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Mere overrepresentation? Using cross-occupational injury and job analysis data to explain men's risk for workplace fatalities ☆

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ABSTRACT

Historically, male workers have comprised a large proportion of occupational fatalities in the US. A common explanation for this has been that men are overrepresented in more physically hazardous occupations. Yet another potential explanation is that prescribed gender roles and norms contribute to higher rates of male worker fatalities compared with female workers. The purpose of this study was to test the assumption of the overrepresentation explanation, first, by testing the degree to which overrepresentation adequately accounts for men and women's differing fatality frequencies across various occupations, and second, by exploring gendered worker, occupation, and organizational attributes which may explain variance in the severity of men's fatality disparity between occupational titles. We used data from the Bureau of Labor Statistics and Occupational Information Network (O*NET). Results indicate that more than 25% of the total occupational fatalities in 2012 occurred outside of what would be expected for equivalent fatality ratios for men and women working in the same occupation. Further, gendered job and worker characteristics significantly predicted variance in men's relative risk for workplace fatalities across occupations (these characteristics, combined with sex representation, explained 10% of the total variance in men's relative fatality risk). The results suggest that men may be at increased risk for occupational fatalities when compared to women in the same occupations, and advocate for investigating the role of gender for future research on injury and fatality discrepancies between male and female workers.

In the United States (US), men are ten times more likely to incur an occupational injury than women (Dodson, 2007). In 2008, although men worked only 14% more hours than women overall, male workers comprised 93% of the reported 5214 fatal workplace injuries (US Department of Labor, 2008). One explanation from the safety literature regarding these numbers is that men experience a greater number of fatalities than women because they are comparatively overrepresented in hazardous occupations. Alternatively, a gender role perspective would indicate that risk perceptions, behavioral norms, and safety behaviors on the job are all influenced by traditional masculine gender role norms.[1]

The assumption that general overexposure to occupational hazards accounts for the larger number of male occupational fatalities is common (e.g., Blueprint for Men's Health Advisory Board, n.d.; Frone, 1998; Robertson, 2007); yet no study to date has empirically addressed the extent to which fatality differences exist between male and female workers while taking into account men's overrepresentation in hazardous occupations. Therefore, it remains unclear whether male workers' higher occupational fatality rates are due to men's overrepresentation in dangerous jobs, due to gendered norms in the workplace, or perhaps both. Investigating this *sex v. gender* explanatory mechanism in men and women's occupational fatalities is important for deconstructing the occupational fatality discrepancy and reducing fatalities in the workplace for both men and women. The exact nature and role that overrepresentation and gender roles each have to play in the fatality discrepancy at least partially informs interventions aimed at reducing workplace fatalities across industries. In the current research study, we take an inductive approach to investigating potential sources of gender disparities in occupational fatalities. Specifically, we address the following research questions. First, to what degree can men's overrepresentation in dangerous occupations explain men's workplace fatality risk? Second, if this overrepresentation cannot fully predict men's workplace fatality rates, what are some gender-relevant worker-, job-, or workplace-characteristics that

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[1] For clarity and consistency, we use "sex" to refer to the biological manifestation of anatomical sex (i.e., male and female) differences, whereas we use "gender" to refer to the societal roles and behaviors ascribed to one's sex.

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can explain additional variance (beyond overrepresentation) when it comes to men's higher rates of workplace fatalities? Below, we present a brief theoretical overview of the connection between gender and workplace injuries, covering both overrepresentation and gender role explanations, followed by an empirical investigation of our aforementioned research questions. Because of the differing scopes of these questions, we addressed them separately using two different yet complementary datasets.

1. Male fatality risk as a function of exposure

It is generally accepted that male workers, on the whole, are exposed to greater levels of occupational hazards than female workers. For example, using data from the US Department of Labor and US Census, Krantz (2002) ranked 250 occupations on several criteria, including physical demands, work stress, and occupational hazards. Twenty-four out of the 25 overall "worst" jobs, as defined by high levels of physical demands, stress, and occupational hazards, were found to have a workforce comprised of at least 95% men (Farrell, 2001; US Department of Labor, 2010). This seems to imply that exposure accounts for men's greater number of fatal injuries compared to women. Some safety researchers have also come to this conclusion. For instance, using self-report data from a sample of adolescent workers, Frone (1998) empirically demonstrated that sex differences in workers with occupational injuries were partially accounted for by the young male workers' greater exposure to physical occupational hazards (and to a lesser extent, self-reported on-the-job substance use). Robertson (2007) also concluded that men's higher rates of injury at work compared to women's are explainable by men's higher exposure to risk in his review of the literature on masculine identity and well-being. Further, even health-promotion pamphlets and handouts targeted at working class men state that working in a high-risk job is the reason why 90% of people who die on the job are men (Blueprint for Men's Health Advisory Board, n.d.). The overall takeaway from this line of reasoning is that men's occupational injury risk is inextricably linked to men's presence in dangerous industries.

2. Male fatality risk as a function of gender norms and roles

Another possible explanation regarding sex discrepancies in US occupational fatalities has to do with gender roles and norms. According to this contention, men in dangerous jobs are more likely to opt or be pressured into doing more dangerous *tasks* (or using more dangerous means to complete tasks) than women working in the same jobs (e.g., Courtenay, 2011). This line of reasoning assumes that it is erroneous to assume equivalent physical safety risk among workers with the same job title. The argument here is that men and women are rarely in a position in which they self-select (or are instructed by a supervisor) to do the exact same tasks in the exact same way, even within the same job title. Instead, men and women with the same job title in the same organization may be segregated by job tasks, with men opting (or being instructed) to perform tasks that are the most physically strenuous or performing tasks more hazardously. For example, in a study of assembly line workers, men were significantly more likely than women to lift loads over 55 lbs, work with the hands below knee level, keep the neck bent backwards, walk for prolonged time periods, kneel or squat for prolonged time periods, and force exertion with the hands or arms (Hooftman et al., 2005). Men were also significantly more likely to operate a vehicle (Hooftman et al., 2005), a task which carries the highest frequency of fatal occupational injuries in the US (US Department of Labor, Bureau of Labor Statistics, 2008).

Along these lines, Courtenay (2000) argues that men's injury rates are partially due to the normalization of risky behavior in masculinity conceptualizations. Men and women working in the same organization with the same job title may also view their own health and safety in different ways. For example, men are more likely to evaluate their own safety and well-being as secondary to completing a task, exerting competence, or establishing toughness to coworkers (Breslin et al., 2007; Gregory, 2006; Iacuone, 2005). Further, men may evaluate risk-prone scenarios differently from women (i.e., less risky) as prescribed by traditional masculine gender roles, and these gendered evaluations can lead to differences in injury and fatality rates in occupations beyond mere exposure. Collectively, this explanation asserts that observed health differences between sexes are at least partly a function of socialized norms surrounding male- and female-ness – i.e., gender (Lee and Owens, 2002).

3. Research questions

Examining overrepresentation and gender-based explanations for sex differences in fatalities is critical from an intervention perspective. On the one hand, if male overrepresentation in dangerous occupations is mainly driving the sex differences in fatal occupational injury rates and fatal injuries are simply a symptom of working in hazardous occupations regardless of worker demographics, then subsequent safety interventions need to occur at the task, job and industry level. However, if the sex differences in occupational injury rates are not fully explainable by male representation alone but instead or also by gender roles and norms, then safety interventions must at least partially address gender-based safety norms and expectations. In the present study, we examine data that allows us to test the over-representation assumption, and we take preliminary steps to examine the gendered assumption. The goal of the latter preliminary work is to provide a foundation for future further examination of the role of gender in explaining men's occupational fatality discrepancies.

Research Question 1: Will male overrepresentation in hazardous occupations account for the discrepancies between male and female occupational fatalities?
Research Question 2: Will occupational fatalities be explained by gendered occupational characteristics and abilities?

Specifically, we examine (a) discrepancies in male vs. female worker fatalities by occupation while accounting for sex representation and (b) the degree to which gender-based occupational characteristics may explain variance in male fatality disparities across occupational groups. We compiled two separate datasets for analysis to address these research questions. First, to examine the degree to which overrepresentation affects men's fatality rates, we use U.S. Bureau of Labor Statistics (BLS) datasets on worker fatalities and sex representation (Sample 1). Second, we merged job analysis data from the Occupational Information Network (O*NET) with the Sample 1 data to directly compare various gendered occupational characteristics, skills, and abilities with men's fatality risk (Sample 2).

