Review Article

Developing a Job Exposure Matrix of Work Organization Hazards in the United States: A Review on Methodological Issues and Research Protocol

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ABSTRACT

Background: Most job exposure matrices (JEMs) have been developed for chemical and physical hazards in the United States (US). In addition, the overall validity of most JEMs of work organization hazards using self-reported data in the literature remains to be further tested due to several methodological weaknesses.

Methods: This paper aims to review important methodological issues with regard to a JEM of work organization hazards using self-report data and to present a research protocol for developing a four-axis (job titles, hazards, sex, and time) JEM of major work organization hazards using the US General Social Survey-Quality of Work-Life (GSS-QWL) data (2002–2018; N = 7,100 workers).

Results: Five methodological weaknesses in existing JEMs of work organization hazards using self-report data were identified: having only two axes (hazard and occupation), using psychometrically weak items and scales, including scales having little interoccupational variability, unresolved optimal minimum numbers of subjects per occupation, and low accessibility. The methodological weaknesses were successfully addressed in the proposed research protocol.

Conclusion: The work organization JEM to be developed will significantly facilitate and strengthen occupational epidemiological studies on work organization hazards and major health outcomes, improve national and occupational surveillance of work organization hazards, and promote interventions for a healthy work environment in the US.

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1. Introduction

A job exposure matrix (JEM), a cross-tabulation between workplace hazards and occupation title, has been used as an essential exposure assessment tool for epidemiological studies, hazard surveillance, prevention of hazards, and risk quantification in occupational safety and health research [1–7]. However, in the United States (US), most job exposure matrices have been developed for chemical and physical hazards [8–14], not for work organization hazards [15] (e.g., job control, job demands, social support at work, low rewards, long work hours, safety climate, and work and family conflicts). Work organization hazards increase the risk of cardiovascular disease (CVD) [16–18], common mental disorders [19–22], dementia [23–25], musculoskeletal disorders [26–29], injuries [30,31], absenteeism [32,33], and presenteeism [34,35]. In addition, in contrast to chemical and physical workplace hazards restricted to some occupational groups, work organization hazards exist in all occupations [5].

However, there is no JEM of work organization hazards based on recent, nationally representative data of US working populations. There has been a JEM of job control and job demands based on Karasek’s demand-control model [36] that were developed using the Quality of Employment Survey (QES) data (1969–1977) [37], but its contemporary applicability and utility for epidemiological research, hazard surveillance, and hazard control are limited [7] because of the substantial changes in the working life of US workers over the past 40 years: for example, changes in organizational practices (e.g., lean production systems), work arrangements (e.g.,
increasing non-standard work), technology (e.g., automation), the structure of occupation, industry, and demographics (e.g., service-driven economy, increased women's labor force participation, and aging workforce), and labor relations (e.g., decreased union density) [15,38]. In addition, the overall validity of most JEMs of work organization hazards using self-reported data in the literature remains to be further tested due to several methodological issues [6,39]. The important methodological issues should be clearly analyzed and resolved prior to creating a high-quality JEM of work organization hazards using self-reported data.

The main purposes of this paper are to discuss important methodological issues with regard to a JEM of work organization hazards based on an extensive review of the literature and to present a research protocol for creating a four-axis (job titles, hazards, sex, and time) JEM of major work organization hazards using the 2002–2018 US General Social Survey-Quality of Work-Life (GSS-QWL) data.

1. Utilities of a JEM of work organization hazards

1.1. For epidemiological research

Work organization hazards (mainly based on the two influential work stress models, the Karasek's model [36] and Siegrist's effort-reward imbalance model [40]), have been intensively studied with CVD [16–18], common mental disorders [19–22], and musculoskeletal disorders [26–29]. However, most epidemiological studies have been conducted with individual self-reports of exposures. Thus, there has been ongoing uncertainty about the reported associations between work organization hazards and health outcomes [7,9,41–44], although there is some evidence of the validity for individual self-reports of job control and job demands against expert observations and administrative records [45–47].

