paper_Appendix_Table_I.xlsx).

METHOD

Sample

We built a consolidated Army STARRS Historical Administrative Data Study (HADS) database combining individual-level data across diverse Army and DoD data systems for all Regular Army, Army National Guard, and Army Reserve soldiers on active duty at any time between January 2004 and December 2009,[29] a total of roughly 1.6 million soldiers. Each soldier was classified by Military Occupation Specialty (MOS; for enlisted soldiers and warrant officers) or Area of Concentration (AOC; for commissioned officers).[30] However, MOS/AOC often changes over time as soldiers gain new competencies and are promoted. Furthermore, soldiers vary in the amount of time they are on active duty. We addressed these two issues by converting the person-level records into person-month records; that is, a series of separate records for each soldier for each month of active duty service over the study period. Each person-month was coded according to the soldier's MOS/AOC during that particular month. The 1.6 million soldiers in the file had a total of 51.1 million person-months (37.0 million in the Regular Army, 5.3 million in the activated Army Reserve, and 8.8 million in the activated Army National Guard). A stratified (by sex, rank, time in service, deployment status, component, and historical time) random sample of one out of every 400 person-months (a total of 111,195 person-months) was selected to produce a dataset of more manageable size. Use of this person-month sample implicitly weighted each MOS/AOC by its frequency of occurrence in the active duty Army. The sample was subsequently reduced to 100,877 by excluding person-months when soldiers were either in training, in the hospital, or in rehabilitation.

Measures

*The O*NET Structure*

Although O*NET descriptors are organized into six domains, the descriptive dimensions are confined to three of these six: the "worker characteristics" domain (80 dimensions in the subdomains of abilities, occupational interests, work values, and work styles); the "worker requirements" domain (68 dimensions in the subdomains of basic skill, cross-functional skill, and knowledge requirements); and the "occupational requirements" domain (98 dimensions in the subdomains of generalized work activities and work context). Consistent with civilian studies,[20,25,26] these were the domains used in the current analysis, as the other three domains either contain information specific to individual occupations rather than applying to all occupations (the "occupation-specific information" domain, where we find such information as the speed of typing required to be a secretary), contain information about work experience requirements (the "experience requirements" domain, where we find such information as apprenticeship requirements), or contain labor market information irrelevant to Army occupations (the "workforce characteristics" domain, where we find occupation-specific information on civilian wage and employment rate trends based on Bureau of Labor Statistics data).

Separate scores (each with a 0–100 range) on the "level" and "importance" of the dimension required for the occupation exist for 161 of the 246 dimensions in the worker characteristics, worker requirements, and occupational requirements domains. Only a single score on either level or importance is provided for the other 85 dimensions. As level and importance scores are highly correlated for dimensions containing both (Pearson r range = 0.58–0.99; interquartile range = 0.88–0.98; median = 0.94), PCA/EFA of the O*NET dimensions in civilian samples have either combined the two scores[25,26] or used only the level score.[20] We combined the two scores using both arithmetic and geometric means. Results reported here are based on arithmetic means, as the component loadings using this method were somewhat stronger than when using geometric means.

*Mapping MOS/AOC Codes to O*NET Occupations*

The Army classifies soldiers into 645 different MOS/AOCs[30] that are recorded in the Defense Manpower Data Center (DMDC) Active Duty Master Personnel File. Monthly information is recorded in this file on changes in MOS/AOC. Both "primary" MOS/AOC (the occupation of the soldier's most recent training) and "duty" MOS/AOC (the job being performed in the month of observation) are recorded. Although primary and duty MOS/AOC are typically the same, they sometimes differ. For example, soldiers with a primary MOS of cook can have a different duty MOS during deployment because civilian contractors are often used as cooks in combat theaters. We focused on duty MOS/AOC rather than primary MOS/AOC in our analysis, as we wanted to focus on the actual day-to-day tasks carried out by soldiers rather than on the duties for which they were trained.

We used a "crosswalk" created by the developers of O*NET and DMDC to assign O*NET codes to the 474 Army MOS/AOCs considered comparable to civilian O*NET occupational groupings (http://www.onetonline.org/crosswalk/MOC/). This crosswalk takes into account that some MOS/AOC numbers changed over time by matching civilian characteristics to MOS/AOCs for appropriate time periods. The other 171 (i.e., 645 − 474) MOS/AOCs were not included in the crosswalk because there is no civilian equivalent occupation (e.g., a mine sweeper). We addressed this problem in two ways. First, we excluded 35 of the 171 because they involved temporary statuses not related to actual jobs (most involving trainees and patients in hospitals or rehabilitation). Second, we created a composite classification scheme for each of the remaining 136 (i.e., 171 − 35) MOS/AOCs to capture the main requirements of that job and then assigned O*NET ratings using the maximum value for each dimension across the multiple O*NET occupational groupings in the composite. In the case of a mine sweeper, for example, we created a composite that included the O*NET occupational groups of Police SWAT team member, skilled heavy equipment operator, and several other civilian occupational groups that captured the key aspects of the skill set and job conditions of an Army mine sweeper. The DMDC reviewed and approved these ratings. These 136 MOS/AOCs were then combined with the 474 already classified to create a set of 610 MOS/AOCs with a score on each of the 246 O*NET dimensions. These 610 MOS/AOCs formed the basis of the analyses reported below.

