Secondary Injuries among U.S. Workers with Disabilities

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List of Terms and Abbreviations

ACS = American Community Survey
CI = Confidence Intervals
MEPS = Medical Expenditure Panel Survey
NCHS = National Center for Health Statistics
NESARC = National Epidemiologic Survey on Alcohol and Related Conditions
NHIS = National Health Interview Survey
ICF= International Classification of Functioning, Disability, and Health
ICD-9-CM = International Classification of Disease, Ninth Revision, Clinical Modification
OR= Odds Ratio
AOR = Adjusted Odds Ratio
RR = Relative Risk
PR = Prevalence Ratio
PSU = Primary Sampling Units
SE= Standard Error

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Final Project Abstract

Background: Occupational injury research and safety training for U.S. workers with disabilities is limited, despite the fact that 4.5-8.5 million U.S. adults (ages 16-64 years) with disabilities are employed and this number is expected to increase as the workforce ages. Many workers with disabilities are employed in the most hazardous sectors of the workforce, including agriculture, construction, and services. Because of physical impairments and functional limitations, workers with disabilities may face special occupational safety issues that need to be addressed. It is widely recognized by both researchers and NIOSH that significant gaps still exist in our knowledge about occupational injuries that U.S. workers with disabilities suffer.

Methods: This research project investigated nonfatal occupational and non-occupational injuries among U.S. workers with disabilities. We used two national representative survey data: 1997-2011 National Health Interview Survey (NHIS) and 2004-2011 Medical Expenditure Panel Survey (MEPS, Panels 9-15). The NHIS data were used to compare prevelance, odds ratio (OR), and characteristics of nonfatal occupational and non-occupational injuries between workers with and without disabilities (Specific Aim 1 & 2). The MEPS data were used to study medical expenditures of nonfatal occupational injuries and to describe potential differences between workers with and without disabilities in medical utilization and expenditures (Specific Aims 3). We also conducted a systematic meta-analysis to synthesize published studies about association between pre-exiting disability and occupational and non-occupational injuries in adults.

Results: Workers with disability were significantly more likely than other workers to suffer occupational injuries (OR=2.39; 95% CI=1.89-3.01) and non-occupational injuries (OR=2.35; 95% CI=2.04-2.71). The 2-year cumulative incidence of occupational injuries was 13.6% (95%CI: 11.6%-15.6%) in workers with persistent disabilities and 7.1% (95%CI: 6.8%-7.4%) in workers without persistent disabilities. Annual rates of occupational and nonoccupational injuries were 6.0 and 16.4 per 100 workers with disabilities and 2.3 and 6.4 per 100 workers without disabilities. Overexertion or strenuous movements and falls accounted for 56.7% of all occupational injuries in workers with disabilities, compared with 45.6% in workers without disability. Workers with disabilities were more frequently injured in the lower extremity (32.3% versus 26.6%) or torso (22.9% versus 16.9%). The average medical expenditure associated with new occupational injuries in the 2-year MEPS reference period was $3778 in workers with disabilities, $2212 in workers without disabilities after adjusting for sociodemographics and medical insurance coverage status (in 2011 U.S. dollars, *P=0.0004*). Of the total expenditures for occupational injuries, Workers' Compensation paid 54.6% for workers with disabilities and 58.9% for workers without disabilities. There were no significant differences in the expenditures

across types of medical services sought by the two groups of workers. Meta-analysis of 11 published studies indicates that workers with disabilities had a significantly elevated OR of occupational injuries (OR=1.62; 95% CI=1.24-2.13).

Conclusions: Workers with disabilities are at significently elevated risk of occupational injuries. These injuries are more sever and average medical care expenditure is significantly higher than injuries suffered by workers with disabilities. Our systematic literature review found limited injury prevantion efforts in the U.S. that target workers with disablities.

SECTION 1

Highlights/Significant Findings

- According to the 2006-2010 National Health Interview Survey (NHIS), rates of nonoccupational and occupational injuries were 16.4 and 6.0 per 100 workers per year for workers with disabilities and 6.4 and 2.3 per 100 workers per year for workers without disabilities, respectively. After controlling for confounding variables in the multivariable logistic regression models, workers with disabilities had more than twice the rate of nonoccupational injuries (adjusted odds ratio [AOR] = 2.35; 95% CI = 2.04, 2.71) and occupational injuries (AOR = 2.39; 95% CI = 1.89, 3.01) compared with workers without disabilities.

- According to the 1997-2011 National Health Interview Survey (NHIS), overexertion or strenuous movements and falls accounted for 56.7% of all occupational injuries in workers with disabilities, compared with 45.6% in workers without a disability. Workers with disabilities were more frequently injured in the lower extremity (32.3% versus 26.6%) or torso (22.9% versus 16.9%).

- Overall, the majority of occupational injuries were minor, with only about 2% of injuries requiring hospitalization and over 90% of injuries with a New Injury Severity Score (NISS) less than 5 (minor injuries: NISS=1-14; moderate injuries: NISS=14-24; severe injuries, NISS=25~75).

- According to the 1997-2011 National Health Interview Survey (NHIS), 3-month occupational injury prevalence dropped for both workers with and without disabilities.

- According to the 2004-2011 medical Expenditure Panel Survey (MEPS), the average medical expenditure associated with new occupational injuries in the 2-year MEPS reference period was $3778 in workers with disabilities, $2212 in workers without disabilities after adjusting for sociodemographics and medical insurance coverage status (in 2011 U.S. dollars, *P=0.0004*).

- Of the total expenditures for occupational injuries, workers' compensation paid 54.6% for workers with disabilities and 58.9% for workers without disabilities.

- There were no significant differences in the expenditures across types of medical services sought by the two groups of workers.

- Meta-analysis results found that the pooled OR was 1.62 (95% CI: 1.24-2.13; $p<0.001$) for occupational injuries and 1.91 (95% CI: 1.59-2.30; $p<0.001$) in studies that compared workers with and without disabilities.

Translation of Findings

- In 2010, Dr. Huiyun Xiang served as an injury expert in the U.S. Department of Health and Human Services' Healthy People 2020 Initiative for the Disability and Health Workgroup. As a member of the committee, he collaborated with other experts to propose a new Healthy People 2020 Objective (DH-19, Developmental) to reduce health disparities and address some of the health issues facing individuals with disabilities who have suffered nonfatal unintentional injuries. Upon review, the committee's proposed objective has been accepted, and a new Healthy People 2020 Objective of reducing injuries among individuals with disabilities has officially been approved. More information can be found about this new Healthy People 2020 Objective at http://www.healthypeople.gov/2020/topicsobjectives2020/objectiveslist.aspx?topicid=9

- The World Health Organization and the World Bank released its first-ever World Report on Disability in 2011. It features Dr. Xiang's scientific publications about injuries among individuals with disabilities and provides a concrete set of recommended actions for government and their partners (http://www.who.int/disabilities/world_report/2011/en/).

Outcomes/Relevance/Impact

As the average life expectancy of the U.S. population continues to increase, the number of working-age adults with disabilities is also expected to rise. This will result in a relatively high pre-existing disability rate, making these individuals more susceptible to both occupational and non-occupational injuries. The development of evidence-based policies and injury prevention programs will be necessary to address these occupational health and safety concerns among U.S. working-age adults with disabilities. Without scientific evidence, it will be difficult to develop adequate evidence-based policies and intervention programs for this special-needs population.

Results and findings of our study are *significant* because they provided answers to several fundamental questions about the risks, patterns, and medical costs of occupational injuries in U.S. workers with disabilities.

Our research promotes the NIOSH mission to address occupational safety and health disparities in special populations and addresses several sections of Healthy People 2010 (Section 20.2: to reduce work-related injuries, resulting medical treatment, lost time from work, or restricted work activities; Section 6: To promote the health of people with disabilities, prevent secondary conditions, and eliminate disparities between people with and without disabilities). Findings from this study have the potential to translate into better evidence-based policies and safety programs that will promote work safety and health among working-age adults with disabilities in the United States.

SECTION 2 - **Scientific Report**

Background

In the United States, persons with disabilities constitute 12.0% of the population.[1] Both the World Health Organization and U.S. Surgeon General have released reports addressing disparities in health of persons with disabilities.[2, 3] These reports identify community participation and health promotion as societal priorities. According to the 2008 American Community Survey, about 4.6 million adults aged 16-64 years with disabilities are employed in the U.S., and the number of workers with disabilities is expected to increase in the coming years as the workforce ages.[4] A public health concern is that workers with disabilities may be at high risk of occupational injuries.[5-8] Reducing the proportion of individuals with disabilities who report non-fatal injuries is among U.S. Healthy People 2020 objectives.[9]

A number of studies have shown that adults with disabilities are more vulnerable to injuries than non-disabled adults.[10-14] Studies using nationally representative datasets have found that the odds of injury increased with increasing severity of disability[10, 12] and with the number of disabilities.[13] The settings and external causes of these injuries differed between individuals with and without disabilities.[11, 12] Falls, for example, were a leading mechanism of injury reported more frequently among those with disabilities.[10-12]

Occupational injuries among workers with disabilities have also been previously studied.[5, 15-19] A number of studies from the 1990s showed an elevated risk of injury among workers with disabilities.[5, 15-17, 19] However, much of the prior research examined only those with specific types of disabilities.[15-19] For example, older workers with poor hearing and poor vision were shown to have an elevated risk for occupational injuries.[17] In contrast, recent research based on workers compensation insurance claims found that workers with cognitive disabilities sustained fewer injuries and experienced fewer absences due to injury than workers without cognitive disabilities.[18]

Previous work has also been critiqued because of the conceptualization and definition of disability[5] and because environmental factors or work accommodations could not be taken into account.[20, 21] Zwerling and his colleagues found that approximately 12% of workers with impairments reported receiving some type of workplace accommodation.[22] Recent work by Leff, et al. has explored the role of environmental factors (e.g. societal attitudes, the natural environment, and policies) in the functioning and societal participation of people with disabilities.[14] Environmental factors were found to be independently associated with injury regardless of disability status. However, disability status remained a risk factor for injury though environmental factors attenuated the association. One current conceptualization of disability, the *International Classification of Functioning, Disability and Health* (ICF), emphasizes environmental factors and has been used in recent studies to evaluate injury risks of persons with disabilities.[10, 12, 23] The ICF defines disability as physical impairments, activity limitations, and participation restrictions that affect one's interaction with the physical and social environment.[24] However, the impact of this refined definition on the number of injuries to workers with disabilities has yet to be determined.