4. Sample 1 and Sample 2 method

4.1. Data sources, procedures, and analyses

4.1.1. Sample 1

We used fatality data from the 2012 Census of Fatal Occupational Injuries database[2] (http://data.bls.gov/cgi-bin/dsrv?fi) and

[2] Note that non-fatal injury data were not examined in the present study because national data was only available for non-fatal injuries in which time-off work was taken, which is a potential gender-related confounder (i.e., men are less likely to take time off to recover from an injury and men are more likely to downplay symptoms in order to avoid taking time off due to an injury; Bonhomme, 2007; Peak et al., 2010; Wilkins, 2005).

representation data from the Women in the Labor Force Databook (http://www.bls.gov/cps/wlf-databook-2012.pdf). These data were merged based on Standard Occupation Classification System (SOC) job codes and titles, which represent job classifications based on common groupings. SOC classifications include 840 detailed occupation codes, which are nested within 461 broad occupation codes, 97 minor occupation codes, and 23 Major Groups. Each code is comprised of 6 digits; the first two represent the Major Group, the third represents the minor group, and so on (see http://www.bls.gov/soc/). Relative risk ratios were then calculated by comparing the number of male and female occupational fatalities in a given occupation against the number of men and women employed in that same occupation. A ratio of these probabilities [with male fatality ratio (# male fatalities/# male workers) in the numerator and female fatality ratio (# female fatalities/# female workers) in the denominator] represents the likelihood that a male worker in a given occupation will incur a fatal injury (when compared to women) considering the representation of male and female workers.[3] This method allowed us to investigate sex differences in occupational fatalities while taking into account the sex representation in each of these jobs. An occupation with a relative risk ratio greater than 1 is one in which the male fatality ratio is greater than the female fatality ratio, and thus may be interpreted as an occupation with a greater risk of fatality for male workers as compared to female workers while taking sex representation into account. A relative risk ratio equal to 1 indicates that the male and female fatality ratios are equivalent and thus at approximately equal risk of fatalities given their respective sex representation, and a relative risk ratio of less than 1 signifies an occupation where the male fatality ratio is less than the female fatality ratio, therefore indicating greater risk for female workers. In the present study, we use relative risk ratios as an indicator of the presence (or lack thereof) of male fatality disparities, such that a relative risk ratio greater than 1 for a given occupation indicates a disproportionate amount of male fatalities. Statistical significance of relative risk ratios were determined by chi-square (χ^2) goodness of fit tests, which compare observed and expected cell frequency values in contingency tables (e.g., Yates, 1934). The chi-square statistic for each relative risk ratio was then compared against critical values of the chi-square distribution for $df = 1$, at which a chi-square value greater than 3.841 is statistically significant at the $p < .05$ level.

Due to the structure and classification of SOC job codes, it was possible to conduct relative risk ratio analyses at some of the varying levels of job categories explained above.[4] Analyses for the present study were conducted at the largest grouping classification (''Major Group'') and the combined third and fourth levels (''Broad Group'' and ''Detail Group''). ''Broad Group'' results are reported when data was incomplete or missing for ''Detail Group'' occupations. Depending on data availability, analyses were conducted on the most specific occupational hierarchical group for which representation and fatality data were both available. Our decision to conduct the analyses at these levels was partially due to logistic limitations – specifically unavailable data for occupations with less than 50,000 workers, along with varying specificity in the hierarchical coding structure between data bases (e.g., data provided at the ''Detail Group'' in one dataset may only be available at the ''Broad Group'' in the other dataset). Investigating relative risk at these two levels was beneficial in that we are able to report results from both a broad perspective with the Major Group, along more specific occupational domains under the combined Broad and Detail Groups.

4.1.2. Sample 2

In order to address our second research question, we used an additional data source with information regarding gendered characteristics of (a) jobs and working environments and (b) the individual interests, skills, and abilities required to perform jobs effectively. For example, is the fatality discrepancy for male truck drivers greater than the fatality discrepancy for male sales representatives due to the more traditionally masculine features of a truck driving occupation (e.g., more labor intensive, requiring more technical knowledge, less reliance on social and interpersonal skills)? Put more simply, how much does the female-ness or male-ness of an occupation predict occupational fatality discrepancy (i.e., differences between men's and women's fatality ratios)?

We compiled and exported occupational and individual interests, skills, and abilities data from the Occupational Information Network (O*NET) job content database (2011; version 16.0) and merged it with the Sample 1 dataset described above. O*NET is a free, publicly accessible online database containing hundreds of job titles, descriptions and requirements, that was developed in the 1990s and initially released to the public in 1998 to replace the Dictionary of Occupational Titles. O*NET development was sponsored by the U.S. Department of Labor/Employment and Training Administration. There are a variety of uses for O*NET. For example, job seekers can find information about jobs that match their qualifications, or can find out about necessary qualifications for jobs they seek. Researchers can also use information on characteristics of workers or jobs in their studies across a variety of disciplines. For example, Ford and Tetrick (2011) examined O*NET work context ratings of occupational hazards and physical demands in relation to workers' psychological empowerment, organizational identification, and safety participation at work, and McGonagle et al. (2015) examined O*NET ratings of work characteristics (e.g., work autonomy, time pressure) as they related to older workers' levels of perceived work ability.

The O*NET database includes a variety of variables related to characteristics of both workers (e.g., abilities, values, styles, knowledge, educational, training, and licensing requirements) and work itself (e.g., work activities, work context, tasks, tools and technologies, and labor market information). Data (ratings) are provided by job incumbents, job experts and job analysts who respond to surveys administered by O*NET. While data was initially provided by job analysts in early stages of O*NET, the data have increasingly been provided by job incumbents over time. Job experts are also called upon to provide ratings for jobs that have small numbers of workers or for which workers are difficult to sample (e.g., remote locations). In terms of recruitment, O*NET reaches out to (a) a random sample of businesses that are expected to employ workers in the targeted occupations, then (b) a random sample of workers within those businesses to complete standardized questionnaires. To reduce participant burden and because the amount of information collected is quite large, three separate questionnaire forms are used, each with one third of the total questions and participants only respond to one (this process is randomized as well). We used 2010 SOC codes for each occupation to link the two datasets.

We relied on gender role theory frameworks (e.g., Bem, 1974; O'Neil, 2008) as a guide in selecting key O*NET variables that could best represent traditional conceptualizations of masculinity and femininity. Specifically, these frameworks propose that individuals categorize aspects of their world in an effort to simplify their cognitive load. Historically, in the United States and Europe, the concept of ''work'' had different meanings for men and women: women inhabited the private ''sphere'' in which they managed the home and the children whereas men inhabited the public ''sphere'' in which they engaged in matters associated with law, politics, and commerce. These spheres were deemed ''natural''

[3] In cases where an occupation had zero female fatalities, in order to avoid a mathematical 'division-by-zero' error, a value of ''0.5'' was substituted so that an approximate relative risk ratio and significance test may be calculated.

[4] For more information regarding SOC coding structure, refer to their latest user guide (as of the publication date of the current manuscript): http://www.bls.gov/soc/soc_2010_user_guide.pdf.

Table 1
O*NET variable descriptions.

Name	ONET structure	Definition	Gender	# of items
Safety risk	Work context	Condensed indicator of safety risk in work context (Bauerle and Magley, 2012)	M	6
Interpersonal orientation	Worker characteristics	Interpersonal characteristics that can affect how well someone performs a job	F	3
Physical abilities	Worker characteristics	Enduring physical attributes of the individual that influence performance	M	9
Interpersonal relationships	Work context	The context of the job in terms of human interaction processes	F	12
Interacting with others	Work activities	Interactions with other persons or supervisory activities that occur while performing this job	F	17
Technical skills	Skills	Developed capacities used to design, set-up, operate, and correct malfunctions involving application of machines or technological systems	M	11
Social skills	Skills	Developed capacities used to work with people to achieve goals	F	6
Realistic	Interests	Preferences for work environments and outcomes that involve work activities that include practical, hands-on problems and solutions	M	1
Social	Interests	Preferences for work environments and outcomes that involve working with, communicating with, and teaching people	F	1
Outdoors, exposed to weather	Work context	How often this job requires working outdoors, exposed to all weather conditions	M	1
Indoors, environmentally controlled	Work context	How often this job requires working indoors in environmentally controlled conditions	F	1

and, as a result, certain characteristics of these spheres became more closely associated with masculinity (e.g., outdoor work, intellectual efforts) and femininity (e.g., interpersonal focus, fine motor-skill tasks). The social normalization of these characteristics, internalization of the norms and, as a result, usage of the associated schemas – or mental representations – has been widely studied in gender-role research, including understanding gender and work (e.g., Powell, 1999) and provided the conceptual basis for our selection and assignment of O*NET variables.