Analysis Methods

Correlation matrices were constructed to characterize bivariate associations of the 246 O*NET dimensions in the HADS sample of 100,877 person-months. PCA of these matrices was carried out using the "parallel analysis" simulation method to determine the optimal number of components to retain.[31] Parallel analysis extracts the maximum number of components that can be reliably distinguished in a dataset.[32] Once a final number of components was selected, an oblique (promax) rotation was used to improve component interpretation. We used oblique rather than orthogonal rotation based on evidence in the civilian literature that significant correlations exist among O*NET component/factor scores.[20,25,26] SAS version 9.2 was used for all analyses.

RESULTS

*Principal Components Analysis of all O*NET Dimensions*

Our first analysis aimed to determine the extent to which we could replicate earlier findings regarding the structure among the 246 O*NET dimensions in civilian research.[25] Parallel analysis suggested that three components could be reliably distinguished in the data. These three together explained 65.0% of total item variance. (Table I) Standardized partial regression coefficients in the promax-rotated solution suggest that these components reflect "physical demands" (e.g., worker ability requirements of physical coordination and manual dexterity; worker skill requirements of maintenance, repair, and control of machines and processes; and work contexts involving hazardous exposures); "interpersonal complexity" of work (e.g., worker characteristic requirements of self-control and concern for others; and occupational requirements of dealing with conflict situations); and "substantive complexity" of work (e.g., worker characteristic requirements of flexibility and originality; worker skill requirements of complex problem solving and judgment; and occupational requirements of thinking creatively, supervising, and providing consultation). The interpersonal complexity and substantive complexity components are correlated r = 0.37, whereas the physical demands component is correlated r = 0.21 with the interpersonal complexity component and r = 0.06 with the substantive complexity component.

*Principal Components Analysis Within the Conceptual O*NET Subdomains*

Another approach to data reduction in civilian studies of the O*NET dimensions has been to work with the conceptual

TABLE I. Standardized Partial Regression Coefficients of Illustrative High-Loading O*NET Dimensions Based on Three-Factor Promax Rotated Exploratory Factor Analysis of all 246 Dimensions in the Army STARRS 2004–2009 Administrative Records Person-Month Sample (n = 100,877)[a]

	I	II	III
I. Physical Demands			
Work Context: Exposure to Contaminants	**0.89**	0.10	0.02
Work Context: Exposure to Hazardous Conditions	**0.84**	0.14	0.20
Abilities: Manual Dexterity	**0.86**	0.07	0.01
Abilities: Control Precision	**0.89**	−0.02	−0.06
Skills: Troubleshooting	**0.89**	−0.31	0.26
Skills: Operation Control	**0.85**	0.07	−0.04
II. Interpersonal Complexity			
Work Context: Frequency of Conflict Situations	0.07	**0.92**	−0.07
Work Context: Deal With Unpleasant People	0.10	**0.94**	−0.32
Work Style: Stress Tolerance	0.13	**0.79**	0.11
Work Style: Concern for Others	−0.05	**0.87**	−0.18
Skills: Negotiation	−0.17	**0.74**	0.21
Skills: Social Perceptiveness	−0.25	**0.78**	0.33
III. Substantive Complexity			
Skills: Complex Problem Solving	0.06	−0.10	**0.90**
Skills: Judgment and Decision-Making	0.00	0.22	**0.77**
Abilities: Flexibility in Using Rules, Combining and Grouping Things	−0.03	0.06	**0.83**
Abilities: Fluency of Ideas	−0.11	0.30	**0.72**
Work Activities: Thinking Creatively	0.07	0.09	**0.75**
Work Activities: Analyzing Data or Information	0.01	0.14	**0.75**

[a]Based on exploratory principal axis factor analysis with promax rotation of 246 O*NET dimensions. The number of factors to extract was determined by simulation. All boldfaced coefficients are significant $p < .001$. Pearson correlations among factors are $r = 0.21$ I–II (physical demands and interpersonal complexity), $r = 0.06$ I–III (physical demands and substantive complexity), and $r = 0.37$ II–III (interpersonal complexity and substantive complexity). The proportions of item variance explained by the factors are 20.9% I, 18.0% II, and 15.0% III. 46 dimensions had relatively pure loadings (≥|0.50| on 1 factor and ≤|0.30| on the other 2 factors) on factor I, another 46 on factor II, and an additional 36 on factor III, with 7 additional dimensions having loadings ≥|0.50| on factors I and II, 4 on factors I and III, and 3 on factors II and II. Only 12 dimensions had loadings < |0.40| on all 3 factors.

dimensions specified by the developers of the O*NET system, to determine the number of dimensions that can be discovered in this scheme in a first-order PCA/EFA, and then to carry out a second-order PCA/EFA of those first-order scale scores.[25] The purpose of doing this is to see if we can find a more nuanced structure among the 246 O*NET dimensions in this way than by working directly with the 246 primary dimensions. We began this phase of analysis by carrying out separate PCAs for the dimensions within each of the nine subdomains specified by the developers of the O*NET system in the worker characteristics, worker requirements, and occupational requirements domains. These within-subdomain PCAs yielded evidence of between one and three reliable components within each of the nine O*NET subdomains (18 components across all subdomains). (Table II) A brief overview of these components follows, with dimensions having highest standardized partial regression coefficients reported in parentheses.