Compared with individual self-reports, a JEM of work organization hazards provides more economical and reliable exposure information on work organization hazards by averaging out individual self-report bias on a group (occupation) level and/or removing the chance of recall bias for exposure. In addition, information on work organization hazards, except for detailed job titles, is missing in most US national data like the National Health and Nutrition Examination Survey [37,48]. If JEM-based work organization hazards are linked to the national clinical and registry data via detailed occupational codes [23–25,48–55], it will substantially facilitate epidemiological studies on a wide range of work organization hazards (see Table 1) and several major national health problems (opioid-related death, obesity, suicide, cancer, as well as CVD) [56–63].

Furthermore, a JEM of work organization hazards, if additionally incorporated into other JEMs of chemical, physical, microbiological, and ergonomic hazards, as in the comprehensive Finnish JEM [5,6], will significantly promote epidemiological studies which can elucidate the independent and combined contributions of multiple worksite hazards in the etiology of chronic diseases (e.g., CVD and cancer) in working populations, which have rarely been explored [63].

1.1.2. For national surveillance and other purposes

In addition to epidemiological research, the JEM-based approach has also served other purposes such as national hazard surveillance (e.g., occupational distributions of chemical hazard exposures by specific chemical agent and exposure level over time) [5], data source of national and occupational estimates of hazard exposures in health risk assessment [5,64] or decision-making for workers' compensation [6,65], and evaluation of the impact and cost of changing occupational exposure limits of chemical hazards [6]. A JEM of work organization hazards also serves the aforementioned purposes. For example, Niedhammer et al. [66] used a JEM approach to monitor occupation-level changes in job control, job demands, and social support at work during 2003–2010 in a French working population. Karasek et al. [37] used a JEM approach to identify high-risk occupations for job strain (a combination of low job control and high psychological job demands) [36] in the US Quality of Employment Survey data, which may function as a strong stimulus for interventions to improve psychosocial working conditions in high-risk occupations. In addition, a JEM of work organization hazards if it is analyzed or further specified by socioeconomic status, gender, or race/ethnicity has great potential to be used as a useful tool for monitoring and promoting social equity in psychosocial working conditions. Some investigators demonstrated differential distributions of job strain by socioeconomic status [19] and gender [45] using a JEM approach and graphic analysis. Furthermore, a JEM of work organization hazards can also be used by workplace stakeholders (individual workers, unions, and management) and practitioners for estimating workers' current and cumulative exposure to work organization hazards based on their job title, gender, and employment period, which may be essential information for decision-making of workers' compensation or interventions to improve psychosocial working conditions.

2. Materials and methods, and Results

2.1. Five methodological issues in creating a high-quality JEM of work organization hazards

Despite the aforementioned utilities, due attention should be given to critical methodological issues in creating a high-quality JEM of work organization hazards particularly using self-reported data. Many JEMs of work organization hazards in the literature have been developed based on large national survey data sets in the US [7], Sweden [67], Finland [5,6,41], Denmark [68], Norway [69], France [20,70], Spain [2,3], and Australia [71]. Most existing JEMs of work organization hazards share some of the following methodological weaknesses:

First, most existing work organization JEMs have only two axes (hazard and occupation) and do not have sex-specific or time period-specific information [2,3,5,6,20,68,70]. A JEM approach can ignore real differences in work organization hazards among workers within the same occupation [1,7,66,67,71]. In addition, work organization profiles may significantly differ by sex and time period even in the same occupation. Furthermore, due to because of possible nondifferential exposure misclassification, a JEM approach is likely to underestimate the real association between work organization hazards and health outcomes in epidemiological studies. Nonetheless, the aforementioned issues of a JEM approach can be mitigated to some extent by creating a JEM with detailed rather than simplified occupation codes [66,73] and with other additional stratification variables [67].