Previous studies have reported a higher prevalence of occupational injuries among workers with disability; however, to our knowledge no study has examined the characteristics of occupational injuries sustained by US workers with disabilities. Information on injury characteristics, such as demographic, causes of injury, places of injury, types of injury and the most vulnerable body regions, is necessary to develop evidence-based injury prevention programs. [25, 26]

In addition, we did not find any prior studies that examined differences between workers with and without disabilities in terms of the health care expenditures associated with occupational injuries. Some research suggests that people with disabilities have poorer health and access medical services more often than people without disabilities.[27, 28] Lysaught found that workers with cognitive disabilities had fewer injury-related workers' insurance claims reported than workers without cognitive disabilities.[18] Currently, it remains unknown if workers with disabilities spend more out-of-pocket or whether they receive less Workers' Compensation after an occupational injury compared with workers without disabilities.

The overarching goal of this research project is to study associations between pre-existing disabilities and secondary injuries and to investigate the medical costs and methods of payments among U.S. working-age adults with disabilities. The central hypotheses of the study are: **(1) that *working-age adults with disabilities are at a significantly higher risk for unintentional occupational and non-occupational injuries than working-age adults without disabilities, and (2) that the costs associated with medical care for these injuries are significantly higher among working-age adults with disabilities.*** Our hypotheses are based on previous studies of occupational injuries among older workers[29, 30] and strong preliminary data from our own research, in which we characterized non-occupational injury risks and patterns of injuries in U.S. children and adults with disabilities.[31-33]

We used the data from two large representative national surveys - the National Health Interview Survey (NHIS) and the Medical Expenditure Panel Survey (MEPS) to achieve three specific aims:

Specific Aim 1: To compare occupational injuries and non-occupational injuries among U.S. workers with and without disabilities.

Specific Aim 2: To compare characteristics of nonfatal occupational injuries among U.S. workers with and without disabilities.

Specific Aim 3: To examine medical expenditures associated with nonfatal occupational injuries among U.S. workers reporting persistent disabilities.

We also conducted a systematic review and meta-analysis to synthesize the evidence of previous studies on the association between pre-existing disability and unintentional injuries in adults with disabilities.

Study Methods and Results

1. Overall Study Design

This research project used two national propability sample survey data: National Health Interview Survey (NHIS) and Medical Expenditure Panel Survey (MEPS). The NHIS data were used to compare prevelance and characteristics of occupational injuries between U.S. workers with and without disabilities (Specific Aim 1 & 2). The MEPS data were used to compare medical expenditures associated with nonfatal occupational injuries among U.S. workers who reported persistent disabilities (Specific Aim 3). In addition, we searched 14 electronic databases to identify original studies published between January 1, 1990 and February 28, 2013 and conducted a meta-analysis to synthesize scientific evidence about association between pre-existing disability and increased risk of nonfatal injuries in adults with disabilities.

A total of five peer-reviewed journal articles were published. The following sections described the data sources, methods, and main findings of this research study.

2. Research Methods and Results for Aim 1 & 2

Specific Aim 1: To compare occupational injuries and non-occupational injuries among U.S. workers with and without disabilities.

Specific Aim 2: To compare characteristics of nonfatal occupational injuries among U.S. workers with and without disabilities.

2.1 Data Source

The National Health Interview Survey (NHIS), which is a survey of the civilian, non-institutionalized population administered by the US Census Bureau for the National Center for Health Statistics (NCHS). The NHIS uses a complex survey design involving stratification, clustering, and oversampling of certain populations (e.g., racial/ethnic minorities) to ensure a sufficient sample size of underrepresented groups. Sample weights provided by NCHS take into account the complex sampling design and non-response. The NHIS interviews are conducted year-round to eliminate seasonal influences on responses.

The NHIS uses computer assisted personal interviews to collect information on all members of selected households, who are at home at the time of the interview. For those who are not home at the time of the interview, information is provided by a knowledgeable adult family member residing in the household. The overall response rate for the survey years was approximately 84%. The last general revision of the NHIS occurred in 2006, so between the years 2006-2010 there were no major changes in the questionnaire or in the weighting structure. This allowed us to calculate nationally representative estimates using the combined multiple-year data. The NHIS is divided into sections depending on which respondent was being interviewed. In this study, we used the person file for demographics including disability information, the family file for personal income, the adult file for occupation, and the injury episode file for injury

characteristics. Results in our study were weighted so they represent national estimates for the U.S. civilian, non-institutionalized population.

2.2 Key Definitions

Identification of Workers

In the NHIS person file, questions were asked about adults aged 18 years or older, "What were you doing last week?" Adults were classified as "workers" if the respondent recorded either "working for pay at a job or business," or "with a job or business but not at work," or "working, but not for pay, at a family-owned job or business." This is the standard definition of a worker in the NHIS and other national surveys, such as the American Community Survey (ACS). We compared these responses to a similar question in the sample adult file to verify employment status of those respondents included in the adult sample survey. Only workers were included in this study.

Definition of Disability

Disability questions in the NHIS survey were based upon the disability classification of the World Health Organization's ICF.[24] Respondents were asked about physical impairments, activity limitations, and participation restrictions. The duration of disability was also asked. The specific disability questions in the NHIS included the following, "Are you limited in any way in any activities because of physical, mental, or emotional problems?" "Are you limited in any way because of difficulty remembering or because you experience periods of confusion?" "Are you limited in the kind OR amount of work you can do because of a physical, mental or emotional problem?" "Because of a health problem, do you have difficulty walking without using any special equipment?" "Because of a physical, mental, or emotional problem, do you need the help of other adults with PERSONAL CARE NEEDS, such as eating, bathing, dressing, or getting around inside the home?" and "Because of a physical, mental, or emotional problem, do you need the help of other adults with ROUTINE NEEDS, such as everyday household chores, doing necessary business, shopping, or getting around for other purposes?" Respondents were categorized as having a disability if they answered "yes" to any of these questions.
This classification of disability is consistent with the bio-psycho-social conceptual model of disability of the ICF and has been used in previous studies.[10, 34, 35] Because disability might be the result of an injury, only those workers who reported a disability prior to the three-month injury recall period were defined as workers with disabilities. This allowed us to investigate injuries among workers with pre-existing disabilities.

Definition of Injuries

The NHIS collects specific data about medically treated injuries that occurred during the 3 months prior to the interview. Interviews are conducted year-round, thereby eliminating seasonal influence. Details about the injury include diagnosis, cause of injury, and activity at the time of injury. Injury information is then verified and coded using the International Classification of Disease for the nature/ diagnosis (ICD-9 CM N code) and external cause (ICD-9 CM E code) of injuries. Each respondent was allowed to record up to 10 injury and poisoning episodes. Every injury occurrence reported by a respondent was counted as a separate injury episode. One injured person may have multiple injury episodes. Occupational injury cases were defined by the

response of “working at a paid job” to the question “what activity were you involved in at the time of the injury?” All other injuries were defined as non-occupational injury cases.

2.3 Statistical Analysis

Data analyses were conducted using SAS 9.2 (SAS Institute, Cary, NC). [36, 37] Our data analyses accounted for the complex survey design of the NHIS. Three SAS procedures were used to analyze the data: SURVEYFREQ, SURVEYMEANS, and SURVEYLOGISTIC. All these procedures incorporated the weight, cluster, and strata information provided in the NHIS public use data files.

To achieve **Specific Aim 1**, we calculated the 3-month injury rates (%) of non-occupational and occupational injuries to workers with and without disabilities by selected sociodemographic variables. Chi-square statistical analyses were conducted to determine if the 3-month injury rate (%) was significantly higher (p-value<0.05) among workers with disabilities than the rate among workers without disabilities. To control for confounding effects of sociodemographic variables on injury risk, two logistic regression models were fitted: one for non-occupational injuries and one for occupational injuries. We considered the following variables in the models: disability status, gender, age, marital status, race/ethnicity, education, occupation, hours worked in the previous week, self-employment, health insurance coverage, and nativity. We calculated adjusted odds ratios (AOR) and 95% confidence intervals (95% CI) of injuries by disability status controlling for sociodemographic variables and occupation (labor vs. non-labor occupation). Finally, we compared leading causes of non-occupational and occupational injuries by injured workers’ disability status.

To achieve **Specific Aim 2**, we translated the ICD-9-CM diagnosis code(s) into New Injury Severity Score (NISS) and entries of the Barell Diagnosis Injury Matrix by using a Stata program ICDPIC. [38] The Abbreviated Injury Scale (AIS) scores each individual injury by body region according to its relative severity on a 6 point scale. The NISS is defined as the sum of the squares of the AIS scores of each of a patient's three most severe AIS injuries regardless of the body region in which they occur. [39] The entries of the Barell matrix are combinations of injury body regions and nature of injury. [40] From these entries, we further extracted body region and nature of injury. Following procedures described in the Survey Description file, we calculated national estimates, weighted proportions (%), and 95% confidence intervals for the proportions, by demographic and other injury characteristics for workers with and without disabilities. The Chi-square test was used to compare rates and proportions.