Additionally, we made an effort to draw upon a variety of O*NET variables representing both worker-oriented and job-oriented facets from as many of the six O*NET Content Domains as possible (see http://www.onetcenter.org/content.html for details on O*NET's Content Structure, as well as more scale information regarding the O*NET constructs listed below). The six O*NET Content Domains are comprised of a mix of worker- and job-oriented knowledge, skills, and ability groupings (i.e., domains), as well as occupation specific and cross-occupation characteristics. Within the O*NET structure, we systematically went through each Content Domain and attempted to select constructs from each which spoke to traditional conceptualizations of masculine-typed or feminine-typed occupations. In the work context domain, we selected the interpersonal relationships variable and also retained the items from a previously established safety risk construct (Bauerle and Magley, 2012), which is comprised of several work context variables. Additionally, we included the "outdoors, exposed to weather" and "indoors, environmentally controlled" items to capture "traditionality" as per the notion of men and women's "separate spheres" (*cf.* Kerber, 1988). In the worker characteristics domain, interpersonal orientation and physical abilities were selected for describing certain characteristics that may be favored, preferred, or expected from workers in male- or female-typed environments. For skills, we selected the technical and social skills constructs to highlight part of the KSAOs that may be required in traditionally gendered occupations. In interests (based on Holland's RIASEC Model; 1973; see also Mariana, 1999), realistic and social interests were selected to reflect values that may comprise workers in traditional occupations. It is important to note that in this context, "realistic" does not refer to the opposite of unrealistic or impractical but rather hands-on problem solving, such as farmworkers, plumbers, and electricians (Holland, 1973). Finally, in the work activities domain, interacting with others was retained to reflect the traditional feminine notion of interpersonal work, such as nursing, midwives, teachers, and human resources. This yielded an initial total of 11 variables representing 68 items were extracted from the O*NET database for use in the present study (Table 1).

Because of the conceptual and empirical overlap from these items and constructs, we attempted to reduce the number of constructs for parsimony and simplicity. Excluding the safety risk construct (Bauerle and Magley, 2012), the 62 items were entered into an exploratory factor analysis. As suggested by Costello and Osborne (2005), a maximum likelihood factor analysis extraction method was chosen with direct oblimin rotation. An initial 10 factor solution was derived, which explained 78.88% of the variance between all items. After a series of factor re-analyses which included iteratively removing low-loading items and adjusting forced factor solutions, a parsimonious 4 factor solution was achieved with 41 of the original items which accounted for 73% of the total variance between items. The items with factor solutions are provided below in Table 2, including specific location of items in the O*NET questionnaires. The four emerged factors were labeled (from 1 to 4): physicality (noted by high stamina, body coordination, strength, and flexibility), technical (noted by a high need for repairing, equipment selection, troubleshooting, and operation monitoring), social – supervisory (noted by a high need for guiding, directing, and motivating subordinates, coordinating the work and activity of others, and developing and building teams), and social – nurture (noted by a high concern for others, social and service orientations, and social perceptiveness).

In addition, as a type of validation check, we surveyed graduate students and professionals in the areas of Industrial/Organizational Psychology and Occupational Health Psychology ($N = 8$) to determine whether these factors were indeed reflective of what individuals in society generally think of as "masculine" and "feminine" occupational characteristics. Respondents rated each of the 41 O*NET items, with the following item stem: "For the following table, read the following O*NET skills, abilities, work activities, work styles, and work interests, and then determine whether or not you think it describes a more feminine or masculine occupation." The response scale ranged from 1 (more masculine than feminine) to 4 (more feminine than masculine). The results aligned well with our groupings. Specifically, the averaged ratings for our factors (i.e., the average score of each items average by factor) are as follows: physicality = 1.85, technical = 1.53, social – supervisory = 2.79, and social – nurture = 3.43. With a scale "median" of 2.5, all factors were rated approximately on the masculinity–femininity continuum as conceptualized.

Table 2
Final factor analysis solution for O*NET items.

Item	ONET survey and item #[a]	Factor loadings			
		1	2[b]	3	4
Stamina	Abilities, 36	**.97**	−.47	−.15	−.06
Gross body coordination	Abilities, 39	**.97**	−.48	−.13	−.05
Dynamic strength	Abilities, 34	**.96**	−.52	−.17	−.14
Static strength	Abilities, 32	**.95**	−.56	−.22	−.15
Extent flexibility	Abilities, 37	**.95**	−.58	−.21	−.17
Trunk strength	Abilities, 35	**.93**	−.50	−.19	−.10
Gross body equilibrium	Abilities, 40	**.90**	−.51	−.08	−.09
Electronic mail	Work context, 4	−**.73**	.42	.47	.25
Realistic	[c]	**.70**	−.69	−.31	−.55
Letters and memos	Work context, 5	−**.61**	.41	.47	.41
Indoors, environmentally controlled	Work context, 15	−**.61**	.47	.23	.32
Equipment maintenance	Skills, 26	.55	−**.98**	−.18	−.39
Repairing	Skills, 28	.52	−**.98**	−.17	−.39
Equipment selection	Skills, 20	.52	−**.93**	−.14	−.43
Troubleshooting	Skills, 27	.56	−**.89**	−.10	−.43
Operation monitoring	Skills, 24	.57	−**.79**	−.05	−.40
Operation and control	Skills, 25	.66	−**.78**	−.15	−.42
Quality control analysis	Skills, 23	.47	−**.75**	.00	−.44
Installation	Skills, 21	.31	−**.67**	−.10	−.28
Guiding directing and motivating subordinates	Work activities, 36	−.13	.04	**.91**	.30
Coordinating the work and activities of others	Work activities, 33	−.11	.08	**.86**	.32
Developing and building teams	Work activities, 34	−.19	.15	**.86**	.40
Coaching and developing others	Work activities, 37	−.14	.10	**.83**	.45
Staffing organizational units	Work activities, 40	−.21	.13	**.80**	.31
Coordination	Skills, 12	−.26	.29	**.79**	.56
Provide consultation and advice to other	Work activities, 38	−.40	.15	**.76**	.30
Instructing	Skills, 15	−.32	.22	**.76**	.51
Training and teaching others	Work activities, 35	−.10	.03	**.70**	.36
Monitoring	Skills, 6	−.18	.08	**.69**	.41
Resolving conflicts and negotiating with others	Work activities, 31	−.25	.33	**.66**	.62
Interpreting the meaning of information for others	Work activities, 25	−.52	.29	**.62**	.36
Concern for others	Work styles, 6	−.06	.30	.27	**.85**
Social orientation	Work styles, 7	−.11	.37	.35	**.83**
Social	[c]	−.29	.51	.37	**.83**
Service orientation	Skills, 16	−.28	.44	.49	**.80**
Social perceptiveness	Skills, 11	−.37	.48	.56	**.79**
Assisting and caring for others	Work activities, 29	.12	.15	.34	**.75**
Cooperation	Work styles, 5	−.23	.33	.36	**.69**
Performing for or working directly with the public	Work activities, 32	−.07	.34	.25	**.68**
Contact with others	Work context, 6	−.19	.33	.34	**.67**
Frequency of conflict situations	Work context, 12	−.11	.23	.45	**.56**

Notes: This is the final factor solution after removing items with <.20 loading values and non-converging items. Highest factor loadings for each item are bolded.

[a] O*NET questionnaires can be found at https://www.onetcenter.org/questionnaires.html.

[b] Before analysis, factor 2 ("technical") was reverse scored.

[c] The 'realistic' and 'social' variables are calculated via algorithms applied to O*NET data based on Holland's (1973) RIASEC model. More information regarding the calculation methods can be found at: http://www.onetcenter.org/dl_files/OIP.pdf.

Together with the safety risk variable, we then merged these five O*NET variables with employment and fatality data using common SOC codes as unique identifiers. In addition, number of workers in each occupation in 2012 and percentage of female workers were used as control variables in an effort to isolate the effects of the gendered job and person characteristics on fatalities.

We utilized relative weights analysis – Johnson's (2000) macro –(http://www1.psych.purdue.edu/~jlebreto/relative.htm) – to determine the relative importance of the various O*NET job and worker characteristics on the fatality relative risk ratios for the various job groups. Relative weights analysis provides the relative importance of each predictor in accounting for variance in the outcome variable while taking into account all others (LeBreton and Tonidandel, 2008). Relative weights analysis is preferable to ordinary least squares regression analysis when predictor variables are inter-correlated (LeBreton and Tonidandel, 2008), as we expected ours to be in this study. Relative weights allowed us to examine each unique contribution of the traditionally masculine O*NET variables once variance accounted for by the traditionally feminine O*NET variables has been parsed out. Additionally, we estimated confidence intervals and statistical significance of relative weights by utilizing Tonidandel and LeBreton's (2011) free web-based tool: http://relativeimportance.davidson.edu/multipleregression.html.

*4.2. O*NET measures*

Table 1 contains the initial pool of O*NET questions included in the aforementioned exploratory factor analysis. All items were on a scale from 1 to 5 with higher scores indicating greater endorsement on items, or greater importance of the skill, ability, or context aspect represented by that item to a particular occupation. All O*NET items can be located at: https://www.onetcenter.org/content.html.