Second, a JEM of work organization hazards should be constructed with valid questionnaire items and scales. However, some JEMs include conceptually or psychometrically weak scales and items. For instance, the Australian JEM [71] includes one scale labeled “job demands and complexity.” But the scale includes conceptually different items (e.g., “My job is more stressful...” and “use many of my skills and abilities”). In addition, some items of standard work stressor scales (e.g., psychological job demands of the Job Content Questionnaire [74]) can be differently understood by workers depending on their occupations (physically vs. mentally demanding jobs) [75–77] or survey times (before and after the Great Recession in 2008) [78]. Thus, the construct-and item-level
measurement equivalence [79,80] between occupation, sex, and time period should be first tested and assured.

Third, despite little interoccuational variability (e.g., R² < 1%), some hazards are included in JEMs of work organization hazards (e.g., fairness of pay in an Australian JEM [71]). In general, job control, psychological job demands, job strain, emotional demands, work hours, and physical job demands have been reported to vary considerably between detailed occupations [20,67,69,71,81]. On the other hand, supervisor support, coworker support, and job insecurity vary to a lesser extent between occupations. Little is known about the interoccuational variability of emerging work organization hazards, such as safety climate and work–family conflict. Cohidon et al. [70] included only the scales having at least a moderate level of interoccuational variability (R² ≥ 10%) in their JEM of work organization hazards.

Fourth, there is no strong empirical basis in the literature for an optimal minimum number of subjects in each occupation for creating a JEM of work organization hazards using self-reported data [39]. Without appropriate tests or justifications, several different minimum numbers of subjects per occupation (e.g., 3, 4, or 10) have been applied to work organization JEMs [41,48,67]. Higher minimum numbers of subjects in each occupation for a JEM will result in more precise exposure estimates. However, the occupations with insufficient numbers of subjects can be excluded from a JEM, which results in a JEM covering a limited proportion of the total job titles available in their source data, for example, 50% in a US QES-based JEM [48] and 37% in a Finish JEM [41]. If the occupations with insufficient numbers of subjects would be included in a JEM after a merge with related occupations into a broader occupation group, their exposure estimates would be less specific. On the other hand, it is also not known yet whether different minimum numbers of subjects per occupation significantly affect the performance of the JEMs in terms of association with health outcomes [39].

Fifth, most existing JEMs of work organization hazards are not available on the Internet [37,67]. For the developed JEM to be widely used among users, the JEM should be available at or downloadable from a user-friendly website, similar to the Spanish JEM website (www.matemesp.org). Such a website will also be an efficient communication channel with users about systematic revisions and updates of the developed JEM [66,82] in the future.

2.2. A research proposal for creating a four-axis JEM of work organization hazards using the GSS-QWL data

Here, I present a research protocol for developing a four-axis (job titles, hazards, gender, and time) JEM of major work organization hazards using the GSS-QWL data (20022018; N = 7,100

| Table 1 |
| --- |
| A preliminary list of 31 items for 16 work organization domains selected from the General Social Survey-Quality of Work-Life (GSS-QWL) Questionnaire for analysis in this project. All 31 items have been used in all five waves (2002, 2006, 2010, 2014, and 2018) of the General Social Surveys |