2.4 Results

For **Specific Aim 1**, we used the 2006-2010 NHIS data. We excluded 490 workers from our analysis because their disability status was unknown (n=150) or the disability occurred during the study reference period (n=340). A total of 183,676 workers aged 18 and older from the 2006-2010 NHIS were included in our final analysis. Among the 175,947 workers without disabilities, 2,426 reported medically treated non-occupational injuries, 944 reported occupational injuries, and 25 workers reported both types of injury. Among the 7,729 workers

with disabilities, 274 reported non-occupational injuries, 101 reported occupational injuries, and 1 worker reported both types of injury in the three months prior to the interview.

Workers with disabilities had rates of 16.4 non-occupational and 6.0 occupational injuries per 100 workers per year compared to 6.4 and 2.3 for workers without disabilities.

Table 1. Three-month Rate (%) of Non-occupatonal Injuries among U.S. Workers by Disability Status, NHIS 2006-2010

	Without Disabilities			With Disabilities				
	Injured n	Weighted % Injured	95% CI	Injured n	Weighted % Injured	95% CI	Rate Ratio	*P* [§]
Total	2,426	1.5	(1.5 - 1.6)	274	3.9	(3.3 - 4.4)	2.5	<.0001
Gender								
Male	1,289	1.6	(1.5 - 1.6)	113	3.2	(2.6 - 3.8)	2.1	<.0001
Female	1,137	1.5	(1.4 - 1.6)	161	4.6	(3.8 - 5.3)	3.0	<.0001
Age (years)								
18-34	958	1.8	(1.7 - 1.9)	50	3.6	(2.6 - 4.6)	2.0	<.0001
35-54	1,053	1.4	(1.3 - 1.4)	135	4.0	(3.3 - 4.8)	3.0	<.0001
55+	415	1.5	(1.3 - 1.7)	89	3.8	(3.0 - 4.7)	2.6	<.0001
Marriage status								
Married	1,231	1.3	(1.2 - 1.4)	123	3.7	(3.0 - 4.4)	2.8	<.0001
Single/never married	768	1.9	(1.8 - 2.1)	59	3.5	(2.6 - 4.5)	1.8	<.0001
Seperated/divorced/widowed	422	1.9	(1.7 - 2.1)	92	4.6	(3.6 - 5.6)	2.4	<.0001
Race/ethnicity								
Non-Hispanic White	1,704	1.8	(1.7 - 1.9)	204	4.1	(3.5 - 4.7)	2.3	<.0001
Non-Hispanic Black	302	1.3	(1.2 - 1.5)	37	3.4	(2.1 - 4.6)	2.5	<.0001
Hispanic	304	0.8	(0.7 - 0.9)	21	2.5	(1.3 - 3.6)	3.0	<.0001
Others	116	1.0	(0.8 - 1.2)	12	*			
Education								
<12 years (no diploma)	189	1.1	(0.9 - 1.2)	19	2.4	(1.2 - 3.6)	2.2	0.002
High school graduate or GED	1,374	1.5	(1.5 - 1.6)	172	3.5	(3.0 - 4.0)	2.3	<.0001
Bachelors degree and above	848	1.8	(1.7 - 1.9)	81	5.7	(4.3 - 7.0)	3.2	<.0001
Occupation								
Non-labor-related	965	1.9	(1.8 - 2.1)	131	4.7	(3.8 - 5.6)	2.4	<.0001
Labor-related	198	1.5	(1.3 - 1.8)	28	3.1	(1.9 - 4.4)	2.1	0.001
Hours worked last week								
Part-time (1-31 hours)	474	1.9	(1.7 - 2.0)	95	3.8	(3.0 - 4.5)	2.0	<.0001
Full-time (32+ hours)	1,873	1.5	(1.4 - 1.6)	168	4.0	(3.3 - 4.7)	2.7	<.0001
Self-employment income								
Yes	335	1.7	(1.5 - 1.9)	56	4.9	(3.6 - 6.3)	2.9	<.0001
No	2,073	1.5	(1.5 - 1.6)	217	3.7	(3.1 - 4.2)	2.4	<.0001
Health insurance coverage								
Not covered	343	1.1	(1.0 - 1.3)	41	3.2	(2.2 - 4.2)	2.8	<.0001
Covered	2,071	1.6	(1.6 - 1.7)	232	4.0	(3.5 - 4.6)	2.5	<.0001
Born in US								
Born in US	2,128	1.7	(1.6 - 1.8)	259	4.1	(3.6 - 4.6)	2.4	<.0001
Not born in US	298	0.8	(0.7 - 0.9)	15	1.8	(0.7 - 2.9)	2.2	0.007

Note: 95% CI = 95% confidence intervals; GED = General Equivalency Diploma.

[§] *P* value from significance test comparing injury prevalence between workers with and without disabilities

*Unreliable estimate not shown (relative standard error greater than 0.30).

Table 2. Three-month Rate (%) of Occupatonal Injuries among U.S. Workers by Disability Status, NHIS 2006-2010

	Without Disabilities			With Disabilities				
	Injured n	Weighted % Injured	95% CI	Injured n	Weighted % Injured	95% CI	Rate Ratio	*P* [§]
Total	944	0.6	(0.5 - 0.6)	101	1.4	(1.1 - 1.6)	2.4	<.0001
Gender								
Male	613	0.7	(0.7 - 0.8)	57	1.5	(1.1 - 2.0)	2.1	<.0001
Female	331	0.4	(0.4 - 0.4)	44	1.2	(0.8 - 1.6)	3.0	<.0001
Age (years)								
18-34	366	0.7	(0.6 - 0.7)	22	1.6	(0.9 - 2.3)	2.4	<.0001
35-54	450	0.6	(0.5 - 0.6)	43	1.4	(1.0 - 1.8)	2.5	<.0001
55+	128	0.5	(0.4 - 0.6)	36	1.3	(0.9 - 1.7)	2.7	<.0001
Marriage status								
Married	493	0.5	(0.4 - 0.6)	47	1.3	(0.9 - 1.7)	2.6	<.0001
Single/never married	276	0.7	(0.6 - 0.8)	21	1.3	(0.7 - 1.9)	2.0	0.003
Seperated/divorced/widowed	175	0.7	(0.6 - 0.9)	32	1.6	(1.0 - 2.1)	2.1	<.0001
Race/ethnicity								
Non-Hispanic White	579	0.6	(0.5 - 0.6)	69	1.4	(1.0 - 1.7)	2.3	<.0001
Non-Hispanic Black	136	0.6	(0.5 - 0.7)	11	*			
Hispanic	194	0.5	(0.5 - 0.6)	17	2.1	(1.0 - 3.3)	3.9	<.0001
Others	35	0.3	(0.2 - 0.5)	4	*			
Education								
<12 years (no diploma)	132	0.6	(0.5 - 0.8)	11	*			
High school graduate or GED	649	0.7	(0.7 - 0.8)	74	1.6	(1.2 - 2.0)	2.2	<.0001
Bachelors degree and above	156	0.3	(0.3 - 0.4)	16	1.0	(0.5 - 1.6)	3.2	<.0001
Occupation								
Non-labor related	244	0.5	(0.4 - 0.5)	35	1.2	(0.8 - 1.5)	2.4	<.0001
Labor-related	184	1.3	(1.1 - 1.5)	21	2.4	(1.3 - 3.6)	1.9	0.011
Hours worked last week								
Part-time (1-31hrs)	121	0.4	(0.3 - 0.5)	34	1.4	(0.9 - 1.8)	3.1	<.0001
Full-time (32+hrs)	802	0.6	(0.6 - 0.7)	64	1.4	(1.0 - 1.8)	2.3	<.0001
Self-employment income								
Yes	97	0.5	(0.4 - 0.6)	11	*			
No	842	0.6	(0.5 - 0.6)	90	1.5	(1.1 - 1.8)	2.5	<.0001
Health insurance coverage								
Not covered	196	0.7	(0.6 - 0.8)	20	1.5	(0.8 - 2.3)	2.3	0.002
Covered	746	0.6	(0.5 - 0.6)	81	1.4	(1.1 - 1.6)	2.4	<.0001
Born in US								
Born in US	770	0.6	(0.6 - 0.7)	92	1.4	(1.1 - 1.7)	2.3	<.0001
Not born in US	174	0.4	(0.4 - 0.5)	9	1.1	(0.3 - 1.9)	2.6	0.010

Note: 95% CI = 95% confidence intervals; GED = General Equivalency Diploma.

[§] *P* value from significance test comparing injury prevalence between workers with and without disabilities

*Unreliable estimate not shown (relative standard error greater than 0.30).