Worker Characteristics Subdomains

Parallel analysis suggested that there are four subdomains in the worker characteristics domain. We refer to these as the "abilities," "occupational interests," "values," and "work styles" subdomains based on inspection of standardized partial regression coefficients. Two components were identified for the 52 dimensions in the abilities subdomain: "physical abilities" (e.g., multilimb coordination and speed of limb movements) and "cognitive abilities" (e.g., oral expression and deductive reasoning). Two components were also identified for the 6 dimensions in the occupational interest subdomain: "teaching/leading" (e.g., social and enterprising) and "creativity/intellectual interests" (e.g., investigative and artistic). Parallel analysis of the 6 dimensions in the work values subdomain (e.g., achievement and recognition) and the 16 dimensions in the work styles subdomain (e.g., initiative and persistence) suggested that these subdomains are one-dimensional.

Worker Requirements Subdomains

Parallel analysis suggested that the worker requirements domain has three subdomains: "basic skills," "cross-functional skills," and "knowledge." The 10 dimensions in the basic skills subdomain appear one-dimensional (e.g., critical thinking and learning strategies). Two components were identified for the 25 dimensions in the cross-functional skills subdomain: "organization skills" (e.g., instructing and judgment/decision making); and "physical system skills" (e.g., troubleshooting and equipment selection). Three components were identified for the 33 dimensions in the knowledge subdomain: "social science" (e.g., therapy/

TABLE II. Summary of Significant Factors Found in Within-Subdomain Exploratory Factor Analyses of the 246 O*NET Variables in the Army STARRS 2004–2009 Administrative Records Person-Month Sample (n = 100,877)[a]

	Number of Dimensions in the Subdomain	Number of Significant Factors	% of Within-Domain Variance Explained	Between-Factor Correlations		
				I	II	III
I. Worker Characteristics						
A. Abilities	52	2	72			
Physical Abilities	33		47	—		
Cognitive Abilities	19		25	0.20	—	
B. Occupational Interests	6	2	62			
Teaching/Leading	3		33	—		
Creativity/Intellectual Interests	3		29	0.04	—	
C. Work Values	6	1	69			
D. Work Styles	16	1	65			
II. Worker Requirements						
A. Basic Skills	10	1	70			
B. Cross-Functional Skills	25	2	70			
Organizational Skills	16		39	—		
Physical System Skills	9		31	0.01	—	
C. Knowledge	33	3	67			
Social Sciences	18		44	—		
Engineering and Technology	9		15	0.28	—	
Business/Management	6		8	0.34	0.22	—
III. Occupational Requirements						
A. Generalized Work Activities	41	3	73			
Supervision	21		51	—		
Interacting With Others	11		14	0.51	—	
Technical Complexity	9		8	0.15	0.21	—
B. Work Context	57	3	67			
Hazardous Work Conditions	29		43	—		
Dealing With Others	19		18	0.45	—	
Interpersonal Intensity	9		6	−0.13	0.18	—
Totals	246	18				

[a]Based on 9 separate exploratory principal axis factor analysis, 1 for all the dimensions in each of the 9 O*NET subdomains. The proportions of item variance in each domain explained by the factors are reported in the third columns. The number of factors to extract in each solution was determined by simulation. Pearson correlations among factors and are reported in the last 2 columns.

counseling and psychology), "engineering and technology" (e.g., engineering/technology and physics), and "business/management" (e.g., administration management and economics-accounting).

Occupational Requirements Subdomains

Parallel analysis suggested that the occupational requirements domain has two subdomains: "generalized work activities" and "work context." Three components were identified for the 41 dimensions in the generalized work activities subdomain: "supervision" (e.g., monitoring and controlling resources; guiding, directing, and motivating subordinates); "interacting with others" (e.g., performing for or working directly with the public and identifying objects, actions, and events); and "technical complexity" (e.g., controlling machines and processes; repairing and maintaining mechanical equipment). An additional three components were identified for the 57 dimensions in the work context subdomain: "hazardous work conditions" (e.g., being exposed to high places and to uncontrolled environmental conditions); "dealing with others" (e.g., dealing with external customers and working with group teams); and "interpersonal intensity" (e.g., electronic mail and telephone).

Second-Order Principal Components Analysis of Subdomain Component Scores

Component-weighted scores were constructed for the 18 scales in the within-subdomain PCAs, and a second-order PCA of those component scores was carried out to examine whether we could recover the three components derived in the aggregate PCA. Parallel analysis suggested that there are, in fact, three components underlying the 18 component-weighted scales in the subdomain PCAs. These three correspond closely to the three component scores found in the aggregate PCA of all 246 individual O*NET dimensions (Table III). Pearson correlations between scores on the three O*NET components based on the aggregate PCA of the 246 dimensions and comparable scores on the second-order PCA of the within-subdomain first-order component scales are r = 0.95 for physical demands, r = 0.92 for interpersonal complexity, and r = 0.90 for substantive complexity. Because specification of all 21 of these variables as predictors in a single

TABLE III. Standardized Partial Regression Coefficients of the 18 Factor-Weighted Scales Obtained From Within-Domain Exploratory Factor Analyses of the O*NET Dimensions Based on Three-Factor Promax Rotated Second-Order Exploratory Factor Analysis of These Scores in the Army STARRS 2004–2009 Administrative Records Person-Month Sample (n = 100,877)[a]