| Work organization domain | Item wording |
| --- | --- |
| Hours of work | How many hours did you work last week, at all jobs? |
| Skill Development | My job requires that I keep learning new things |
| Decision Making | I have an opportunity to develop my own special abilities |
| Workload | My job lets me use my skills and abilities |
| Role Conflict | How often are there not enough people or staff to get all the work done? |
| Physical Demands | Does your job require you to do repeated lifting, pushing, pulling or bending? |
| Resource Adequacy | Does your job regularly require you to perform repetitive or forceful hand movements or involve awkward postures? |
| Supervisor Support | My supervisor is concerned with the welfare of those under him or her |
| Coworker Support | How often are you given a lot of freedom to decide how to do my own work |
| Recognition | My supervisor is helpful to me in getting the job done |
| Respect | The people I work with take a personal interest in me |
| Promotions | When I do my job well, are you likely to be praised by your supervisor or employer? |
| Pay Fairness | How fair is what you earn on your job in comparison to others doing the same type of work you do? |
| Job Security | The job security is good |
| Safety Climate | The safety of workers is a high priority with management where I work |
| Workload | Effort, reward, and effort-reward imbalance scales can be additionally created based on Karasek’s Demand-Control Model [36]. Job Control – Skill Development + Decision Making. Psychological Job Demands – Workload + Role Conflict. High Job Strain – A combination of low job control and high psychological job demands. Effort, reward, and effort-reward imbalance scales can be additionally created based on Siegrist’s Effort-Reward Imbalance Model [40]. Effort – Psychological Job Demands. Reward – Recognition + Respect + Promotions + Pay Fairness + Job Security. Effort-Reward Imbalance – A combination of low reward and high effort. |
| Work and Family Conflict | How often do the demands of your job interfere with your family life? |
| Work organization domain | Item wording |
| Work and Family Conflict | How often do the demands of your job interfere with your work on the job? |
workers). This research protocol will be informative to those who are interested in detailed information on how to create a high-quality JEM of work organization hazards while addressing the aforementioned JEM-related methodological issues using self-reported data.

The main aims of this project are (1) to develop a four-axis (hazard, occupation, sex, and time) JEM of major work organization hazards using recent national survey data and (2) to create a user-friendly website with the newly validated JEM. To create the four-axis JEM of major work organization hazards, core questionnaire items and scales for major work organization hazards (e.g., 31 items for 16 scales, Table 1) will be selected from GSS-QWL data (2002–2018). The core items and scales will be tested for their measurement equivalence between sex, occupations, and survey times, and inter-occupational variability. Nine two-axis (hazard and occupation) JEMs with different minimum numbers of subjects per occupation will be created with validated scales. The best two-axis JEM will be determined based on tests against individual-based scores for hazard classification and associations with health-related outcomes. The final four-axis JEM will further specify sex and time. The information in the developed JEM will be summarized into Microsoft Excel and Access files that will be easily downloadable and searchable for information by users at a user-friendly website.

2.2.1. NIOSH QWL questionnaire

In 2001, National Institute for Occupational Safety and Health (NIOSH) developed the Quality of Work-Life (QWL) questionnaire (76 items in total; 60 items for working conditions and 16 items for health-related outcomes) to assess the contemporary working life of US workers [83]. The NIOSH QWL questionnaire has been used in nationally representative samples of US workers every four years as part of the General Social Survey (GSS) since 2002. Thus, the GSS-QWL data (2002–2018) are one of the best data sources for assessing the contemporary working life of US workers [87]. The main aims of this project are (1) to develop a four-axis (hazard, occupation, sex, and time) JEM of major work organization hazards, core questionnaire items and scales for major work organization hazards (e.g., 31 items for 16 scales, Table 1) will be selected from GSS-QWL data (2002–2018). The core items and scales will be tested for their measurement equivalence between sex, occupations, and survey times, and inter-occupational variability. Nine two-axis (hazard and occupation) JEMs with different minimum numbers of subjects per occupation will be created with validated scales. The best two-axis JEM will be determined based on tests against individual-based scores for hazard classification and associations with health-related outcomes. The final four-axis JEM will further specify sex and time. The information in the developed JEM will be summarized into Microsoft Excel and Access files that will be easily downloadable and searchable for information by users at a user-friendly website.

2.2.2. The GSS-QWL data (2002–2018)

As noted in the earlier passage, the NIOSH QWL questionnaire has been administered as part of the GSS in 2002 (N = 1,725), 2006 (N = 1,669), 2010 (N = 1,133), 2014 (N = 1,207), and 2018 (N = 1,369). In total, 7,103 workers as a full-timer or part-timer filled out the GSS-QWL questionnaire. Among them, 7,071 workers had a valid occupational code (see the following passage). The GSS used the National Opinion Research Center at the University of Chicago National Sampling Frame for an equal probability multistage cluster sample of housing units for the entire United States. The participation rates of the NIOSH QWL surveys have been 6971% in 2002, 2006, 2010, and 2014 [86]. However, the participation rate of the NIOSH QWL survey was 59% in 2018 [87]. To provide better exposure estimates, a four-axis JEM of major work organization hazards will be created (Fig. 1).