5. Sample 1 results

Merging the fatality and sex representation data yielded an initial 242 unique occupational titles that included at least one occupational fatality. After removing job titles that had no information on the percent of women in the occupation workforce (188 occupations) and removing remaining job titles with less than a combined total of 2 occupational fatalities in 2012 (27), a grand total of 174 job titles were derived for the analyses, comprising 22 major job codes, 57 broad codes, and 95 detail codes. Although a considerable amount of occupations were removed from the final data set, the remaining combined 152 broad and detail job codes represented nearly 90% of the total 2012 workforce (90,125,000 workers in data set vs. 104,262,000 US workers in 2012) and 87% of the total 2012 fatalities (4035 fatalities represented in dataset vs. 4628 total fatalities in 2012).

5.1. Major Group results

As displayed in Table 3, with the exception of three major categories (computer and mathematical occupations, community and social service occupations, and food preparation and serving related occupations), relative risk ratios for occupational fatalities were statistically significant (as determined by chi-square probability statistics), such that men were anywhere from 2.53 times (construction and extraction occupations) to 34.78 times (life, physical, and social science occupations) more likely to incur a fatal occupational injury than women,[5] even when taking gender representation in each occupation into consideration. In these cases where fatality relative risk ratios were significant, we calculated the number of male fatalities that we would expect if the ratios were in fact equal (using a calculation of expected values), then found the difference between this expected value and the actual value for male fatalities within each job grouping. In other words, we calculated what the value of male fatalities would have to be in order to equal the female fatality ratio, then subtracted this expected fatality number from the observed fatalities for men in each occupational grouping. The fatality disparities from Major Group titles with statistically significant relative risk ratios summed to nearly 3150 deaths; in other words, at the broadest level of analysis, nearly 68% of the total fatalities in 2012 (3150 out of 4628 total fatalities) were fatalities incurred by male workers which could not be explained by assuming equal rates of male and female worker fatalities.

5.2. SOC Broad and Detail Group results

Results from the Broad and Detail Group data were more varied and complex, as illustrated in Table 4. Out of 152 job groups, 39 had significant relative risk ratios based on the chi-square values for the test of equivalent proportions, accounting for 2170 fatalities or 47% of the total number of workplace fatalities in 2012. We again calculated a fatality disparity statistic for these job subsets, and the total fatalities from this statistic for occupations in which the relative risk ratio was significant yielded a total of approximately 1288 fatalities for men. In other words, for this subsample of jobs, out of a total of 4628 fatalities in 2012, more than 25% could not be explained by sex representation in employment statistics.

It should be noted that seven of the relative risk ratios were significant *for women* (i.e., relative risk ratios less than 1); indicating that women were at greater risk of occupational fatalities than men, given sex representation in those occupations. However, five of these seven were statistical artifacts, as there were only actual female fatalities for only two of these occupations [6]: railroad conductors and yardmasters, and administrative services managers, with a combined total female fatality count of 8 deaths.

Although clearly some variance exists between these job groups on dimensions of fatality frequency and disparities, overall the results indicate that men may generally have a higher observed risk of occupational fatalities than women, even when taking men's overrepresentation in hazardous occupations into consideration. However, more than three quarters of the relative risk ratios in our combined broad and Detail Group analyses were not significant. This led us to question whether there were occupational characteristics that could distinguish between these occupational titles, and features of either the worker or the workplace that may account for variance in sex-based fatality discrepancies in occupations in which men are most at risk of occupational fatalities. Our next set of analyses aimed to identify potential sources of these discrepancies. Specifically, using the relative risk ratio as an indicator of men's fatality disparity and our outcome of interest, we sought to explain variance in men's occupational fatality relative risk ratios between jobs using O*NET job content data.

6. Sample 2 results

Table 5 contains a correlation matrix with Cronbach's alpha on the diagonal and descriptive statistics for O*NET and control variables. A natural log transformation was applied to the relative risk ratio and total number of employees due to negative distributional skew prior to analysis. Merging the combined Broad and Detail Group data with O*NET data yielded a final sample of 131 occupational groupings achieved for Sample 2 analyses (no overlapping groups were included, so no occupations were counted more than once). The occupations that were dropped from the Sample 1 dataset were either lacking miscellaneous job title data in O*NET, and/or were lacking data on the selected measures in the O*NET database.

Table 6 contains the results for the relative weights analysis. The raw weights can be interpreted as the contribution of each predictor to the overall R^2. With all predictors in the same model, the control variables (total number of workers and the percentage of female workers) accounted for only small and non-significant amounts of variance in relative risk ratios; 0.5% and 5.1%, respectively. The total R^2 with all 7 variables included was .10, indicating that 10% of variance in the relative risk ratios was accounted for by the 5 O*NET and 2 control variables combined. In other words, these variables accounted for 10% of the variance in the degree to which men are more likely than women to incur a fatal occupational injury while accounting for sex representation by occupation (and, 5% of this 10% variance, or 1% of total variance, was accounted for by percentage of female workers, 0.5% of the variance was accounted for by the total number of workers in each category, and 94.5% of the total variance in the degree to which men are more likely than women to incur a fatal occupational injury are accounted for by the O*NET variables). Also included in Table 6 are the confidence interval tests of significance for the relative weights as explained in Tonidandel and LeBreton (2011). Only safety risk and social – supervisory emerged as significant unique predictors of the relative risk ratios at $p < .05$. Together, these two variables accounted for 6% of the total variance in the relative risk ratios.

7. Exploratory post-hoc analyses

To further investigate the connection between the results of the relative weights analysis and the nature of their relationship with the relative risk ratios within the context of occupational job codes, we conducted some additional analyses using the Sample 2

[5] To contextualize these effects, Hopkins (2010) suggests that ratios greater than 3 are "large," and values greater than 5.7 are "very large."

[6] That is to say, the remaining 5 occupations did not have any female fatalities due to the zero substitution used in calculating the relative risk ratios. See footnote 3.

Table 3
Relative risk ratios for occupational fatalities by sex.

SOC Major Group titles	Relative risk ratio	Chi-square	Male deaths	Female deaths[a]	O – E men's fatalities[b]
19-0000 – life, physical, and social science occupations	34.78***	16.03	21	0	20.88
23-0000 – legal occupations	28.45***	12.79	14	0	13.90
17-0000 – architecture and engineering occupations	11.43*	4.69	36	0	35.37
51-0000 – production occupations	9.07***	61.99	213	9	189.50
37-0000 – building and grounds cleaning and maintenance occupations	8.77***	115.59	251	18	222.40
11-0000 – management occupations	5.90***	165.33	422	45	350.40
39-0000 – personal care and service occupations	5.68***	64.50	44	27	36.25
45-0000 – farming, fishing, and forestry occupations	5.18***	44.80	247	14	199.30
25-0000 – education, training, and library occupations	5.15***	28.17	24	13	19.34
27-0000 – arts, design, entertainment, sports, and media occupations	5.14***	22.56	44	8	35.44
29-0000 – healthcare practitioners and technical occupations	4.50***	35.93	33	22	25.67
41-0000 – sales and related occupations	4.35***	91.04	197	43	151.70
43-0000 – office and administrative support occupations	4.19***	52.93	55	36	41.89
53-0000 – transportation and material moving occupations	3.97***	119.18	1177	56	880.80
33-0000 – protective service occupations	3.88***	35.98	264	18	195.90
31-0000 – healthcare support occupations	3.77***	10.61	8	15	5.88
13-0000 – business and financial operations occupations	3.47***	10.32	22	8	15.66
49-0000 – installation, maintenance, and repair occupations	2.89*	4.92	350	4	229.00
15-0000 – computer and mathematical occupations	2.75	0.50	4	0	3.71
47-0000 – construction and extraction occupations	2.53**	7.43	790	8	478.00
21-0000 – community and social service occupations	1.62	1.35	11	12	4.19
35-0000 – food preparation and serving related occupations	1.48	1.83	26	21	8.47

[a] In instances where female deaths = 0, a value of 0.5 was substituted to calculate an approximate relative risk ratio value.
[b] Observed men's fatalities minus expected men's fatalities.
* Indicates statistical significance at $p < .05$.
** Indicates statistical significance at $p < .01$.
*** Indicates statistical significance at $p < .001$.

dataset. We looked for patterns among the relative weight predictors, groupings of job codes, and relative risk ratios.