Table 3. Multivariate Logistic Regression Models of Non-occupational Injuries and Occupational Injuries in Past Three Months among U.S. Workers, NHIS 2006-2010

	Non-occupational Injuries		Occupational Injuries	
	AOR	95% CI	AOR	95% CI
Disability status				
Workers without disabilities (Ref)	1.00		1.00	
Workers with disabilities	2.35	(2.04 - 2.71)	2.39	(1.89 - 3.01)
Gender				
Female (Ref)	1.00		1.00	
Male	1.09	(1.00 - 1.19)	1.60	(1.37 - 1.86)
Age (year)				
35-54 (Ref)	1.00		1.00	
18-34	1.26	(1.12 - 1.41)	1.19	(1.00 - 1.42)
55+	0.98	(0.86 - 1.12)	0.88	(0.72 - 1.07)
Marriage status				
Married (Ref)	1.00		1.00	
Single/never married	1.33	(1.17 - 1.52)	1.14	(0.94 - 1.38)
Seperated/divorced/widowed	1.48	(1.30 - 1.68)	1.39	(1.13 - 1.70)
Race/ethnicity				
Non-Hispanic White (Ref)	1.00		1.00	
Non-Hispanic Black	0.77	(0.66 - 0.88)	0.99	(0.82 - 1.20)
Hispanic	0.66	(0.54 - 0.80)	0.96	(0.76 - 1.22)
Others	0.76	(0.59 - 0.96)	0.81	(0.47 - 1.39)
Education				
Bachelors degree and above (Ref)	1.00		1.00	
High school graduate or GED	0.83	(0.75 - 0.91)	1.93	(1.57 - 2.37)
<12 years (no high school diploma)	0.75	(0.62 - 0.91)	1.67	(1.25 - 2.24)
Occupation				
Non-labor-related (Ref)	1.00		1.00	
Labor-related	0.84	(0.70 - 1.00)	1.89	(1.52 - 2.36)
Unknown	0.79	(0.73 - 0.87)	1.11	(0.94 - 1.31)
Hours worked last week				
Full-time (32+ hours) (Ref)	1.00		1.00	
Part-time (1-31 hours)	1.16	(1.04 - 1.30)	0.78	(0.61 - 0.98)
Self-employment income				
No (Ref)	1.00		1.00	
Yes	1.18	(1.05 - 1.34)	0.91	(0.71 - 1.17)
Health insurance coverage				
Covered (Ref)	1.00		1.00	
Not covered	0.76	(0.66 - 0.87)	1.00	(0.82 - 1.22)
Born in US				
Born in US (Ref)	1.00		1.00	
Not born in US	0.65	(0.54 - 0.78)	0.74	(0.57 - 0.96)

Note: AOR = adjusted odds ratio; 95% CI = 95% confidence intervals. AORs were obtained from logistic regression analyses with all the variables in the table included in the models.

Tables 1 and 2 show the 3-month rates of medically attended non-occupational and occupational injuries to workers with and without disabilities by select sociodemographic characteristics. Overall, the rate of non-occupational injuries among workers without disabilities was 1.5% (95% CI =1.5%-1.6%) compared with 3.9% (95% CI=3.3%-4.4%) among workers with disabilities, yielding a rate ratio of 2.5 (P<0.001). The rate of occupational injuries among workers without disabilities was 0.6% (95% CI =0.5%-0.6%) compared with 1.4% (95% CI =1.1%-1.6%) among workers with disabilities, with a similar rate ratio of 2.4 (P <0.001). This rate ratio was generally consistent across the sociodemographic variables.

Table 3 presents the adjusted odds ratios and 95% CIs of non-occupational and occupational injuries from the logistic regression models. Only the variables listed in Table 4 were considered for inclusion in the models. Each of these variables was statistically significant in the univariate models with the following exceptions. Gender was not significant in the univariate model for non-occupational injuries; race/ethnicity and self-employment income were not significant in the univariate models for occupational injuries. All variables were included in the final multivariable models. The adjusted OR for workers with disabilities was 2.35 (95% CI=2.04-2.71) for non-occupational injuries and 2.39 (95% CI=1.89-3.01) for occupational injuries compared with workers without disabilities. Those with significantly higher odds of occupational injury included: male workers; workers who were separated, divorced, or widowed; and workers born in the U.S. Workers in labor-related employment sectors had a significantly higher adjusted OR=1.89 (95% CI=1.52-2.36) of occupational injuries compared with workers in non-labor sectors. Low education level was a significant risk factor for occupational injuries but not for non-occupational injuries. Among all variables examined in the logistic regression models, disability status was the variable with the highest adjusted OR for non-occupational and occupational injuries.

For **Specific Aim 2**, we used the 1997-2011 NHIS data. Our analysis included 633,710 workers ≥18 years who met the study's inclusion criteria. Of the 633,710 workers, 4,105 workers reported 4,203 occupational injuries during the survey reference period. Among the 604,134 workers without disabilities, 3,678 workers reported 3,757 medically treated occupational injuries, with a three month incidence of 0.62 injuries per 100 workers. Among the 29,576 workers with disabilities, 427 workers reported 446 occupational injuries, translating into a three month incidence of 1.51 injuries per 100 workers. The difference between these two rates is statistically significant (p<0.0001). The prevalence for workers with disabilities decreased by 34% (the average in the period of 2006-2011 compared with the average in 1997-2001), while for workers without disabilities the prevalence decreased by 25%.

Results in Table 4 indicate that occupational injuries to workers with disabilities tended to be slightly more severe than injuries to workers without disabilities. Workers with a disability who sustained an occupational injury tended to miss more work days and a higher proportion of their injuries were in a higher NISS group. Overall, however, the majority of injuries were minor, with only about 2% of injuries requiring hospitalization and over 90% of injuries with a NISS less than 5.

Table 4. Characteristics of the occupational injuries sustained by US workers with and without disabilities, NHIS 1997-2011

	Without Disabilities				With Disabilities				
	Sample n	National estimate [a]	Weighted % [a]	95% CI	Sample n	National estimate [a]	Weighted % [a]	95% CI	P value [b]
Total	3,757	833,833			446	99,217			
Hospitalized									0.9297
Yes	88	17,654	2.1	(1.6 - 2.6)	14	2,212	2.2	(1.0 - 3.5)	
No	3,663	814,678	97.7	(97.2 - 98.2)	431	96,751	97.5	(96.2 - 98.9)	
Days of work missed									<0.0001
None	1,588	362,794	43.9	(42.2 - 45.6)	137	29,458	30.0	(25.3 - 34.6)	
Less than one day	431	98,287	11.9	(10.7 - 13.1)	51	10,386	10.6	(7.5 - 13.6)	
One to five days	1,002	219,169	26.5	(24.9 - 28.1)	131	32,917	33.5	(28.2 - 38.8)	
Six or more days	698	144,177	17.4	(16.2 - 18.7)	121	25,172	25.6	(21.4 - 29.8)	
Injury severity									<0.0001
NISS 1	2,549	564,655	72.8	(71.2 - 74.4)	260	57,685	63.0	(58.1 - 67.9)	
NISS 2-4	812	178,308	23.0	(21.5 - 24.4)	119	26,750	29.2	(24.6 - 33.8)	
NISS 5-75	143	32,807	4.2	(3.5 - 5.0)	32	7,148	7.8	(5.5 - 10.1)	
Location where injured									<0.0001
Shopping center, restaurant, store, bank, gas station, or other place of business	571	127,143	15.2	(14.0 - 16.5)	93	21,902	22.1	(17.3 - 26.8)	0.0020
Industrial or construction area	1,015	226,989	27.2	(25.7 - 28.8)	92	18,883	19.0	(15.1 - 23.0)	0.0038
Health care facility (include hospital)	173	37,879	4.5	(3.9 - 5.2)	37	7,985	8.0	(5.6 - 10.5)	0.0007
Other public building	292	67,530	8.1	(7.1 - 9.1)	35	7,096	7.2	(4.5 - 9.8)	0.9552
Home (outside)	166	36,251	4.3	(3.7 - 5.0)	24	5,047	5.1	(3.1 - 7.0)	0.3548
Other locations [c]	1,540	338,041	40.5	(38.8 - 42.3)	165	38,304	38.6	(33.7 - 43.5)	
Cause of injury									0.0002
Overexertion/strenuous movements	932	206,180	24.7	(23.2 - 26.2)	132	29,382	29.6	(24.8 - 34.5)	0.0279
Fall	811	174,600	20.9	(19.4 - 22.4)	120	26,847	27.1	(22.5 - 31.6)	0.0105
Struck by object or person	485	106,818	12.8	(11.6 - 14.0)	61	13,824	13.9	(10.4 - 17.4)	0.6484
Cut/pierce	534	123,742	14.8	(13.6 - 16.0)	38	8,635	8.7	(5.9 - 11.5)	0.0009
Transportation	131	27,963	3.4	(2.7 - 4.0)	15	3,179	3.2	(1.7 - 4.7)	0.8928
Other causes [d]	864	194,529	23.3	(21.8 - 24.8)	80	17,350	17.5	(13.9 - 21.1)	

Body region and injury nature (Barell injury matrix)												0.0007
Back and buttock, sprains and strains	330	75,820	9.5	(8.5	-	10.6)	41	9,244	9.9	(6.8	- 12.9)	0.6701
Wrist, hand and fingers, open wound	541	124,288	15.6	(14.4	-	16.9)	35	8,192	8.8	(5.8	- 11.7)	0.0001
Trunk, unspecified injury	112	22,924	2.9	(2.3	-	3.5)	28	6,058	6.5	(4.0	- 9.0)	0.0002
Lower leg and ankle, sprains and strains	214	47,995	6.0	(5.2	-	6.8)	22	5,380	5.8	(3.2	- 8.3)	0.4166
Shoulder and upper arm, sprains and strains	166	35,670	4.5	(3.8	-	5.2)	22	4,905	5.2	(3.2	- 7.3)	0.6193
Other and unspecified lower extremities, sprains and strains	172	39,857	5.0	(4.2	-	5.8)	23	4,884	5.2	(2.5	- 7.9)	0.6010
Foot and toes, fracture	75	17,876	2.2	(1.7	-	2.8)	13	3,099	3.3	(1.3	- 5.3)	0.2163
Pelvis and urogenital, sprains and strains	47	9,833	1.2	(0.9	-	1.6)	11	2,688	2.9	(0.8	- 5.0)	0.0375
Other and unspecified lower extremities, unspecified injury	77	15,554	2.0	(1.5	-	2.4)	13	2,585	2.8	(1.3	- 4.2)	0.2864
Hand and fingers, contusion/superficial	66	15,524	2.0	(1.4	-	2.5)	8	2,494	2.7	(0.7	- 4.6)	0.9552
Others (all other body region and injury type combinations in Barell matrix)	1,759	390,138	49.0	(47.2	-	50.8)	204	43,903	47.0	(41.7	- 52.2)	
Body region												0.0007
Extremities, lower	931	211,444	26.6	(24.9	-	28.3)	130	30,162	32.3	(27.2	- 37.3)	0.0734
Extremities, upper	1,418	319,203	40.1	(38.3	-	42.0)	126	29,042	31.1	(26.1	- 36.0)	<0.0001
Torso	597	134,392	16.9	(15.5	-	18.3)	98	21,392	22.9	(18.6	- 27.2)	0.0008
Other head, face and neck (excluding traumatic brain injuries)	315	68,004	8.5	(7.5	-	9.6)	28	5,960	6.4	(4.1	- 8.7)	0.1203
Vertebral column injury	196	40,469	5.1	(4.3	-	5.8)	28	4,930	5.3	(3.4	- 7.2)	0.3456
Other body regions [e]	102	21,967	2.8	(2.2	-	3.4)	10	1,944	2.1	(0.7	- 3.4)	
Injury nature												0.0001
Sprains and strains	1,365	306,854	38.6	(36.8	-	40.4)	156	34,922	37.4	(32.3	- 42.4)	0.5623
Open wound	849	192,228	24.2	(22.7	-	25.6)	65	14,658	15.7	(12.0	- 19.4)	<0.0001
Contusions/superficial	410	93,169	11.7	(10.5	-	12.9)	54	13,250	14.2	(10.4	- 18.0)	0.4788
Unspecified	308	62,601	7.9	(7.0	-	8.8)	60	12,632	13.5	(10.1	- 16.9)	0.0003
Fracture	320	72,345	9.1	(8.0	-	10.2)	41	9,786	10.5	(7.3	- 13.7)	0.7153
Other injury types [f]	307	68,282	8.6	(7.6	-	9.5)	44	8,182	8.8	(6.2	- 11.3)	