- Axis I: Detailed occupational codes (N = 461): Four-digit codes of the 2010 US Census Occupation Classification (COC) are included in the GSS-QWL survey data. However, in contrast with the 2010 COC system, the 2010 US Standard Occupational Classification (SOC) system has a clear hierarchical coding structure [88,89], which is essential to create a 100% coverage of the JEM for all detailed occupations in the QWL survey data [64,66,73]. There are 23 major groups, 97 minor groups, and 461 broad occupations in the 2010 SOC system. If the hazard information is not available at the most detailed level, the hazard information at the next most detailed level will be used. Thus, the VOC codes in QWL-QWL data will be recoded into the hierarchical major (two-digit, e.g., 11-0000: “Management Occupations”), minor (three-digit, e.g., 11-1000: “Top Executives”), and broad (six-digit, e.g., 11-1010: “Chief Executives”) 2010 SOC codes using the standard crosswalk between the 2010 US COC and SOC codes available on the website of the US Census Bureau [90].
- Axis II: Work organization hazards (N ≤ 16): The final number of work organization hazards will be determined after the validation procedures of selected NIOSH QWL items and scales (see the following passages “Psychometric analysis” and “Interooccupation variability”).
- Axis III: Sex (N ≤ 2): Men and women. The four-axis JEM will provide both general and sex-specific information on work organization hazards. Work organization profiles may significantly differ between men and women even in the same occupation. For instance, job control level was significantly lower in women than in men even though they hold the same occupational title [67]. In addition, the inter-occupational variability of work organization hazards may differ by gender [41,67].
- Axis IV: Time (N ≥ 2). The four-axis JEM will provide both the whole period (2002–2018) and period-specific (e.g., 2002–2006 and 2010–2018) information on work organization hazards. For instance, work organization profiles may significantly differ between the survey periods before and after the Great Recession in 2008. Myers et al. [91] reported that job strain, low job control, and work–family conflict significantly increased in
US working populations over the period 2002–2014, while no significant changes were observed for psychological job demands, social support at work, and rewards.

2.2.3. Psychometric analysis

2.2.3.1. Selection of important NIOSH QWL items

Among the original NIOSH QWL 60 items for working conditions, we will select important NIOSH QWL items for analysis with the following criteria: (1) whether they have been used in all five waves of GSS (2002–2018); (2) whether item wording is clear; (3) whether they are important work stressors from the perspectives of contemporary work stress theories, such as the Demand-Control model [40], the Effort-Reward Imbalance model [51], or organizational justice model [92]; or/and (4) whether their health effects have been documented in the literature. A preliminary list of important NIOSH QWL items and scales is presented in Table 1 (31 items for 16 domains).

2.2.3.2. Measurement equivalence between occupation, sex, and time

One central issue is measurement equivalence (construct-level and item-level) of the selected NIOSH QWL items and scales between comparison groups. In other words, whether an item “elicits the same conceptual frame of reference” in comparison groups should be examined along with “whether respondents calibrate the intervals anchoring the measurement continuum in the same manner” [80, p. 644]. The two issues will be addressed by factor analysis and differential item functioning (DIF) analysis.

Factor structure of selected QWL items will be explored and compared between sex, time periods (2002–2006 vs. 2010–2018), and five high-level occupation groups based on the US SOC major codes [88,89] (Management, Business, Science, and Arts; Service; Sales and Office; Natural Resources, Construction, and Maintenance; and Production, Transportation, and Material Moving). Given a lack of previous factor analyses of the QWL items, exploratory factor analysis will be undertaken. The scree test and the eigenvalue criterion (>1) as well as underlying theoretical concepts will be used to determine the number of factors. The criterion of the significance of the factor coefficient will be set at 0.30, as usual. The items having low factor loadings in factor analyses will not be used for the final JEM.