7.1. Cluster analysis

First, we used the five O*NET variables from the relative weights analysis to organize Broad and Detail job codes into meaningful groups using *k*-means cluster analysis.[7] In short, *k*-means clustering partitions *n* observations into *k* clusters in which each observation belongs to the cluster with the nearest mean. The goal is to group observations that are similar to each other based on a set of criteria. Here, the job codes represented the observations that were grouped according to similarity based on the five aforementioned variables. Ideally, the cluster solution that is retained should contain enough clusters to capture the complexity and variance in n observations while at the same time leaving a non-exhaustive, parsimonious number of clusters. We retained a parsimonious solution whereby the analysis produced three groupings or clusters of jobs based on the O*NET variables. We interpreted and labeled these clusters based on their cluster centers, which give an indication of the strength of association between an item and the cluster itself. In other words, the cluster center is the mean value of a particular item in a given cluster. Table 7 contains the final cluster centers for this 3-cluster solution. In this case, the clusters that emerged from the analysis could logically be labeled "masculine," "gender-neutral," and "feminine" based on the cluster center values for each O*NET variable. For instance, cluster #1 contains the lowest of the three cluster centers on both social constructs, but highest on physicality and safety risk – hence it was labeled "masculine." As shown, there is a somewhat linear trend among all variables across the three clusters, with masculine variables *decreasing* from left to right and with feminine variables *increasing* from left to right across the three clusters.

[7] In response to reviewer feedback, we also clustered occupations based on tertiles of percent of women in each occupation (i.e., low, medium, and high percent women) and obtained similar results (full tertile results available from the first author, upon request).

7.2. Cluster differences in risk ratios

With a somewhat even distribution of job codes between the three clusters, a oneway analysis of variance (ANOVA) was conducted to probe for cluster differences on their relative risk ratios. Percent of women in occupation was added to the analysis both as a manipulation check for the cluster solutions and to contextualize the results for the relative risk ratio group differences. ANOVA results indicated that the clusters were appropriately conceptualized, with percent of women increasing significantly across the masculine, neutral, and feminine clusters, $F(2, 128) = 18027.60$, $p < .01$, $\eta_p^2 = .34$. Although the relative risk ratio did not vary significantly between the masculine and neutral clusters, the feminine cluster was significantly greater than the relative risk ratios in both the masculine and neutral clusters, $F(2, 128) = 225.41$, $p < .05$, $\eta_p^2 = .06$. Table 8 includes mean values of the relative risk ratio and percent women in occupation by cluster.

8. Discussion

The purpose of this research study was to test the assumption of overrepresentation as a viable explanatory mechanism for men's fatality disparities by using a two-prong approach: first, by testing the degree to which overrepresentation adequately accounts for men and women's differing fatality frequencies across various occupations, and second, by laying a foundation for an alternative gendered argument by exploring gendered worker, occupation, and organizational attributes which may explain variance in the severity of men's fatality disparity between occupational titles.

The overrepresentation perspective on the sex disparities in occupational fatalities was supported to a large degree in the current study. Yet, we also observed evidence across both samples that there are likely additional factors involved in these sex disparities. Although only 25% of the Broad and Detail occupations investigated yielded significant relative risk ratios, a total of 75% of the occupations investigated had relative risk ratios greater than 1, and more than 25% of the fatalities in 2012 were accounted for by men's fatality disparities in occupational titles with significant

Table 4
Relative risk ratios for occupational fatalities – broad and detail occupations.

SOC broad and detail group titles	Relative risk ratio	Chi-square	Male deaths	Female deaths[a]	O – E men's fatalities[b]	# workers in thousands	% women
11-1011 – chief executives	15.1*	6.42	20	0	20	1513	27.4
11-1021 – general and operations managers	7.39	2.62	9	0	9	1064	29.1
11-2020 – marketing and sales managers	11.55*	4.5	7	0	7	967	45.2
11-3010 – administrative services managers	0.08*	4.89	0	5	−6.34	144	44.1
11-3031 – financial managers	1.15	0.03	3	3	0.39	1228	53.5
11-3051 – industrial production managers	2.99	0.62	7	0	7	261	17.6
11-3071 – transportation, storage, and distribution managers	1.11	0	3	0	3	287	15.6
11-9010 – farmers, ranchers, and other agricultural managers	5.89***	53.95	254	14	210.86	944	24.5
11-9021 – construction managers	2.74	0.54	20	0	20	983	6.4
11-9030 – education administrators	1.81	0.72	4	4	1.79	811	64.4
11-9051 – food service managers	5.36***	12.17	24	4	19.53	1085	47.2
11-9081 – lodging managers	2.86	1.89	7	2	4.56	154	45
11-9111 – medical and health services managers	23**	9.57	5	0	5	585	69.7
11-9141 – property, real estate, and community association managers	2.06	1.81	10	5	5.14	644	50.7
11-9151 – social and community service managers	23.9**	9.97	5	0	5	315	70.5
13-2011 – accountants and auditors	15.58*	6.2	5	0	5	1765	60.9
17-1020 – surveyors, cartographers, and photogrammetrists	2.31	0.32	3	0	3	51	27.8
17-2051 – civil engineers	2.86	0.57	9	0	9	358	13.7
17-2070 – electrical and electronics engineers	0.79	0.02	4	0	4	335	9
17-2141 – mechanical engineers	0.38	0.46	4	0	4	288	4.5
17-3020 – engineering technicians, except drafters	2.34	0.35	6	0	6	395	16.3
19-2030 – chemists and materials scientists	4.75	1.27	3	0	3	105	44.2
21-1020 – social workers	0.35	0.57	0	6	−1.44	734	80.6
21-1090 – miscellaneous community & social service specialists	4.15*	4.11	4	3	3.04	94	75.7
21-2011 – clergy	2.58	0.44	5	0	5	408	20.5
23-1011 – lawyers	12.64*	5.17	14	0	14	1061	31.1
25-1000 – postsecondary teachers	16.75**	7.01	9	0	9	1350	48.2
25-2020 – elementary and middle school teachers	0.44	0.33	0	5	−1.14	2838	81.4
25-2030 – secondary school teachers	16.1*	6.54	6	0	6	1127	57.3
25-2050 – special education teachers	0.78	0.03	0	4	−0.64	366	86.2
25-3090 – miscellaneous teachers and instructors	26.7***	11.54	7	0	7	860	65.6
27-1010 – artists and related workers	6.4	1.95	3	0	3	212	51.6
27-1020 – designers	1.24	0.07	3	3	0.58	756	55.3
27-2012 – producers and directors	5.51	1.64	4	0	4	121	40.8
27-2020 – athletes, coaches, umpires, & related workers	3.83*	5.46	20	3	14.78	267	36.5
27-2040 – musicians, singers, and rel. workers	3.3	0.69	3	0	3	203	35.5
27-2099 – entertainers and performers, sports & related workers, all other	2.24	0.52	3	1	1.66	51	42.8
27-4021 – photographers	8.74	3.05	4	0	4	178	52.2
29-1020 – dentists	3.19	0.68	5	0	5	167	24.2
29-1051 – pharmacists	6.96	2.19	3	0	3	286	53.7
29-1060 – physicians and surgeons	10.44*	4.07	10	0	10	911	34.3
29-1141 – registered nurses	0.48	0.27	0	10	−1.04	2875	90.6
29-2041 – emergency medical technicians & paramedics	1.36	0.14	6	2	1.59	172	31.2
31-1010 – nursing, psychiatric, and home health aides	2.79*	4.16	5	13	3.21	2119	87.9
33-1012 – first-line supervisors of police and detectives	5.38	1.73	15	0	15	112	15.2
33-1021 – first-line supervisors of fire fighting and prevention workers	0.06**	6.77	6	0	6	64	0.5
33-2011 – firefighters	1.97	0.24	28	0	28	295	3.4
33-3010 – bailiffs, correctional officers, and jailers	5.44	1.69	7	0	7	371	28
33-3021 – detectives and criminal investigators	1.65	0.21	5	1	1.97	160	24.8
33-3051 – police and sheriff's patrol officers	2.53*	6.17	123	7	74.44	657	12.6
33-9030 – security guards and gaming surveillance officers	28.15***	12.99	62	0	62	903	18.5
33-9091 – crossing guards	1.65	0.44	4	3	1.58	61	55.3
35-1011 – chefs and head cooks	1.64	0.11	3	0	3	403	21.5
35-1012 – first-line supervisors of food preparation and serving workers	1.82	0.82	5	4	2.25	552	59.3
35-2010 – cooks	1.21	0.1	8	4	1.39	1970	37.7
35-3011 – bartenders	11.95*	4.46	4	0	4	412	59.9
35-3021 – combined food preparation and serving workers, including fast food	5.55	2.8	3	1	2.46	343	64.9
35-3031 – waiters and waitresses	0.11	3.35	0	11	−4.45	2124	71.2
37-1011 – first-line supervisors of housekeeping and janitorial workers	8.9	3.19	5	0	5	277	47.1
37-1012 – first-line supervisors of landscaping, lawn service, and groundskeeping workers	4.61	1.39	28	0	28	281	7.6
37-2011 – janitors and cleaners, except maids and housekeeping cleaners	2.53*	4.78	36	6	21.8	2205	29.7
37-2012 – maids and housekeeping cleaners	0.53	0.2	0	7	−0.95	1457	88.1
37-2021 – pest control workers	0.3	0.72	3	0	3	73	4.7
37-3010 – grounds maintenance workers	1.91	2.15	178	5	84.96	1298	5.1
39-1010 – first-line supervisors of gaming workers	4.53	1.18	3	0	3	146	43