[a] due to missing values, the subtotals may not add up to total and percentages may not add up to 100% amongst categories

[b] Chi-square test

[c] Other locations include street or highway, school, parking lot, home(inside), residential institution (exclude hospital), farm, sport facility, athletic field, playground, park or recreation area (include bike or jog path), sidewalk, child care center or preschool, river/lake/stream/ocean, other or unspecified

[d] Other causes include machinery, fire/burn/scald related, animal or insect bite, poisoning, and other

[e] Other body regions include traumatic brain injury, spinal cord injury, and other and unspecified body regions

[f] Other injury nature include burns, internal injury, amputation, nerves injury, and blood vessels injury

Table 4 also shows the location and cause of injuries. Compared with injuries sustained by workers without a disability, a higher proportion of occupational injuries among workers with disabilities occurred at a shopping center, restaurant, store, bank, gas station, or other place of business, or at a health care facility, and less likely occurred in industrial or construction areas. Overexertion/strenuous movements and falls were the two leading causes of work-related injuries for both US workers with and without disabilities. However, among the injuries to workers with disabilities, these two types of injuries accounted for a higher share of the total: 56.7% for workers with disabilities versus 45.6% for workers without disability.

The top three types of injuries (by body region injured and nature of injury) for workers with disabilities were sprains and strains of the back and buttock (9.9%), open wounds of the wrist/hand/fingers (8.8%), and unspecified injuries of the trunk (6.5%). The injury profile was different for workers without disabilities, with the top three injuries being open wounds to the wrist/hand/fingers (15.6%), sprains and strains of the back and buttock (9.5%), and lower leg or ankle sprains and strains (6.0%). Workers with disabilities had a higher percentage of unspecified injuries of the trunk (6.5% versus 2.9%) and fewer open wound injuries of the wrist/hand/fingers (8.8% versus 15.6%) compared with workers without disabilities. With respect to body region injured, a higher proportion of workers with disabilities were injured in the lower extremities (32.3% versus 26.6%) and torso (22.9% versus 16.9%) than workers without disabilities. Although the leading injury type for both groups was sprains and strains (37.4% and 38.6%, for workers with and without disabilities, respectively), workers with a disability had more unspecified injuries (13.5% versus 7.9%) and fewer open wound injuries (15.7% versus 24.2%)

2.5 Conclusions

Using a large nationally representative NHIS data set, our study demonstrated that disability status was strongly associated with injury risk among U.S. workers. Compared with workers with no disability, workers with disabilities were significantly more likely to experience both non-occupational and occupational injuries. We found that workers with disabilities, however, were more likely to be injured away from work than in the workplace.

Our study reported the differences in workplace injury patterns among workers with and without disabilities. Workers with disabilities sustained more work-related injuries, and these injuries tended to be more severe compared with those sustained by workers without disabilities. For workers with disabilities, overexertion/strenuous movements and falls were the two most common mechanisms; sprains and strains were the most common type of injuries for both workers with and without disabilities.

One good news is that occupational injury prevalence declined during the 15 years period from 1997-2011 among U.S. workers with and without disabilities.

3. Research Methods and Results for Aim 3

Specific Aim 3: To examine medical expenditures associated with nonfatal occupational injuries among U.S. workers reporting persistent disabilities.

3.1 Data Source

The MEPS is conducted annually and is cosponsored by the Agency for Healthcare Research and Quality (AHRQ) and the National Center for Health Statistics (NCHS).[41] It provides nationally representative estimates of health care use, insurance coverage, medical expenditures and sources of payment for the civilian non-institutionalized population. MEPS has a major household component (MEPS-HC). MEPS-HC obtains data from a nationally representative sample of households through an overlapping panel design in which new respondents are sampled and recruited from the National Health Interview Survey (NHIS). Each year the newly recruited respondents become part of a new panel and are then interviewed 5 times over a 2.5-year period. Respondents are questioned about medical expenditures incurred in a 2-year reference period. An additional component of MEPS, the medical provider component (MPC) supplements and corroborates information received from the MEPS-HC component. In this study, we pooled together 7 panels of MEPS data (the time period of pooled data spans 8 years, from 2004 to 2011).

3.2 Key Definitions

Identification of Workers
Workers were defined as those aged 18-64 years who self-reported "currently employed", "has a job to return to", or "employed any time during the reference period" in any round of the *5* MEPS interviews.

Definition of Persistent Disabilities
The World Health Organization's International Classification of Functioning, Disability and Health (ICF) [35] considers impairments, activity limitations, and participation restrictions and also emphasizes the roles of the environmental and personal factors. The 2004-2011 MEPS utilized ICF concepts, and there were groups of questions associated with impairments, limitations and participation restrictions that were asked in the different interview rounds. Some questions were asked each of the five rounds; other questions were asked in two or three of the rounds:[41]

(1) Activities of daily living (ADL) limitations, asked in rounds 1-5.
(2) Instrumental Activities of Daily Living (IADL) limitations, asked in rounds 1-5.
(3) Difficulty performing physical actions (e.g. walking, bending, lifting, stooping), asked in round 1, round 3, and round 5.
(4) Work, housework or school limitations, asked in round 1, round 3, and round 5.
(5) Difficulty seeing (with glasses or contacts), asked in round 2 and round 4.
(6) Difficulty hearing (with hearing aid, if used), asked in round 2 and round 4.
(7) Cognitive limitations, asked in round 1 and round 3.

Since not all questions were asked in all 5 rounds of interviews, a persistent disability in our

study was defined as a limitation or difficulty that existed at all rounds in which the related questions were asked. For example, ADL questions were asked in all 5 rounds, if in all 5 rounds this person reported having ADL limitation, then he/she had a persistent limitation in ADL. Similarly, if one person had seeing difficulties in round 2 and round 4 (vision questions only were asked in round 2 and round 4), then he/she had persistent vision impairment. If a person had any persistent impairments, limitations, or participation restrictions in the above 7 categories, we defined this person as a worker with persistent disabilities.

Definition of Occupational Injuries

When a medical condition was first reported, the respondent was asked specifically whether this medical condition is an injury or not (yes or no). In our study, injury was defined as occupational injury if the respondent said that the injury occurred at work. If a respondent had multiple injury conditions associated with a single date, the expenditures were grouped and considered the consequences of one injury event. We examined whether or not respondents reported missed work days and bed days related to their occupational injuries.

We excluded injuries that occurred prior to the first round of the MEPS interview, because our study aimed to investigate the effect of pre-existing and persistent disabilities on occupational injury and the associated health care expenditures. Since we excluded "old" injuries from our study, the national estimates of injury incidence should be unbiased, but the total expenditures should not be considered as all medical expenditures for all occupational injuries, since expenditures of some injuries could censor at the end of the reference period. .

Medical Expenditures

Expenditures were defined as the sum of payments paid for medical care services, including out-of-pocket payments, payments from private insurance, payments made by Medicare and Medicaid, or payment by Workers' Compensation, or other sources, associated with newly occurred occupational injuries during a 2-year reference period. MEPS does not collect data of payments for over-the-counter-drugs and alternative care services. We also excluded certain expenses because the survey questions did not associate these expenses with specific injuries: dental services, durable medical equipment, and other miscellaneous items.[42] All expenditures were adjusted for inflation and converted to constant 2011 dollars using the Personal Health Care Expenditure (PHCE) index for overall health care.[43]

Types of service were grouped in the following categories: hospital inpatient services, ambulatory services, emergency department services, prescribed medicines, and home health services. Sources of payment included the following categories: out of pocket, private insurance, Medicare, Medicaid, Workers' Compensation, and an other sources category. Greater details about the categories of types of service and sources of payment can be found in the MEPS documentation.[41]

3.3. Statistical analysis

Data analyses were conducted using SAS version 9.3. [44] Seven panels of data (Panels 9-15) were combined to generate the larger sample needed to improve estimate precision. The following

MEPS data files were used: (1) longitudinal panel data files; (2) medical condition files (2004-2011); (3) medical event files(2004-2011), including prescribed medicine files, office-based medical provider visit files, outpatient visit files, emergency room visit files, hospital inpatient stay files, and home health visit files; (4) medical condition and medical event linkage files. We selected occupational injury-related conditions from condition files, and then linked them with medical event files to get medical service and expenditure information associated with these occupational injuries. The expenditure information was also linked with panel data to get sociodemographic information. In the final stage, weights of the pooled 7 panels of data were adjusted by dividing by 7 to get the final applied weight. These survey weights allowed us to produce nationally representative estimates for the period of 2004 to 2011. Our data analyses accounted for the complex survey design of MEPS.