DIF analysis by sex, occupation group, and time period, as in the aforementioned factor analysis for selected QWL scales including at least two or more items. An item shows DIF if “all respondents at a given level of the attribute measured (at a given index score) do not have equal probability of scoring positively on the item regardless of subgroup membership” [93]. The partial gamma coefficient method [79,94] will be used for DIF statistics. Moderate to large DIF between comparison groups will be defined as items with partial gamma outside the interval (−0.31 to 0.31) and its 95% confidence interval significantly outside the interval (−0.21 to 0.21) [93]. If an item turns out to be a “moderate to large” DIF item, it will not be used for the final JEM.

2.2.4. Interoccupation variability

The proportion of the total variance in each work organization hazard will be examined with R² values by the 2010 six-digit SOC codes in the QWL data (2002–2018). This will be done separately for men and women because the interoccupation variability may differ by sex [67,71]. According to the recommendation of Cohidon et al. [70], only the scales having at least a moderate level of inter-occupational variability (R² ≥ 10%) will be included in the final JEM. R² values will be greater than 10% at least in job control (skill discretion and decision authority) [36], psychological job demands, job strain, work hours, and physical effort scales in the QWL data, which will be in line with the literature [20,67,69,71,81].

2.2.5. Determining the best two-axis JEM

Given the unknown optimal minimum number of subjects per occupation for creating a JEM [39], nine two-axis JEMs with varying minimum numbers of subjects per occupation (from 2 to 10) will be created. Preliminary analyses indicated that the number of subjects per SOC broad (six-digit) occupation in the QSS-QWL data (N = 7,071) varied from 1 to 201. Among the total 369 broad occupations available in the QSS-QWL data, 331 broad occupations (N = 7,033) had two or more 2 subjects, whereas 38 broad occupations had only one subject. On the other hand, 159 broad occupations (N = 6,031) have at least 10 or more subjects, whereas 172 broad occupations had 9 or fewer subjects. The hazard scores for a broad occupation having sufficient numbers of subjects will be estimated by averaging the hazard scores of all subjects in the broad occupation. However, the hazard scores for a broad (six-digit) occupation (e.g., “Chief Executives”: 11-1010) having insufficient numbers of subjects will be estimated from the average scores in the upper-level (e.g., three-digit) occupational group (e.g., “Top Executives”: 11-1000) to which the broad occupation belongs in the hierarchical SOC system.

The JEMs will be based on estimates of population means for the scales validated in the aforementioned procedures, weighted based on sampling weights of survey data of CSS-QWL data [87]. As a sensitivity analysis, unweighted estimates will also be obtained. To obtain unbiased estimates of population means for each scale in the presence of missing data (<30%), missing data values will be imputed by the multiple imputation method [95]. The hazard scores for each six-digit occupation will be also dichotomized at the medians of the hazard scores [66,69] in the whole QWL data for classifying each occupation into a low- or high-hazard occupation.

The created nine two-axis JEMs will be compared against the individual self-reports in terms of the agreement level for hazard classification (high/low) and associations with the four standard Healthy Days (HD) measures of the Centers for Disease Control and Prevention (general health, mental health, physical health, and activity limitation) [96,97] available in the QSS-QWL data. The agreement level for low- and high-hazard occupations will be examined with kappa statistics, sensitivity, and specificity. As recommended [97–99], the HD measures will be dichotomized at fair or poor for general health and 14 or more unhealthy days for the other three measures for analyses. In comparison with the individual self-reports, among the eight two-digit JEMs, the best two-axis JEM will be chosen with two criteria of high agreement level and consistent associations with the HD measures. Associations will be examined using multivariate logistic regression analysis after controlling for age and gender. The analysis will be conducted with consideration of the characteristics of complex survey data of the QSS-QWL data.