(*continued on next page*)

Table 4 (*continued*)

SOC broad and detail group titles	Relative risk ratio	Chi-square	Male deaths	Female deaths[a]	O – E men's fatalities[b]	# workers in thousands	% women
39-1021 – first-line supervisors of personal service workers	3.55	2.2	3	2	2.16	246	70.3
39-2021 – nonfarm animal caretakers	2.88	1.84	3	3	1.96	179	74.2
39-3090 – miscellaneous entertainment attendants and related workers	23.29**	10.3	14	0	14	180	45.4
39-5011 – barbers	1.96	0.41	7	1	3.43	109	21.9
39-5012 – hairdressers, hairstylists, and cosmetologists	1.29	0.03	0	5	−0.39	785	92.8
39-7010 – tour and travel guides	3.51	0.77	3	0	3	51	36.9
39-9011 – childcare workers	1.99	0.22	0	4	−0.25	1314	94.1
39-9021 – personal care aides	0.69	0.06	0	4	−0.72	1071	84.7
39-9030 – recreation and fitness workers	23.82**	10.09	6	0	6	406	66.5
41-1011 – first-line supervisors of retail sales workers	6.48***	45.62	93	11	78.65	3237	43.4
41-1012 – first-line supervisors of non-retail sales workers	14.43*	6.11	22	0	22	1151	24.7
41-2010 – cashiers	4.11***	18.92	21	13	15.89	3275	71.8
41-2031 – retail salespersons	2.27*	3.93	18	8	10.06	3341	50.2
41-3031 – securities, commodities, and financial services sales agents	2.32	0.32	3	0	3	280	27.9
41-3099 – sales representatives, services, all other	2.7	0.46	3	0	3	457	31
41-4010 – sales representatives, wholesale and manufacturing	9.62*	3.72	13	0	13	1277	27
41-9091 – door-to-door sales workers, news and street vendors, and related workers	29.62***	13.1	9	0	9	198	62.2
43-5021 – couriers and messengers	2.93	0.6	8	0	8	213	15.5
43-5052 – postal service mail carriers	0.47	2.35	7	9	−7.87	318	37.7
43-5071 – shipping, receiving, and traffic clerks	3.85	0.96	5	0	5	527	27.8
43-5081 – stock clerks and order fillers	1.38	0.29	10	4	2.73	1453	35.5
43-9061 – office clerks, general	1.88	0.91	3	8	1.41	1103	83.4
45-1011 – first-line supervisors of farming, fishing, and forestry workers	4.6	1.36	14	0	14	50	14.1
45-2090 – miscellaneous agricultural workers	2.35**	8.49	121	12	69.51	711	18.9
45-4020 – logging workers	1.45	0.14	65	0	65	63	1.1
47-1011 – first-line supervisors of construction trades and extraction workers	6.05	2.12	105	0	105	634	2.8
47-2020 – brickmasons, blockmasons, and stonemasons	0.02***	28.57	8	0	8	122	0.1
47-2031 – carpenters	1.43	0.07	44	0	44	1223	1.6
47-2040 – carpet, floor, and tile installers and finishers	0.13	2.38	3	0	3	150	2.2
47-2050 – cement masons, concrete finishers, and terrazzo workers	0.17	1.79	3	0	3	68	2.7
47-2061 – construction laborers	11.35*	4.73	190	0	190	1387	2.9
47-2073 – operating engineers and other construction equipment operators	1.21	0.02	46	0	46	348	1.3
47-2080 – drywall installers, ceiling tile installers, and tapers	0.05**	8.87	8	0	8	129	0.3
47-2111 – electricians	2.2	0.33	60	0	60	692	1.8
47-2141 – painters, construction and maintenance	3.96	1.09	34	0	34	485	5.5
47-2150 – pipelayers, plumbers, pipefitters, and steamfitters	0.68	0.07	26	0	26	534	1.3
47-2181 – roofers	1.83	0.2	60	0	60	196	1.5
47-2211 – sheet metal workers	0.68	0.07	7	0	7	123	4.6
47-2221 – structural iron and steel workers	1.04	0.01	18	0	18	65	2.8
47-3010 – helpers, construction trades	1.41	0.06	15	0	15	53	4.5
47-4011 – construction and building inspectors	1.52	0.09	9	0	9	118	7.8
47-4051 – highway maintenance workers	0.82	0.03	27	0	27	108	1.5
47-5040 – mining machine operators	0.04**	10.19	7	0	7	65	0.3
49-1011 – first-line supervisors of mechanics, installers, and repairers	2.26	0.34	18	0	18	292	5.9
49-2011 – computer, automated teller, and office machine repairers	0.72	0.05	3	0	3	296	10.7
49-2020 – radio and telecommunications equipment installers and repairers	1.11	0.01	9	0	9	158	5.8
49-2097 – electronic home entertainment equipment installers and repairers	0.04**	10.21	4	0	4	50	0.5
49-3011 – aircraft mechanics and service technicians	0.2	1.53	6	0	6	153	1.6
49-3021 – automotive body and related repairers	0.18	1.65	5	0	5	140	1.8
49-3023 – automotive service technicians and mechanics	0.8	0.03	33	0	33	867	1.2
49-3031 – bus and truck mechanics and diesel engine specialists	0.19	1.67	19	0	19	316	0.5
49-3040 – heavy vehicle and mobile equipment service technicians and mechanics	0.69	0.08	34	0	34	194	1
49-3050 – small engine mechanics	0.11	3.08	4	0	4	56	1.4
49-3090 – miscellaneous vehicle and mobile equipment mechanics, installers, and repairers	0.44	0.34	12	0	12	87	1.8
49-9021 – heating, air conditioning, and refrigeration mechanics and installers	0.59	0.14	18	0	18	340	1.6
49-9040 – industrial machinery installation, repair, and maintenance workers	2.05	0.27	53	0	53	454	1.9
49-9044 – millwrights	0.68	0.07	5	0	5	53	6.4
49-9051 – electrical power-line installers and repairers	1.28	0.04	26	0	26	110	2.4
49-9052 – telecommunications line installers and repairers	1.21	0.02	12	0	12	177	4.8

Table 4 (*continued*)

SOC broad and detail group titles	Relative risk ratio	Chi-square	Male deaths	Female deaths[a]	O – E men's fatalities[b]	# workers in thousands	% women
49-9071 – maintenance and repair workers, general	2.83	0.6	63	0	63	442	2.2
49-9090 – miscellaneous installation, maintenance, and repair workers	1.64	0.13	22	0	22	205	3.6
51-1011 – first-line supervisors of production and operating workers	16.96**	7.4	35	0	35	808	19.5
51-2090 – misc. assemblers and fabricators	8.73	3.19	7	0	7	919	38.4
51-4041 – machinists	0.63	0.1	8	0	8	397	3.8
51-4120 – welding, soldering, and brazing workers	4.54	1.37	45	0	45	593	4.8
51-5112 – printing press operators	1.25	0.02	3	0	3	201	17.2
51-6011 – laundry and dry-cleaning workers	6.85	2.14	3	0	3	185	53.3
51-8031 – water and wastewater treatment plant and system operators	0.85	0.01	9	0	9	72	4.5
51-9010 – chemical processing machine setters, operators, and tenders	1.16	0.01	3	0	3	68	16.2
51-9020 – crushing, grinding, polishing, mixing, and blending workers	2.82	0.56	8	0	8	100	15
51-9061 – inspectors, testers, sorters, samplers, and weighers	7.02	2.41	7	0	7	689	33.4
51-9120 – painting workers	1.42	0.06	4	0	4	150	15.1
53-2010 – aircraft pilots and flight engineers	0.97	0.04	68	3	−2.17	129	4.1
53-3020 – bus drivers	1.81	1.49	13	6	5.81	558	45.5
53-3030 – driver/sales workers and truck drivers	1.52*	5	746	28	255.48	3201	5.4
53-3041 – taxi drivers and chauffeurs	2.28	2.71	60	4	33.7	336	13.2
53-3099 – motor vehicle operators, all other	0.38	2.84	10	4	−16.08	63	13.3
53-4010 – locomotive engineers and operators	0.37	0.49	7	0	7	57	2.6
53-4031 – railroad conductors and yardmasters	0.1***	15.42	5	3	−45.57	52	5.6
53-6021 – parking lot attendants	1.05	0	4	0	4	81	11.6
53-7021 – crane and tower operators	0.83	0.02	10	0	10	62	4
53-7030 – dredge, excavating, and loading machine operators	0.99	0	15	0	15	51	3.2
53-7051 – industrial truck and tractor operators	5.43	1.79	34	0	34	537	7.4
53-7061 – cleaners of vehicles and equipment	5.74	1.9	16	0	16	315	15.2
53-7062 – laborers and freight, stock, and material movers, hand	4.09***	11.08	89	5	67.26	1849	18.7
53-7081 – refuse and recyclable matl. collectors	4.24	1.23	30	0	30	106	6.6
53-7199 – material moving workers, all other	0.76	0.03	4	0	4	59	8.7

[a] In instances where female deaths = 0, a value of 0.5 was substituted to calculate an approximate relative risk ratio value.
[b] Observed men's fatalities minus expected men's fatalities.
* Indicates statistical significance at $p < .05$.
** Indicates statistical significance at $p < .01$.
*** Indicates statistical significance at $p < .001$.