	Physical Demands	Interpersonal Complexity	Substantive Complexity
I. Worker Characteristics			
A. Abilities			
Physical Abilities	**0.63**	**0.68**	−0.29
Cognitive Abilities	0.04	0.31	**0.77**
B. Occupational Interests			
Teaching/Leading	**−0.61**	0.49	0.38
Creativity/Intellectual Interests	**0.49**	0.14	0.38
C. Work Values	0.09	**0.55**	**0.54**
D. Work Styles	0.04	**0.78**	0.21
II. Worker Requirements			
A. Basic Skills	−0.03	0.28	**0.82**
B. Cross-Functional Skills			
Organizational Skills	0.05	0.18	**0.85**
Physical System Skills	**0.94**	−0.26	0.10
C. Knowledge			
Social Sciences	−0.06	**0.82**	0.20
Engineering and Technology	**0.88**	−0.21	0.47
Business/Management	0.06	−0.06	**0.75**
III. Occupational Requirements			
A. Generalized Work Activities			
Supervision	0.21	0.01	**0.90**
Interacting With Others	−0.01	**0.88**	0.10
Technical Complexity	**0.94**	0.05	−0.10
B. Work Context			
Hazardous Work Conditions	**0.81**	0.39	−0.17
Dealing With Others	−0.04	**0.97**	−0.09
Interpersonal Intensity	−0.22	−0.16	**0.83**

[a]Based on second-order exploratory principal axis factor analysis with promax rotation of 18 first-order factor-weighted O*NET subdomain factor scores. The number of factors to extract was determined by simulation. All boldfaced coefficients are significant $p < .001$. Pearson correlations among factors are $r = 0.15$ physical demands and interpersonal complexity, $r = 0.03$ physical demands and substantive complexity, and $r = 0.43$ interpersonal complexity and substantive complexity. The proportions of item variance explained by the factors are 11% physical demands, 24% interpersonal complexity, and 46% substantive complexity.

equation would yield highly unstable coefficients as a result of the strong three-component structure underlying the 18 domain-specific scales, we regressed scores on each of the subdomain 18 scales onto the three domain scores to generate 18 residual subdomain component scores that would be independent of the three main components.

*Associations of Rank With the 21 O*NET Dimensions*

As assignment of MOS/AOCs is contingent on a soldier's rank, we were interested in examining the associations of rank/grade with the 3 domain and 18 subdomain scores. To do this, one-way analysis of variance was used to examine associations of a seven-category rank/grade classification scheme (E1-E2; E3-E4; E5-E9; Warrant Officer; Commissioned Officer Lieutenant I-II; Commissioned Officer Captain Major; and Commissioned Officer Lieutenant Colonel and above) with each of the three domain scores and 18 residual subdomain scores. Results showed that rank/grade account for only small proportions of variance in the component scores, with a mean ε^2 of 0.03, an ε^2 range of 0.001–0.175, and with 20 of the 21 models having an $\varepsilon^2 < 0.10$. These results suggest that the majority of the information in the O*NET component scores reflects variation within rather than between these broadly defined rank-grade groupings (Table IV).

DISCUSSION

Our aim in this study was to identify meaningful summary measures of military occupational characteristics that could be used in future research to examine associations of occupational characteristics with diverse soldier outcomes (e.g., job satisfaction, work performance, health). The results are broadly consistent with the two civilian studies in which PCA/EFA was estimated with the full set of O*NET dimensions.[25,26] Both civilian studies, consistent with our study, found three components/factors underlying the O*NET dimensions. In addition, one of those two earlier studies carried out a second-order EFA and found the same three-factor structure as we did among the first-order O*NET subdomain factor scores.[25] Furthermore, a number of previous PCA/EFA studies of individual O*NET subdomains[25] and more limited sets of O*NET dimensions[20,24,33–35] found

TABLE IV. Means and Standard Deviations Obtained from Multiple Linear Regressions of 21 O*NET Component Scores[a] onto 7 Categories of Rank in the Army STARRS 2004–2009 Administrative Records Person-Month Sample (n = 100,877)