In my preliminary analysis with the unweighted GSS-QWL data (2002–2018), the performance of the two-axis JEM of job control and physical demands was not affected by varying minimum numbers of subjects per occupation from 2 to 10. For instance, the agreement levels for low job control between individual self-reports and each of nine JEMs with the varying minimum numbers of subjects were similar: kappa values, 0.29–0.31. The association between JEM-based low job control and self-rated general health was consistent across the nine JEMs (prevalence ratios ranged from 1.79 to 1.85), which was also very similar to the association using individual self-reports (1.87). The aforementioned analyses will be repeated with weighted GSS-QWL data and will be done for other work organization hazards (e.g.,
2.2.6. Creating the final four-axis JEM

The best two-axis JEM will be further specified with sex-specific and time-specific information on work organization hazards. For example, if the best two-axis JEM would be the one having “2” as the minimum number of subjects per occupation, among the 331 broad occupations having ≥2 subjects in the GSS-QWL data (2002–2018), 265 broad occupations for men and 237 occupations for women would have additional sex-specific hazard information. In addition, 271 broad occupations during 2002–2006 and 267 broad occupations during 2010–2018 will have additional time-specific hazard information.

2.2.7. A website with the developed JEM for researchers and practitioners

A user-friendly website with the developed JEM of major work organization hazards will be created. The information in the developed JEM will be summarized into Microsoft Excel and Access files. Excel files of the JEM would be more suitable for researchers who want to use the JEM for epidemiological research and analysis. Access files of the JEM would be better for practitioners and other users to search for the scores of work organization hazards by occupation, sex, and time period. The website will provide the following contents: background, methodology, users’ manual, the developed JEM in Access and Excel files, publications with the developed JEM, revisions and updates of the JEM (when additional information is available, for example, the 2002 GSS-QWL survey data to be released in 2023), contact information for Question (Q) & Answer (A) and the following JEM-related websites: the website for successful interventions for specific work organization hazards (https://healthywork.org) and the US websites for the JEMs of chemical and physical hazards (e.g., power-frequency magnetic fields: https://www.cdc.gov/niosh/topics/emf/jem-powerfreq/jempowerfreq.html).

3. Discussion

In this article, I discussed five important methodological issues in creating a JEM of work organization hazards particularly using self-reported data: having only two axes (hazard and occupation), using psychometrically weak items and scales, including scales having little interoccupational variability, unresolved optimal minimum numbers of subjects per occupation, and low accessibility of existing JEMs of work organization hazards. I presented a research protocol for creating a JEM of major work organization hazards using the GSS-QWL data (2002–2018) in which the aforementioned methodological issues were addressed by creating a four-axis (hazard, occupation, sex, and time) JEM, using only psychometrically validated items and scales, including only scales having at least a moderate level of interoccupational variability, empirically determining an optimal minimum numbers of subjects, and creating a user-friendly website with the work organization JEM (WOJEM) to be developed. Given the fact that work organization hazards significantly vary by time and gender, and most of existing JEMs of work organization hazards have only two-axes (hazard and occupation), the proposed four-axis WOJEM will serve as a valuable tool to more accurately estimate workers’ current and cumulative exposure to work organization hazards, based on their job title, gender, and employment period. In addition, the validity of the proposed four-axis WOJEM is expected to be high due to the rigorous validation tests for psychometric validity, interoccupational variability, and optimal minimum numbers of subjects. The research protocol will be also a good practical guide to researchers and practitioners who are interested in developing a high-quality JEM of work organization hazards using self-reported data. The new JEM of work organization hazards based on recent, nationally representative data of US working populations will significantly facilitate and strengthen occupational epidemiological studies on work organization hazards and major health outcomes, improve national and occupational surveillance of work organization hazards, and promote interventions for a healthy work environment in the US.

Conflicts of interest

All authors have no conflicts of interest to declare.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.shaw.2020.05.007.

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