We first calculated the total number of workers who reported at least one occupational injury, the total number of occupational injuries that occurred during the 2-year reference period, and total expenditures associated with these injuries. Next, we calculated the 2-year cumulative incidence rates by disability status and by sex, age, race, marital status, education, income, and medical insurance coverage status, and 95% CIs were calculated for all incidence rates.

We produced national estimates of the average expenditures, including mean and median, associated with occupational injuries according to the type of medical services and sources of payments, calculated the proportions and 95% CIs for each category of service types and sources of payment. Because of the highly skewed nature of the expenditure data distributions, bootstrap methods were used to calculate the 95% CIs. Specifically, the expenditure data from MEPS have been shown to exhibit a marked positive skewness, with a few respondents with high medical expenditures and many respondents reporting zero or low expenditures.

Finally, to estimate the average medical expenditure for occupational injuries per injured worker during the MEPS reference period and to assess the impact of sociodemographic variables on medical expenditures, we used multivariable linear regression models on logarithm transformed data. Since the expenditure data were highly skewed to the right, a natural logarithm transformation was used to transform the expenditure data. Then we used linear regression to examine the association of the log-transformed expenditures with disability status, adjusting for the socio-demographic variables. Duan's Smearing method was used to re-transform the estimated means to the original scale (in 2011 U.S. Dollars).[45] We conducted sensitivity analysis by comparing the linear regression results while including and excluding records with extreme expenditure values (outliers).

3.4 Results

For **Specific Aim 3**, we used the 2004-2011 MEPS data (Panels 9-15). It was estimated that there were 8.2 million U.S. workers, 18-64 years of age, living with at least one persistent disability (Table 5). They sustained over 1.1 million occupational injuries during a 2 year reference period. The total medical care expenditures could be as high as 3.0 billion US dollars in the two years.

Table 5. Occupational injuries and expenditures in U.S. workers with and without persistent disabilities, MEPS Panel 9-15 (2004-2011)

	With persistent disabilities			Without persistent disabilities		
	Sample	National estimate	95% CI	Sample	National estimate	95% CI
Workers	2,443	8,234,651	(7,761,354 - 8,707,948)	48,811	149,723,110	(145,275,390 - 154,170,830)
Injured workers	264	940,466	(804,892 - 1,076,039)	3,034	9,058,813	(9,012,898 - 9,986,766)
Injuries	313	1,119,847	(938,891 - 1,300,803)	3,396	10,640,931	(10,109,207 - 11,172,655)
Total expenditures ($) *†	845,602	3,043,561,436	(1,947,258,035 - 4,139,864,836)	6,103,029	18,600,268,967	(15,581,000,000 - 21,619,600,000)
Expenditure per injured worker ($) *†	3,203	3,236	(2,145 - 4,327)	2,012	1,953	(1,647 - 2,021)
Expenditure per injury ($) *†	2,702	2,718	(1,839 - 3,597)	1,797	1,748	(1,475 - 1,941)

* All expenditures were adjusted for inflation and converted to constant 2011 U.S. dollars using the Personal Health Care Expenditure (PHCE) index for overall health care.[21]

† The MEPS does not collect data on payments for over-the-counter-drugs and alternative care services. We also excluded certain expenses because the survey questions did not associate these expenses with specific injuries: dental services, durable medical equipment, and other miscellaneous items (eyeglasses, contact lenses, ambulance transportation services, orthopedic items, hearing devices, prostheses, bathroom aids, medical equipment, disposable supplies, and other miscellaneous items or services).[20]

The unadjusted mean and median expenditures per injury were higher for those injuries sustained by workers with persistent disabilities when compared with those injuries sustained by workers without persistent disabilities (Table 6). The mean expenditures per injury during the 2-year reference period were $3,236 and $1,953, while the median expenditures per injury were $476 (95%CI: $277-$675) and $293(95%CI: $259-$328), for workers with and without persistent disabilities, respectively. Expenditure disparities existed among the subgroups defined by sex, age, race, marital status, education, income, and medical insurance (Table 6).

When medical services were sought after occupational injury, workers with persistent disabilities spent similar proportions of total expenditures on different types of service when compared to workers without persistent disabilities (Table 4). Also, as to payment sources, we did not find significant differences among these two groups. When comparing workers with persistent disabilities with those without persistent disabilities, workers' compensation was the primary source of payment (54.6% vs.58.9%, respectively), and out-of-pocket payments accounted for only 6.7% vs. 6.3%, respectively. The proportions of workers reporting missed work days associated with their occupational injuries were 47.3% and 46.4% among workers with and without disabilities, respectively; the proportions of workers with disabilities reporting bed days associated with occupational injuries was 15.3% versus 8.8% of workers without disabilities (data not shown).

Table 6. Mean and median expenditures of occupational injuries in U.S. workers with and without persistent disabilities during a 2 year reference period, MEPS Panel 9-15 (2004-2011)

	With persistent disabilities				Without persistent disabilities			
	Injured workers (N)	Mean expenditure $	Median expenditure $	95% CI of Median	Injured workers (N)	Mean expenditure $	Median expenditure $	95% CI of Median
Total**	264	3,236	476	(277 - 675)	3,034	1,953	293	(259 - 328)
Sex								
Male	163	3,178	390	(294 - 486)	1,926	1,764	240	(198 - 283)
Female	101	3,348	576	(360 - 791)	1,108	2,299	355	(317 - 393)
Age (years)								
18-24	17	2,100	437		398	820	169	(131 - 207)
25-44	79	2,354	312	(270 - 355)	1,521	1,803	290	(244 - 336)
45-54	98	3,385	492	(224 - 760)	735	2,056	324	(241 - 407)
55-64	70	4,165	793	(612 - 974)	380	3,579	449	(359 - 539)
Race								
White and other race/not Hispanic	207	3,360	491	(301 - 680)	1,796	1,786	306	(263 - 350)
Black-no other race/not Hispanic	27	2,210	318		465	3,535	313	(241 - 385)
Hispanic	30	2,691	272		773	1,720	204	(159 - 248)
Marital status								
Married	124	4,226	738	(487 - 989)	1,634	2,039	352	(306 - 398)
Widowed/divorced/separated	88	2,794	467	(335 - 600)	534	2,408	289	(216 - 362)
Never married/others	52	1,634	265	(60 - 470)	866	1,556	202	(160 - 245)
Education								
Less than high school	57	3,933	500	(196 - 804)	748	1,970	263	(197 - 330)
High school	94	3,627	823	(613 - 1,032)	1,074	1,952	313	(257 - 368)
College and higher	113	2,620	295	(141 - 448)	1,212	1,948	284	(222 - 346)
Income								
Low income (<200% FPL)	97	3,597	399	(151 - 647)	1,093	1,359	199	(157 - 241)
Middle income (200-399% FPL)	85	1,391	319	(157 - 480)	1,109	1,995	331	(280 - 383)
High income (≥400% FPL)	82	4,715	854	(756 - 953)	832	2,425	314	(261 - 367)

Medical insurance									
Any private	182	3,824	556	(367	- 744)	2,060	2,140	345	(306 - 384)
Public only	17	2,505	29			237	1,308	262	(184 - 340)
Uninsured	65	1,699	387	(333	- 442)	737	1,452	125	(85 - 165)

* All expenditures were adjusted for inflation and converted to constant 2011 dollars using the Personal Health Care Expenditure (PHCE) index for overall health care.[21]

** The maximum values of medical costs is $62499 for workers with a disability, $190097 for workers without a disability.

When medical services were sought after occupational injury, workers with persistent disabilities spent similar proportions of total expenditures on different types of service when compared to workers without persistent disabilities (Table 7). Also, as to payment sources, we did not find significant differences among these two groups. When comparing workers with persistent disabilities with those without persistent disabilities, workers' compensation was the primary source of payment (54.6% vs.58.9%, respectively), and out-of-pocket payments accounted for only 6.7% vs. 6.3%, respectively. The proportions of workers reporting missed work days associated with their occupational injuries were 47.3% and 46.4% among workers with and without disabilities, respectively; the proportions of workers with disabilities reporting bed days associated with occupational injuries was 15.3% versus 8.8% of workers without disabilities (data not shown).

Table 7. Distribution of health care expenditures of occupational injuries in U.S. workers with and without persistent disabilities, by type of service and by payment source, MEPS Panel 9-15 (2004-2011)

	With persistent disabilities			Without persistent disabilities		
	National estimate of total expenditures $*	%	95% CI†	National estimate of total expenditures $*	%	95% CI†
Total expenditure	3,043,561,436	100.0		18,600,268,967	100.0	
By type of service						
Ambulatory	2,037,236,338	66.9	(53.3 - 79.3)	11,459,137,983	61.6	(54.2 - 68.8)
Hospital inpatient	590,888,203	19.4	(6.7 - 33.9)	4,215,970,792	22.7	(14.7 - 31.0)
Emergency department	338,056,992	11.1	(6.1 - 18.8)	2,429,569,682	13.1	(10.6 - 16.0)
Prescribed medicines	75,782,022	2.5	(1.7 - 3.7)	448,568,399	2.4	(2.0 - 2.9)
Home health	1,597,880	0.1	#	47,022,111	0.3	#
By source of payment						
Workers' compensation	1,661,552,730	54.6	(39.1 - 67.9)	10,959,552,249	58.9	(52.6 - 64.8)
Private insurance	1,041,255,520	34.2	(20.9 - 48.7)	4,976,573,224	26.8	(22.1 - 31.8)
Family (out of pocket)	203,340,450	6.7	(4.2 - 9.8)	1,166,144,683	6.3	(5.2 - 7.7)
Medicare	627,465	0.0	#	34,129,906	0.2	(0.1 - 0.3)
Medicaid	8,367,652	0.3	(0.1 - 0.5)	280,628,289	1.5	(0.9 - 2.2)
Other**	128,417,618	4.2	(2.0 - 7.4)	1,183,240,616	6.4	(4.6 - 8.4)

* All expenditures were adjusted for inflation and converted to constant 2011 U.S. dollars using the Personal Health Care Expenditure (PHCE) index for overall health care.[21]

† Calculated using bootstrap methods (the number of repeating bootstrap samples is 2000)

** This Other sources category includes payments from the Department of Veterans Affairs (except TRICARE); other Federal sources (Indian Health Service, military treatment facilities, and other care provided by the Federal Government); various State and local sources (community and neighborhood clinics, State and local health departments, and State programs other than Medicaid); various unclassified sources (e.g., automobile, homeowner's, or other liability insurance, and other miscellaneous or unknown sources); Medicaid payments reported for persons who were not reported as enrolled in the Medicaid program at any time during the year; and private insurance payments reported for persons without any reported private health insurance coverage during the year.