	Rank (Predictors)														
	E1-E2		E3-E4		E5-E9		Warrant Officer		Commissioned Officer Lt. I-II[b]		Commissioned Officer Captain/Major		Commissioned Officer Lt. Col. or Above[c]		
Component (Outcomes)	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	Model ε^2
I. Worker Characteristics															
A. Abilities															
Physical Abilities	−0.02	0.24	−0.01	0.24	−0.01	0.25	0.19	0.26	0.09	0.25	0.07	0.26	0.03	0.26	0.024
Cognitive Abilities	0.02	0.24	0.03	0.25	0.00	0.27	0.13	0.42	−0.14	0.36	−0.12	0.35	−0.16	0.36	0.034
B. Occupational Interests															
Teaching/Leading	−0.06	0.43	−0.04	0.42	0.02	0.46	0.13	0.47	0.18	0.54	0.07	0.63	0.09	0.62	0.013
Creativity/Intellectual Interests	0.09	0.56	0.07	0.60	−0.06	0.70	−0.17	1.04	−0.33	0.72	0.03	1.08	0.11	1.29	0.014
C. Work Values	−0.03	0.33	−0.02	0.34	−0.04	0.33	0.46	0.76	0.11	0.33	0.17	0.36	0.17	0.36	0.066
D. Work Styles	−0.03	0.38	−0.03	0.39	0.01	0.42	0.59	0.53	−0.12	0.37	−0.03	0.47	−0.01	0.49	0.051
II. Worker Requirements															
A. Basic Skills	−0.01	0.21	0.00	0.21	−0.01	0.21	0.16	0.28	0.01	0.26	0.03	0.31	0.00	0.35	0.014
B. Cross-Functional Skills															
Organizational Skills	−0.05	0.31	−0.05	0.31	0.00	0.35	0.12	0.33	0.20	0.28	0.17	0.34	0.14	0.40	0.038
Physical System Skills	0.02	0.43	0.03	0.43	0.02	0.45	−0.11	0.61	−0.29	0.32	−0.17	0.34	−0.10	0.33	0.024
C. Knowledge															
Social Sciences	0.03	0.26	0.02	0.27	−0.03	0.28	0.03	0.52	0.03	0.22	0.00	0.35	0.01	0.46	0.006
Engineering and Technology	0.08	0.41	0.05	0.39	−0.01	0.41	0.17	0.41	−0.27	0.66	−0.27	0.64	−0.20	0.66	0.046
Business/Management	0.01	0.68	0.02	0.69	0.06	0.75	−0.24	1.05	−0.20	0.79	−0.31	0.96	−0.20	0.96	0.019
III. Occupational Requirements															
A. Generalized Work Activities															
Supervision	0.01	0.27	0.00	0.27	0.02	0.29	−0.30	0.43	0.00	0.36	−0.06	0.42	−0.03	0.42	0.028
Interacting With Others	0.02	0.33	0.02	0.34	0.01	0.37	−0.27	0.39	−0.10	0.22	−0.06	0.27	−0.06	0.30	0.021
Technical Complexity	0.00	0.21	0.01	0.22	0.00	0.22	−0.02	0.16	−0.03	0.21	0.01	0.26	−0.02	0.30	0.001
B. Work Context															
Hazardous Work Conditions	0.00	0.21	−0.01	0.22	0.00	0.22	−0.05	0.18	0.06	0.26	0.03	0.30	0.06	0.32	0.005
Dealing With Others	0.02	0.29	0.02	0.31	0.00	0.30	−0.31	0.44	0.01	0.23	0.01	0.34	−0.04	0.40	0.025
Interpersonal Intensity	0.01	0.67	0.00	0.68	0.03	0.65	0.23	0.36	−0.15	0.60	−0.23	0.67	−0.15	0.69	0.013
IV. Higher-Order Components															
A. Interpersonal Complexity	−0.04	1.03	−0.09	1.02	−0.04	0.99	0.06	0.50	0.37	0.68	0.40	0.62	0.32	0.59	0.020
B. Physical Demands	0.27	0.88	0.18	0.93	−0.02	1.01	−0.23	0.76	−0.46	0.97	−0.85	0.96	−1.14	0.90	0.093
C. Substantive Complexity	−0.15	0.96	−0.21	0.94	−0.12	1.00	0.57	0.61	1.16	0.49	1.19	0.45	1.23	0.44	0.175
n	8,984		36,901		42,261		2,368		2,190		6,182		1,991		

[a]All component scores were initially standardized to a mean of 0 and a variance. The 18 subdomain scores were then regressed on the 3 component scores (Interpersonal complexity, Physical demands, Substantive complexity) and the residuals of these subdomain scores were used as outcomes in this table. This means that variances of the residual subdomain scores vary but are consistently less than 1.0, while variance of the domain scores is 1.0. [b]Lt. I-II = first or second lieutenant. [c]Lt. Col. = lieutenant colonel.

within-subdomain components/factors were similar to most of those identified here.

Despite these broad consistencies, three noteworthy differences exist between our results and the civilian results. First, although psychomotor abilities were the most prominent items in civilian studies of the physical demands factor, this factor is dominated by hazardous work conditions in Army MOS/AOCs. This difference is likely as a result of the fact that the two civilian EFA studies that analyzed the full set of O*NET dimensions both treated the O*NET occupational groupings as the unit of analysis, thus giving equal weight to each grouping no matter how common it was in the civilian labor force, whereas our analysis, as noted in the section on sampling, mapped the O*NET dimensions onto the population of all active duty soldiers, implicitly weighting the data by the distribution of MOS/AOCs in the Army. The greater prominence of hazardous work conditions in our analysis, then, reflects the greater importance of these conditions among Army occupations than civilian occupations.

Second, the interpersonal complexity component in our analysis is different from the comparable factor in the civilian studies in that our interpersonal complexity component consists more exclusively of O*NET dimensions related to interpersonal aspects of work and includes more complex characteristics, such as social challenges and conflict situations, than the civilian factor; whereas, the civilian factor not only has strong positive loadings on O*NET interpersonal complexity dimensions but also strong negative loadings on O*NET dimensions involving use of technical equipment. In the Army sample, the latter dimensions loaded more strongly on the physical demands component. We suspect that these differences are due to differences in the nature of Army occupations, with the interpersonal complexity of Army occupations not having the same inverse relationships to the technical complexity of work as in the civilian labor force.