Table 5
ONET and gender fatality descriptive statistics, coefficient alphas, and bivariate correlations.

Variables	Mean	SD	Scale	1	2	3	4	5	6	7	8
(1) Fatality relative risk ratio	4.20	5.17	–	–							
(2) Percentage of female workers	31.28	27.60	–	.15*	–						
(3) Total number of workers	550.47	690.44	–	0.04	.36**	–					
(4) Safety risk	2.83	0.91	1–5	−.26**	−.67**	−.24**	(.91)				
(5) Physicality	2.72	0.38	1–5	−.18*	−.38**	−0.08	.80**	(.72)			
(6) Technical	2.07	0.68	1–5	−.19**	−.67**	−.26**	.75**	.45**	(.96)		
(7) Social – supervisory	2.93	0.51	1–5	.24**	.22**	0.02	−.33**	−.35**	−.23**	(.96)	
(8) Social – nurture	3.37	0.58	1–5	.20**	.72**	.29**	−.59**	−.32**	−.56**	.57**	(.87)

Note: Higher relative risk ratios indicate greater risk of fatality for male workers as compared to female workers for a given occupation. SD = standard deviation. Cronbach's alpha on the diagonal.
* Indicates statistical significance at $p < .05$.
** Indicates statistical significance at $p < .01$.

relative risk ratios (1287 fatalities out of a total of 4628 fatalities in 2012). This seems to indicate at least trend-level data in a direction counter to what we would expect given a simple overrepresentation argument. Mere exposure certainly drives occupational fatalities; however, with regards to different observed frequencies between male and female workers' fatalities, it would seem that this is not a completely sufficient explanatory mechanism from the current data.

It is also important to note differences between the findings for the Major Group occupations and the Broad and Detail occupations. Although a glance at the Major Group findings alone would suggest that nearly all occupations have at least some degree of disproportionate fatality risk for male workers, clearly the results from the Broad and Detail occupations suggest otherwise. It is important to view these differences from a specificity lens; that is, estimates for number of workers and fatalities become prone to more error at greater levels of specificity (e.g., more specific job codes). A possible takeaway is that, although there is evidence across most jobs that some level of heightened male fatality risk exists, it may be that a few specific occupations are driving these results and thus result in overestimation of the risk in other similarly grouped occupations. For example, the transportation and material moving occupations (53-0000) had a relative risk ratio of 3.97 and a fatality discrepancy of 880 deaths. The results for driver/sales workers and truck drivers (53-3030) indicate a relative risk ratio of 1.52 and a fatality discrepancy of 255, with total fatalities from this job code comprising 62.7% of the total fatalities for the transportation Major Group. Great care should be taken when

Table 6
Relative weights output for the fatality odds ratios.

	Raw weights	% of total R^2	LB CI	UB CI
Control variables				
Total number of workers	.00	0.5	−0.017	0.013
Percentage of female workers	.01	5.1	−0.016	0.020
Predictor variables				
Safety risk	.03	28.5	0.005	0.072
Physicality	.01	10.7	−0.015	0.035
Technical	.01	12.4	−0.001	0.035
Social – supervisory	.03	33.1	0.001	0.107
Social – nurture	.01	9.8	−0.004	0.043
Total R^2	.10	100		

Note: CI = confidence Intervals. LB = lower bound; UB = upper bound.
CI's that do not contain zero are statistically significant at $p < .05$.

Table 7
Final cluster centers for 3-cluster solution.

O*NET variables	Masculine cluster	Neutral cluster	Feminine cluster
Safety risk	3.73	2.64	1.70
Physicality	2.95	2.81	2.30
Technical	2.71	1.80	1.40
Social – supervisory	2.68	3.00	3.22
Social – nurture	2.90	3.64	3.79
Total # of cases per cluster	77	55	52

Table 8
Relative risk and percent women cluster means.

	Masculine cluster	Neutral cluster	Feminine cluster
Relative risk ratio	2.86_a	4.37_b	6.02_a
Percent women in occupation	7.87_{ab}	42.45_a	49.41_b

Note: $_{a,b}$Numbers that share a letter significantly differ at $p < .05$ in a paired difference test.

interpreting the Major Group results out of context, as certainly jobs within these codes vary greatly with respect to risk and gender composition.

In laying foundational work for a gender theory approach to men's fatality disparities, results obtained using Sample 2 provide strong yet surprising support. With the general trend of male deaths and men's fatality disparities leaning heavily towards the more physical, risky, and masculine occupations, we expected similar findings in these results when predicting variance in the relative risk ratios (that is, that the masculine O*NET variables would be *positively* associated with relative risk ratios). However, the results from the second sample and exploratory analyses seem to indicate greater fatality risk for men in feminine occupations. Across job groupings in our analytical subset, as men's fatality ratios increased in the numerator and incrementally outweighed women's fatality ratios in the denominator (i.e., given sex representation, as men's risk for fatal occupational injuries increased), job characteristics overall tended more towards traditionally feminine occupations (e.g., interpersonal relationships, interaction with others) and further away from traditionally masculine occupations (e.g., safety risk, technical skills). As one example, the social and Human Service Assistants occupation had 77.5% female workforce in 2012, which had lower than average safety risk and technical skill requirements but a relative risk ratio of 6.73. Comparatively, electrical power line installers and repairers had less than 2% female workface for the same year and exceptionally high safety risk and technical skill requirements, yet a relative risk ratio of only 1.28. These examples serve to further illustrate that, while masculine occupations may have a greater number of total occupational fatalities, based on the proportions of male and female workers and male and female fatalities, men in feminine occupations in 2012 were at more risk for occupational fatalities when compared to women working under the same occupational title.

As such, these results suggest that men's fatality risk (when taking sex representation into account) is higher in traditionally feminine jobs. We interpret these unexpected trends through a gendered perspective. Several qualitative exploratory studies found that men working in a "feminine" job are more likely than women in the same job to take on physically demanding tasks in an effort to cognitively restructure the feminine job to more closely align with their own masculine identity (Cross and Bagihole, 2002; Shen-Miller et al., 2010; Williams, 1993). Perhaps it could be argued that men in feminine occupations take on more risk as a way of establishing and sustaining this identity. Certainly there are a greater raw number of fatalities in jobs that have a high safety risk (e.g., "masculine" jobs), and in addition, in our results for the Broad and Detail occupations, we did see that some jobs that would be categorized as more "masculine" had larger relative risk ratios, however, the extent to which men appear to be disproportionally at risk for fatal occupational injuries in traditionally feminine is an area of research which requires more detailed investigation. An example is measuring individuals' perceptions of gender norms in their occupations, along with their personal gender role ideologies and testing these as predictors of subsequent risky work behaviors and workplace injuries. From a practical perspective, we encourage managers to be cognizant of the workload distribution in traditionally feminine jobs, so men working in these occupations are not being asked to overtax themselves. Work redesign might be necessary to protect men's well-being in these jobs.

This study is not without limitations. One is the fact that we were only able to include 152 of 242 possible occupational titles due to limitations of the BLS data. However, as mentioned, this included 87% of the total US occupational fatalities in 2012. Another is statistical – that is, we had to substitute a value of 0.5 in order to calculate risk ratios (see Yarnold, 1970 for a discussion on small cell frequencies and chi-square tests). There were many occupations for which women had no fatalities, and a few for men. Although rigorous multi-level perceptual data (e.g., workers' conformity to masculine ideology), along with other data sources, is needed to fully address the role of gender in explaining potential occupational fatality discrepancies, the present research offers some foundational work in addressing this gendered hypothesis through a preliminary investigation of gender-based characteristics that are distinctive of traditionally masculine and feminine occupations, and the degree to which these characteristics may or may not explain variance in male fatality disparities across various occupational groups.

The O*NET database is also not without limitations. For one, the O*NET data only varies between occupations and not within occupations. Therefore, we may have missed some within-occupation variance on our O*NET variables. Additionally, some may question the construct validity of the measures derived from the database, particularly those that were measured using a single item. However, we selected scales and items for inclusion carefully, and notably we did find good reliability coefficients for all multi-item scales. Finally, the O*NET data, similar to the census of fatal occupational injuries database, contains data on U.S. occupations only. The extent to which these results generalize to non-U.S. contexts is unknown.