Not presented because the estimation was based on small number of patients (n<10).

Table 8 shows results from the multivariable linear regression models. Adjusted by sex, age, race, marital status, education, income, and health insurance coverage status, workers with persistent disabilities spent more for occupational injuries during a 2-year reference period than workers without persistent disabilities ($3,778 vs. $2,212). As the age of the worker increased, so did the adjusted mean expenditure. The adjusted mean expenditure for workers ages 18-24 years of age was $2,030, and the adjusted mean expenditure for the 55-64 year old group was $4,045. Workers without health insurance appeared to spend less ($2,461 vs. $3,573 for those with private insurance and $2,747 for those with public insurance). There were 4 outlier occupational injury expenditures greater than $100,000 ($110,615, $111,944, $155,552, and $190,097); each of these occurred in workers without persistent disabilities. When we excluded these outliers from the linear regression, the disability variable remained statistically significant (p=0.0003), and the conclusions were the same. The mean expenditure changed to $3346 in workers with persistent disabilities vs. $1941 in workers without persistent disabilities.

Table 8. Linear regression models for occupational injury-related medical expenditures in U.S. workers, MEPS Panel 9-15 (2004-2011)*

	Model 1		Model 2		Model 3		Model 4	
	Mean estimates **	**P value**	**Mean estimates** **	**P value**	**Mean estimates** **	**P value**	**Mean estimates** **	**P value**
Disability status								
Without persistent disabilities (ref.)	2,500		2,450		2,474		2,212	
With persistent disabilities	**4,797**	**<0.0001**	**4,087**	**0.0008**	**4,167**	**0.0006**	**3,778**	**0.0004**
Sex								
Male (ref.)			3,077		3,116		2,833	
Female			3,254	0.4844	3,309	0.4502	2,950	0.6135
Age (years)								
18-24 (ref.)			2,165		2,264		2,030	
25-44			2,664	0.1148	2,737	0.1473	2,489	0.1203
45-54			**3,799**	**0.0001**	**3,798**	**0.0004**	**3,417**	**0.0004**
55-64			**4,575**	**<.0001**	**4,516**	**<.0001**	**4,045**	**<.0001**
Race								
White and other race/not Hispanic (ref.)			3,243		3,229		2,896	
Black-no other race/not Hispanic			3,330	0.8405	3,423	0.6521	3,017	0.7537
Hispanic			2,934	0.3154	2,995	0.4491	2,764	0.6418
Marital status								
Married (ref.)			3,352		3,367		2,959	
Widowed/divorced/separated			2,994	0.2614	3,085	0.3918	2,755	0.4811
Never married/others			3,158	0.5711	3,187	0.6031	2,962	0.9936
Education								
Less than high school			3,213	0.6402	3,375	0.3021	3,163	0.0995
High school			3,223	0.5423	3,250	0.3837	2,892	0.2783
College and higher (ref.)			3,059		3,018		2,640	
Income								
Low income (<199% FPL)					2,904	0.3185	2,795	0.9667
Middle income (200-399% FPL) (ref.)					3,168		2,806	
High income (≥400% FPL)					**3,598**	**0.1912**	3,080	0.3464
Medical insurance								
Any private (ref.)							3,573	
Public only							2,747	0.1187
Uninsured							**2,461**	**0.0008**

ref= Reference group; FPL= Federal Poverty Level

* The regression excluded 33 subjects whose total expenditure is zero although they reported one or more medical treatments; ** The original data were transformed with the natural logarithm; mean estimates were transformed back and adjusted with Duan's Smearing Method.

3.5 Conclusions

Using MEPS longitudinal data, we found that U.S. workers with persistent disabilities had significantly higher risk of sustaining occupational injuries than workers without persistent disabilities (rate ratio=1.9). The average medical care expenditure for occupational injuries per injured worker in workers with disabilities was $3,778 in the two year reference period as compared with workers without persistent disabilities ($2,212). We did not find distributional differences in the health care expenditures by type of service nor by source of payment between these two groups. Workers with persistent disability and workers without persistent disability had similar proportions paid by workers' compensation and paid out-of-pocket.

4. Meta-analysis Results and Conclusions

We conducted a systematic review and meta-analysis to characterize the association between pre-existing disability and unintentional injuries in adults with disabilities.

We searched 14 databases **(**Medline, CINAHL, PsycINFO, ERIC, Alt Health Watch, Sport Discus, Scopus, ISI Web of Knowledge, Cochrane Library, Clinical Key, CAB Abstracts, Global Health, Health and Safety Science abstracts, and National Agriculture Safety databases). Our literature search was limited to studies published between Jan 1, 1990 and Feb 28, 2013 without language restrictions.

A search strategy was developed for each searchable database using a combination of free text or keywords to search throughout the full texts. We used search terms from two categories relating to disability (eg, "disabilit*", "limit*", "disabl*", "deficien*", and "handicap*") and injury (eg, "injur*", "hurt*", "trauma", "fall*"and "wound*"). Additional strategies included web-based searches for special literature (recently published abstracts or conference proceedings, or manuscripts in press), and the screening of reference lists of retrieved studies.

All analyses were conducted using the STATA software version 12.0 (StataCorp, Texas, USA). For a total of 20 studies, we extracted the original data (number of participants with and without disabilities and the number injured in each group). For the remainder of the studies that did not report these numbers, we extracted the crude ORs and the 95% CIs. The STATA software has the capacity to combine both types of data to calculate the pooled ORs and the 95% CIs. We first described the characteristics of the included studies, and then conducted heterogeneity tests to determine the best approach for pooling the studies' results. When heterogeneity (the degree of dissimilarity in the results of selected studies, I^2 statistic) was statistically significant, we used random-effect models to compute the pooled effects as opposed to fixed-effect models. We calculated pooled ORs and 95% CIs, and performed Z tests to evaluate the statistical significance of the pooled effects.

Figure 1 summarizes the pooled OR of occupational and non-occupational injuries. Eleven included papers[16, 46-55] focused on occupational injuries, and 14 studies [10-12, 56-66] focused on non-occupational injuries; one paper investigated both.[67] The pooled OR was 1.62 (95% CI 1.24-2.13; I^2 87.8%; Z=3.49; p<0.001) in the studies of occupational injuries; while the pooled OR was 1.91

(95% CI 1.59-2.30; I^2 90.6%; Z=6.87; p<0.001) in the subgroup studies of non-occupational injuries. The overall combined OR was 1.79 (95% CI 1.53-2.09; I^2 90.6%; Z=7.39; p<0.001).