Third, consistent with the last point, the intercomponent correlations involving the physical demands component were different in two respects in our study compared to the one civilian study where these correlations were reported.[25] The first is that although the physical demands and interpersonal complexity components inversely correlated in the civilian labor force (all variables factor scores $\varepsilon = -0.25$; subdomain factor scores $\varepsilon = -0.14$),[25] they are positively correlated among Army MOS/AOCs (all variables component scores $\varepsilon = 0.21$; subdomain component scores $\varepsilon = 0.18$). This means that civilian occupations with high interpersonal complexity are less likely than other occupations to be physically demanding, whereas Army MOS/AOCs with high interpersonal complexity are more likely than others to be physically demanding. This difference reflects the fact that Army leaders are more likely than civilian leaders to "lead from the front." Similarly, the correlation of physical demands with substantive complexity is more negative in the civilian data (all variables factor scores $r = -0.16$; second-order subdomain factor scores $\varepsilon = -0.29$)[25] than in the Army (all variables component scores $\varepsilon = 0.06$; subdomain components scores $\varepsilon = -0.03$), reflecting the fact that civilian jobs requiring complex problem solving and creative thinking are less likely than Army MOS/AOCs requiring comparable skills to involve exposure to hazardous work conditions.

As noted in the introduction, prior literature on differences in health outcomes across military occupations has relied for the most part on coarse categorical schemes for classifying MOS/AOCs based on broad similarities in occupational functions (e.g., distinguishing combat arms from other occupations).[11,14,36] Although such schemes might be sufficient for studying some soldier outcomes, the O*NET scales derived here make it possible to augment these broad occupational classification schemes to investigate more subtle characteristics of differences in job conditions across MOS/AOCs related to a wide range of soldier outcomes. We have posted the 21 summary scales derived here at (http://www.armystarrs.org/publications) for use by other researchers.

These 21 scales could be used in a number of ways. For one, they could be used as the basis of a cluster analysis[37] of commonly occurring multivariate job profiles that might be treated as predictors of adverse outcomes that have been previously studied in both military and civilian occupations, such as substance use, obesity, hypertension, physical injury, hospitalization, disability discharge, and suicide.[11,12,14,20,36] Another possibility would be to use the 21 scales in nested discretized form as the starting point for regression tree analyses aimed at detecting multivariate job condition profiles associated with high risk of adverse outcomes.[38] This is a particularly attractive option for studying effects of job conditions on health given that much of the theorizing about these effects, most notably the influential demand–control model[5] and its extensions,[39] hypothesize that mismatch between multiple job conditions is centrally involved in the adverse health effects of pathogenic occupations.

Several limitations of this study should be noted. First, errors may have occurred in selecting composite civilian occupational groups to characterize MOS/AOCs that lack civilian equivalents. Second, the decision to use maximum O*NET dimension scores across these composite occupational groups rather than alternatives (e.g., means; unique ratings assigned by Army occupational experts) might have affected results. Third, additional imprecision could have been introduced by O*NET scores being imperfect, as this scoring is based on rater judgments and therefore less fine-grained than worker reports of actual job conditions,[40] leading to conservative bias in estimates of associations between actual job conditions and outcomes.[26] Fourth, even if O*NET ratings are accurate for prototypic civilian job contexts, it might be that the job conditions for some occupations are different in the Army than the civilian labor force. Fifth, given that our analysis was based on a person-month dataset rather than a dataset of 610 MOS/AOCs, results were weighted to think of individuals as the unit of analysis rather than to think of occupations as the unit of analysis. We considered this a preferred approach in that our interest is in using these scales to understand individual differences (rather than occupational differences) in health outcomes, but it needs to be noted that the results might be suboptimal for carrying out research in which occupations rather than individuals are of primary interest.

Despite these limitations, this study usefully extends O*NET classifications to Army MOS/AOCs. Future research is needed to determine whether the scales derived here have similar associations with mental and physical health outcomes as those found in civilian studies.[41–43] If so, it would be useful to extend the analyses to evaluate the extent to which other aspects of Army service (e.g., length of deployment, time in service, rank) may moderate these relationships. Such research could be valuable in helping target health promotion and risk reduction efforts to soldiers.