As previously stated, data on percent of women was unavailable for occupations with less than 50,000 workers. This was somewhat problematic from an analytical and theoretical perspective, as a great deal of the most hazardous occupations do not employ many people (e.g., mine shuttle car operators at 1000 workers, signal and track switch repairers, 5000, or wood sawing machine operators, 30,000). The data from the women in the labor force codebook is obtained from the BLS Current Population Survey (CPS), and while the exact methodology for this monthly data collection, including collection, sampling, and weighting strategies, is included in much greater detail elsewhere (http://www.census.gov/cps/), it is worthwhile to mention that linking participants' oral accounts of job descriptions to SOC codes can be an error-prone, arduous task. For example, often job titles vary with respect to region, industry, and workplace even within the same set of job tasks. It is also worth mentioning that, for multiple jobholders, the CPS provides information only on the job that participants work the greatest number of hours. Lastly, and perhaps the biggest limitation of using O*NET and BLS data, is that exposure, risk, fatalities, and gendered phenomena can vary dramatically dependent on a variety of factors that were not investigated in this study, and it should be interpreted with caution that not all individuals who share an SOC job title also share the same exact degree of fatality risk.

Finally, it is worth mentioning the number of occupational titles in which there were zero female fatalities. While we selected fatalities over injuries due to the clearly binary condition of onset, fatalities are quite low frequency statistically speaking. In cases in which there is a significant relative risk ratio and zero female fatalities, we interpret the finding as such: given the number of workers, percent of women, and male and female fatalities in this occupation, we would *reasonably* expect more female fatalities or less male fatalities than are being observed. A re-examination of the Broad and Detail Group results gives us 106 occupational titles in which there were no observed female deaths. Of these 106 occupational titles, only 24 had significant relative risk ratios, accounting for 476 of the 1288 observed – expected fatalities, or 37%. While this is a sizable portion of the occupations in this table, occupations with female fatalities still comprise a large proportion of this fatality discrepancy. Future research should investigate these trends longitudinally so that a finer, more precise analysis may be afforded.

9. Conclusion

This study is a first attempt to empirically highlight the scope of men's workplace fatality disparities and probe possible explanatory mechanisms, challenging the popular over-representation explanation for such disparities. Our results indicate that across a wide variety of occupations, men appear to be at increased risk for occupational fatalities when compared to women in the same occupations, and that this may be especially true for men in traditionally feminine jobs. Based on our results, we advocate for future research explicitly investigating the role of gender roles and norms as explanatory mechanisms for injury and fatality discrepancies between male and female workers.

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References

Bauerle, T.J., Magley, V.J., 2012. Accident risk at work: using the O*NET database to construct a unidimensional factor of occupational risk for workplace accidents. In: Paper Presented at The Bi-annual Meeting for the European Academy of Occupational Health Psychology Conference, Zurich, Switzerland.

Bem, S.L., 1974. The measurement of psychological androgyny. J. Consulting Clin. Psychol. 42, 155–162.

Blueprint for Men's Health Advisory Board (n.d.). Blueprint for men's health: a guide to a healthy lifestyle. Men's Health Network Library. Retrieved from http://www.menshealthnetwork.org/library/blueprint.pdf.

Bonhomme, J.J., 2007. Men's health: impact on women, children and society. J. Men's Health Gender 4 (2), 124–130.

Breslin, F.C., Polzer, J., MacEachen, E., Morrongiello, B., Shannon, H., 2007. Workplace injury or "part of the job"?: towards a gendered understanding of injuries and complaints among young workers. Social Sci. Med. 67, 782–793.

Costello, A.B., Osborne, J.W., 2005. Best practices in exploratory factor analysis: four recommendations for getting the most from your analysis. Pract. Assessment, Res. Eval. 10 (7), 1–9.

Courtenay, W.H., 2000. Constructions of masculinity and their influence on men's well-being: a theory of gender and health. Social Sci. Med. 50 (10), 1385–1401.

Courtenay, W.H., 2011. Dying to be Men: Psychosocial, Environmental, and Biobehavioral Directions in Promoting the Health of Men and Boys. Routledge, New York.

Cross, S., Bagihole, B., 2002. Girls' jobs for the boys? men, masculinity and non-traditional occupations. Gender, Work Organization 9 (2), 204–226.

Dodson, D.C., 2007. Men's health compared with women's health in the 21st century USA. J. Men's Health Gender 4 (2), 121–123.

Farrell, W., 2001. The Myth of Male Power: Why Men are The Disposable Sex. Berkley Books, New York, NY.

Ford, M.T., Tetrick, L.E., 2011. Relations among occupational hazards, attitudes, and safety performance. J. Occup. Health Psychol. 16, 48–66.

Frone, R.M., 1998. Predictors of work injuries among employed adolescents. J. Appl. Psychol. 83 (4), 565–576.

Gregory, C., 2006. Among the dockhands: another look at working-class male culture. Men Masculinities 9 (2), 252–260.

Holland, J.L., 1973. Making Vocational Choices: A Theory of Careers. Prentice-Hall, Englewood Cliffs.

Hooftman, W.E., van der Beek, A.J., Bongers, P.M., van Mechelen, W., 2005. Gender differences in self-reported physical and psychosocial exposures in jobs with both female and male workers. J. Occup. Environ. Med. 47 (3), 244–252.

Hopkins, W.G., 2010. Linear models and effect magnitudes for research: clinical and practical applications. Sport Sci. 14, 49–57.

Iacuone, D., 2005. "Real men are tough guys": hegemonic masculinity and safety in the construction industry. J. Men's Stud. 13 (2), 247–266.

Johnson, J.W., 2000. A heuristic method for estimating the relative weight of predictor variables in multiple regression. Multivariate Behav. Res. 35, 1–19.

Kerber, L.K., 1988. Separate spheres, female worlds, woman's place: the rhetoric of women's history. J. Am. History 75, 9–39.

Krantz, L., 2002. Jobs Rated Almanac. Barricade Books, Fort Lee.

LeBreton, J.M., Tonidandel, S., 2008. Multivariate relative importance: extending relative weight analysis to multivariate criterion spaces. J. Appl. Psychol. 93, 329–345.

Lee, C., Owens, R.G., 2002. The Psychology of Men's Health. Open University Press, Buckingham.

Mariana, M., 1999. Replace with a database: O*NET replaces the dictionary of occupational titles. Occupational Outlook Quarterly Online, vol. 43 (1). Spring, 1999, pp. 3–9. Accessed from <http://www.bls.gov/careeroutlook/1999/Spring/art01.pdf>.

McGonagle, A.K., Fisher, G.G., Barnes-Farrell, J.L., Grosch, J.W., 2015. Individual and work factors related to perceived work ability and labor force outcomes. J. Appl. Psychol. 100, 376–398. http://dx.doi.org/10.1037/a0037974.

O'Neil, J.M., 2008. Summarizing 25 years of research on men's gender role conflict using the gender role conflict scale: new research paradigms and clinical implications. Counseling Psychologist 36 (3), 358–445.

Peak, T., Gast, J., Ahlstrom, D., 2010. A needs assessment of Latino men's health concerns. Am. J. Men's Health 4 (1), 22–32.

Powell, G.N., 1999. Handbook of Gender and Work. Sage, Thousand Oaks.

Robertson, S., 2007. Understanding Men's Health: Masculinity, Identity, and Well-being. Open University Press, New York, NY.

Shen-Miller, D.S., Olson, D., Boling, T., 2010. Masculinity in nontraditional occupations: ecological constructions. Am. J. Men's Health, pp. 1–12. Published online at <http://jmh.sagepub.com>.

Tonidandel, S., LeBreton, J.M., 2011. Relative importance analysis: a useful supplement to regression analysis. J. Business Psychol. 26, 1–9.

US Department of Labor, Bureau of Labor Statistics, 2008. Fatal occupational injuries by worker characteristics and event or exposure, 2008 Census of Fatal Occupational Injuries. Retrieved from <http://stats.bls.gov/iif/oshwc/cfoi/cftb0238.pdf>.

US Department of Labor, Bureau of Labor Statistics, 2010. Employment and Earnings, April 2010 Averages. Retrieved from <http://www.bls.gov/opub/ee/empearn201004.pdf>.

Wilkins, D., 2005. "Getting it sorted": identifying and implementing practical solutions to men's health. J. Men's Health Gender 2 (1), 13–16.

Williams, C., 1993. Doing 'Women's Work': Men in Nontraditional Occupations. Sage Publications, Thousand Oaks, CA.

Yarnold, J.K., 1970. The minimum expectation in χ^2 goodness of fit tests and the accuracy of approximations for the null distribution. J. Am. Stat. Assoc. 65 (330), 864–886.

Yates, F., 1934. Contingency table involving small numbers and the χ^2 test. Suppl. J. R. Stat. Soc. 1, 217–235.