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The Army STARRS Team consists of Co-Principal Investigators: Col Robert J. Ursano USAF (Ret.), (Uniformed Services University of the Health Sciences) and Murray B. Stein, MD, MPH (University of California San Diego and VA San Diego Healthcare System); Site Principal Investigators: Steven Heeringa, PhD (University of Michigan) and Ronald C. Kessler, PhD (Harvard Medical School); National Institute of Mental Health (NIMH) collaborating scientists: CAPT Lisa J. Colpe, PhD, MPH (USPHS) and Michael Schoenbaum, PhD; Army liaisons/consultants: COL Steven Cersovsky, MD, MPH (USAPHC) and Kenneth Cox, MD, MPH (USAPHC); Other team members: Pablo A. Aliaga, MA (Uniformed Services University of the Health Sciences); COL David M. Benedek, Army, MD (Uniformed Services University of the Health Sciences); Susan Borja, PhD (National Institute of Mental Health); Gregory G. Brown, PhD (University of California San Diego); Laura Campbell-Sills, PhD (University of California San Diego); Catherine L. Dempsey, PhD, MPH (Uniformed Services University of the Health Sciences); Richard Frank, PhD (Harvard Medical School); Carol S. Fullerton, PhD (Uniformed Services University of the Health Sciences); Nancy Gebler, MA (University of Michigan); COL Robert K. Gifford Army, PhD (Ret.) (Uniformed Services University of the Health Sciences); Stephen E. Gilman, ScD (Harvard School of Public Health); Marjan G. Holloway, PhD (Uniformed Services University of the Health Sciences); Paul E. Hurwitz, MPH (Uniformed Services University of the Health Sciences); Sonia Jain, PhD (University of California San Diego); Tzu-Cheg Kao, PhD (Uniformed Services University of the Health Sciences); Karestan C. Koenen, PhD (Columbia University); Lisa Lewandowski-Romps, PhD (University of Michigan); Holly Herberman Mash, PhD (Uniformed Services University of the Health Sciences); COL James E. McCarroll Army, PhD, MPH (Ret.) (Uniformed Services University of the Health Sciences); Katie A. McLaughlin, PhD (Harvard Medical School); James A. Naifeh, PhD (Uniformed Services University of the Health Sciences); Matthew K. Nock, PhD (Harvard University); Rema Raman, PhD (University of California San Diego); Sherri Rose, Ph.D. (Harvard Medical School); Anthony J. Rosellini, Ph.D. (Harvard Medical School); Nancy A. Sampson, BA (Harvard Medical School); LCDR Patcho Santiago, USN, MD, MPH (Uniformed Services University of the Health Sciences); Michaelle Scanlon, MBA (National Institute of Mental Health); Jordan Smoller, MD, ScD (Harvard Medical School); Michael L. Thomas, PhD (University of California San Diego); Patti L. Vegella, MS, MA (Uniformed Services University of the Health Sciences); Christina Wassel, Ph.D. (University of Pittsburgh); and Alan M. Zaslavsky, PhD (Harvard Medical School).

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REFERENCES

1. Gatchel RJ, Schultz IZ (editors): Handbook of Occupational Health and Wellness. New York, NY, Springer, 2012.
2. Vernon HM: Health in Relation to Occupation. London, UK, Oxford University Press, 1939.
3. Spector PE: Job Satisfaction: Application, Assessment, Causes, and Consequences. Thousand Oaks, CA, Sage, 1997.
4. Jackson SE, Schuler RS: A meta-analysis and conceptual critique of research on role ambiguity and role conflict in work settings. Organ Behav Hum Decis Process 1985; 36(1): 16–78.
5. van der Doef M, Maes S: The Job Demand-Control (-Support) model and psychological well-being: a review of 20 years of empirical research. Work Stress 1999; 13(2): 87–114.
6. Juslen HT, Wouters MC, Tenner AD: Lighting level and productivity: a field study in the electronics industry. Ergonomics 2007; 50(4): 615–24.
7. Kales SN, Tsismenakis AJ, Zhang C, Soteriades ES: Blood pressure in firefighters, police officers, and other emergency responders. Am J Hypertens 2009; 22(1): 11–20.
8. Zimmerman FH: Cardiovascular disease and risk factors in law enforcement personnel: a comprehensive review. Cardiol Rev 2012; 20(4): 159–66.
9. Andersen K, Hawgood J, Klieve H, Kolves K, De Leo D: Suicide in selected occupations in Queensland: evidence from the State suicide register. Aust N Z J Psychiatry 2010; 44(3): 243–9.
10. Harrington D, Bean N, Pintello D, Mathews D: Job satisfaction and burnout: predictors of intentions to leave a job in a military setting. Admin Soc Work 2001; 25(3): 1–16.
11. Gordon B, Moshe S, Blanc PD, et al: The association between occupation and the incidence of knee disorders in young military recruits. Mil Med 2013; 178(1): 61–7.
12. Gubata ME, Piccirillo AL, Packnett ER, Cowan DN: Military occupation and deployment: descriptive epidemiology of active duty U.S. Army men evaluated for a disability discharge. Mil Med 2013; 178(7): 708–14.
13. Helmkamp JC: Occupation and suicide among males in the US Armed Forces. Ann Epidemiol 1996; 6(1): 83–8.
14. Trofimovich L, Reger MA, Luxton DD, Oetjen-Gerdes LA: Suicide risk by military occupation in the DoD active component population. Suicide Life Threat Behav 2013; 43(3): 274–8.
15. Cifuentes M, Boyer J, Lombardi DA, Punnett L: Use of O*NET as a job exposure matrix: a literature review. Am J Ind Med 2010; 53(9): 898–914.
16. Tippins NT, Hilton ML (editors): A Database for a Changing Economy: Review of the Occupational Information Network (O*NET). Washington, DC, National Academies Press, 2010.
17. Mumford MD, Peterson NG: The O*NET content model: structural considerations in describing jobs. In: An Occupational Information System for the 21st Century: The Development of O*NET, pp 21–30. Edited by NG Peterson, MD Mumford, WC Borman, PR Jeanneret, EA Fleishman. Washington, DC, American Psychological Association, 1999.
18. Peterson NG, Mumford MD, Borman WC, et al: Understanding work using the occupational information network (O*NET): implications for practice and research. Pers Psychol 2001; 54(2): 451–92.
19. U.S. Department of Labor: O*NET version 15. Washington, DC, U.S. Department of Labor, 2010.
20. Alterman T, Grosch J, Chen X, et al: Examining associations between job characteristics and health: linking data from the Occupational Information Network (O*NET) to two U.S. national health surveys. J Occup Environ Med 2008; 50(12): 1401–13.
21. Bell JF, Zimmerman FJ, Diehr PK: Maternal work and birth outcome disparities. Matern Child Health J 2008; 12(4): 415–26.
22. d'Errico A, Punnett L, Cifuentes M, et al: Hospital injury rates in relation to socioeconomic status and working conditions. Occup Environ Med 2007; 64(5): 325–33.
23. Zimmerman FJ, Christakis DA, Vander Stoep A: Tinker, tailor, soldier, patient: work attributes and depression disparities among young adults. Soc Sci Med 2004; 58(10): 1889–901.
24. Barnes AJ, Zimmerman FJ: Associations of occupational attributes and excessive drinking. Soc Sci Med 2013; 92: 35–42.
25. Hadden WC, Kravets N, Muntaner C: Descriptive dimensions of US occupations with data from the O*NET. Soc Sci Res 2004; 33(1): 64–78.
26. Meyer JD, Cifuentes M, Warren N: Association of self-rated physical health and incident hypertension with O*NET factors: validation using a representative national survey. J Occup Environ Med 2011; 53(2): 139–45.
27. Brannick MT, Levine EL, Morgeson FP: Job and Work Analysis: Methods, Research, and Applications for Human Resource Management. Thousand Oaks, CA, Sage, 2007.
28. Passarelli G: Employees' skills and organizational commitment. Int Bus Res 2010; 4(1): 28.
29. Kessler RC, Colpe LJ, Fullerton CS, et al: Design of the army study to assess risk and resilience in servicemembers (Army STARRS). Int J Methods Psychiatr Res 2013; 22(4): 267–275.
30. Department of the Army: Military occupational classification and structure. Department of the Army pamphlet 611-21, 2007. Available at http://www.apd.army.mil/pdffiles/p611_21_v1.pdf; accessed September 30, 2013.
31. Hayton JC, Allen DG, Scarpello V: Factor retention decisions in exploratory factor analysis: a tutorial on parallel analysis. Organ Res Methods 2004; 7(2): 191–205.
32. Preacher KJ, Zhang G, Kim C, Mels G: Choosing the optimal number of factors in exploratory factor analysis: a model selection perspective. Multivariate Behav Res 2013; 48(1): 28–56.
33. Crouter AC, Lanza ST, Pirretti A, Goodman WB, Neebe E: The O*NET Jobs Classification System: a primer for family researchers. Fam Relat 2006; 55(Oct): 461–72.

34. Glomb TM, Kammeyer-Mueller JD, Rotundo M: Emotional labor demands and compensating wage differentials. J Appl Psychol 2004; 89(4): 700–14.
35. Spreng RN, Rosen HJ, Strother S, et al: Occupation attributes relate to location of atrophy in frontotemporal lobar degeneration. Neuropsychologia 2010; 48(12): 3634–41.
36. Gronroos NN, Zouris JM, Wade AL: Odds of hospitalization among Marine Corps personnel by military occupational specialty and causative agents during OEF and OIF. Mil Med 2009; 174(7): 715–20.
37. Kaufman L, Rousseeuw PJ: Finding Groups in Data: An Introduction to Cluster Analysis. Hoboken, NJ, Wiley, 2009.
38. Azzalini A, Scarpa B: Data Analysis and Data Mining: An Introduction. New York, NY, Oxford University Press, 2012.
39. Karasek R: The stress-disequilibrium theory: chronic disease development, low social control, and physiological de-regulation. Med Lav 2006; 97(2): 258–71.
40. Cifuentes M, Boyer J, Gore R, et al: Inter-method agreement between O*NET and survey measures of psychosocial exposure among healthcare industry employees. Am J Ind Med 2007; 50(7): 545–53.
41. Cooper CL, Quick JC, Schabracq MJ (editors): International Handbook of Work and Health Psychology. New York, NY, Wiley, 2009.
42. Stansfeld S, Candy B: Psychosocial work environment and mental health—a meta-analytic review. Scand J Work Environ Health 2006; 32(6): 443–62.
43. Tausig M, Fenwick R: Work and Mental Health in Social Context. New York, NY, Springer, 2012.

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Listed the authors as: Darabos Nikica, MD, PhD; Cesarec Marijan, MD; Grgurovic Denis, MD; Rutic Zeljko, MD; Darabos Anela, MD; Kenneth Egol, MD, PhD

The list of authors should read as: Nikica Darabos, MD, PhD; Marijan Cesarec, MD; Denis Grgurovic, MD; Zeljko Rutic, MD; Anela Darabos, MD; Kenneth Egol, MD, PhD

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The list of authors should read as: Stephen C. Davis, BS; Franco Pissani, BS; Ramon B. Montero, MS

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Listed the authors as: MAJ Amy Vertrees, MC USA; CAPT Eric Elster, MC USN; Rahul Jindal, MD, PhD, MBA; Camillo Ricordi, MD; COL Craig Shriver, MC USA

The list of author should read as: MAJ Amy Vertrees, MC USA; CAPT Eric Elster, MC USN; Rahul M. Jindal, MD, PhD, MBA; Camillo Ricordi, MD; COL Craig Shriver, MC USA

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