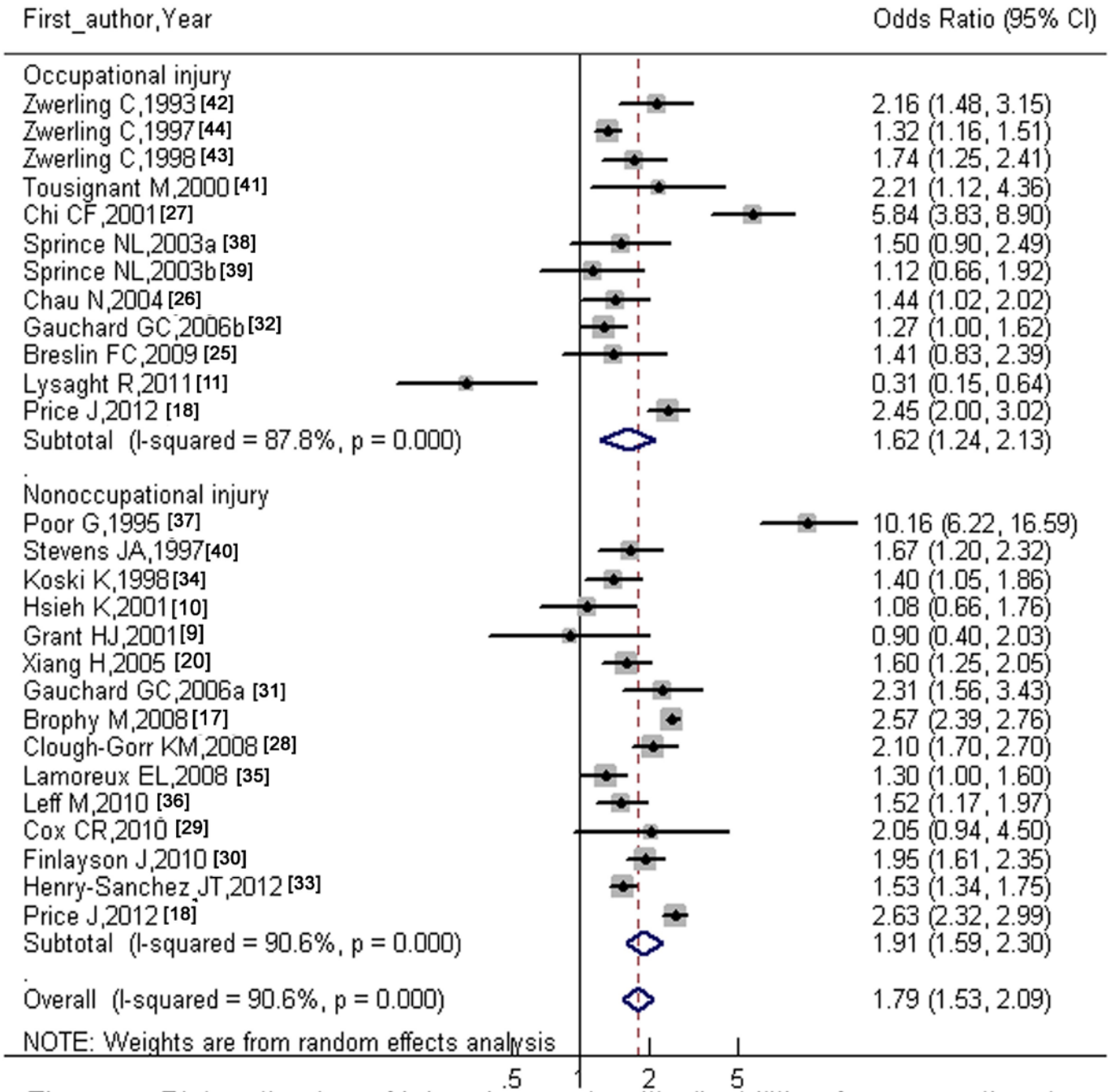

Figure 1 Risk estimates of injury in people with disabilities for occupational and non-occupational injuries.

Conclusions

Findings this NIOSH-funded research project provide answers to important occupation safety questions whether U.S. workers with disabilities face a significantly higher risk of occupational injuries than U.S. workers without disabilities and whether patterns of injuries and medical expenditures differ between the two groups. This study concludes that U.S. workers with disabilities have a significantly elevated risk of non-fatal occupational and non-occupational injuries compared with the US workers with disabilities.

Workers with disabilities sustained more work-related injuries, and these injuries tended to be more severe compared with those sustained by workers without disabilities. For workers with disabilities, overexertion/strenuous movements and falls were the two most common mechanisms; sprains and strains were the most common type of injuries for both workers with and without disabilities.

The average medical care expenditure for occupational injuries per injured worker in workers with disabilities was $3,778 in the two year reference period as compared with workers without persistent disabilities ($2,212). We did not find distributional differences in the health care expenditures by type of service nor by source of payment between these two groups. Workers with persistent disability and workers without persistent disability had similar proportions paid by workers' compensation and paid out-of-pocket.

One good news is that occupational injury prevalence declined during the 15 years period from 1997-2011 among U.S. workers with and without disabilities.

Many individuals in the disability advocacy community are understandably concerned that highlighting the increased risk of occupational injuries among workers with disabilities may discourage employers from hiring individuals with disabilities. In addition to safety concerns, employers also have expressed concerns about productivity, absenteeism, turnover, interpersonal situations on the job, and fears about costs, either from implementing accommodations or increases in insurance rates.[68] Some of these expressed issues may be misconceptions in that they are from employers who may not have had direct experience working with or supervising workers with disabilities. Previous studies have shown that, relative to other employers, those who have had previous experience hiring individuals with disabilities reported more favorable attitudes toward employing persons with disabilities.[68] A series of investigations conducted by the DuPont company concluded that hiring workers with disabilities did not contribute to an increase in compensation costs or lost-time injuries.[68]

A 2006 special report to the National Institute for Occupational Safety and Health (NIOSH) by Dewey,[69] recommended that occupational safety issues among workers with developmental disabilities should be proactively addressed by assisting employers in "building safety support systems that protect the individual needs of employees, that encourage communications between all parties, and that include appropriate and tailored health and safety training." [70] However, few researchers, agencies or organizations in the U.S. have examined the occupational safety of workers with disabilities, and there is a serious lack of data regarding occupational injuries among workers with disabilities.[8, 69]

Findings from this study fill some of the data gaps, but they are not enough. By demonstrating the increase in occupational injuries to workers with disabilities, this study shows the need for better accommodation and safety programs in the workplace. Similar to the pleas from the World Health Organization[2] and the U.S. Surgeon General[3], the 2006 special report to the NIOSH recommended that federal agencies with an interest in the employment of workers with disabilities and their safety and health in the workplace should take the lead in further assessing the health and safety issues facing U.S. workers with disabilities and in funding more research.[69] The report also calls for funding of educational/outreach programs that teach U.S. workers with disabilities occupational safety and health skills.

References Cited

1. U.S. Census Bureau, American Community Survey: 2009 Selected Social Characteristics in the United States, In: Bureau, U. S. C. (ed), Washington, DC, 2010.

2. World Health Organization, World Report on Disability: World Health Organization, 2011.

3. U.S. Department of Health and Human Services, The Surgeon General's Call to Action to Improve the Health and Wellness of Persons With Disabilities, Washington, DC, 2005.

4. Kruse, D., Schur, L. and Ali, M., Disability and occupational projections, Monthly Labor Review Online, 2010, 133(10).

5. Zwerling, C., Whitten, P. S., Davis, C. S. and Sprince, N. L., Occupational injuries among workers with disabilities: the National Health Interview Survey, 1985-1994, JAMA, 1997, 278(24):2163-2166.

6. Nonfatal occupational injuries and illnesses among older workers --- United States, 2009, MMWR Morb Mortal Wkly Rep, 2011, 60(16):503-508.

7. Agran, M. and Madison, D., Prevalence of injuries among supported employees., J Vocat Rehabil, 1995, 5(1):5-13.

8. Lenhart, S. W., Protecting workers with developmental disabilities, Appl Occup Environ Hyg, 2000, 15(2):171-181.

9. Department of Health and Human Services, Healthy People 2020, Washington (D.C.): HHS.

10. Xiang, H., Leff, M. and Stallones, L., Non-fatal injuries among adults with activity limitations and participation restrictions, Inj Prev, 2005, 11(3):157-162.

11. Finlayson, J., Morrison, J., Jackson, A., Mantry, D. and Cooper, S. A., Injuries, falls and accidents among adults with intellectual disabilities. Prospective cohort study, J Intellect Disabil Res, 2010, 54(11):966-980.

12. Brophy, M., Zhang, X. and Xiang, H., Injuries among US adults with disabilities, Epidemiology, 2008, 19(3):465-471.

13. Vladutiu, C. J., Casteel, C. and Runyan, C. W., Disability and risk of non-fatal residential injuries among adults, Inj Prev, 2008, 14(5):302-305.

14. Leff, M., Stallones, L., Xiang, H. and Whiteneck, G., Disability, environmental factors and non-fatal injury, Inj Prev, 2010, 16(6):411-415.

15. Moll van Charante, A. W. and Mulder, P. G., Perceptual acuity and the risk of industrial accidents, Am J Epidemiol, 1990, 131(4):652-663.

16. Zwerling, C., Ryan, J. and Schootman, M., A case-control study of risk factors for industrial low back injury. The utility of preplacement screening in defining high-risk groups, Spine (Phila Pa 1976), 1993, 18(9):1242-1247.

17. Zwerling, C., Sprince, N. L., Davis, C. S., Whitten, P. S., Wallace, R. R. and Heeringa, S. G., Occupational injuries among older workers with disabilities: a prospective cohort study of the Health and Retirement Survey, 1992 to 1994, Am J Public Health, 1998, 88(11):1691-1695.

18. Lysaght, R., Sparring, C., Ouellette-Kuntz, H. L. and Marshall, C. A., Injury incidence and patterns in workers with intellectual disability: a comparative study, J Intellect Dev Disabil, 2011, 36(4):280-284.

19. Zwerling, C., Whitten, P. S., Davis, C. S. and Sprince, N. L., Occupational injuries among older workers with visual, auditory, and other impairments. A validation study, J Occup Environ Med, 1998, 40(8):720-723.

20. Seelman, K., Risk of injury among workers with disability, JAMA, 1998, 279(17):1348; author reply 1349-1350.

21. Blanck, P. D., Risk of injury among workers with disability, JAMA, 1998, 279(17):1349; author reply 1349-1350.

22. Zwerling, C., Whitten, P. S., Sprince, N. L., Davis, C. S., Wallace, R. B., Blanck, P. and Heeringa, S. G., Workplace accommodations for people with disabilities: National Health Interview Survey Disability Supplement, 1994-1995, J Occup Environ Med, 2003, 45(5):517-525.

23. Sinclair, S. A. and Xiang, H., Injuries among US children with different types of disabilities, Am J Public Health, 2008, 98(8):1510-1516.

24. World Health Organization, International Classification of Functioning, Disability and Health, Geneva, Switzerland: World Health Organization, 2001.

25. Centers for Disease Control and Prevention National Center for Injury Prevention and Control (NCIPC), Saving Lives and Protecting People from Violence and Injuries, 2013.

26. Holder, Y., Peden, M., Krug, E., Lund, J., Gururaj, G. and Kobusingye, O., Injury surveillance guidelines, Geneva: World Health Organization, 2001.

27. National Council on Disability (U.S.), The current state of health care for people with disabilities, Washington, D.C.: National Council on Disability, 2009.

28. Palmer, M., Nguyen, T., Neeman, T., Berry, H., Hull, T. and Harley, D., Health care utilization, cost burden and coping strategies by disability status: an analysis of the Viet Nam National Health Survey, Int J Health Plann Manage, 2010, 26(3):e151-168.

29. Zwerling, C., Sprince, N. L., Davis, C. S., Whitten, P. S., Wallace, R. R. and Heeringa, S. G., Occupational injuries among older workers with disabilities: a prospective cohort study of the Health and Retirement Survey, 1992 to 1994, Am J Pub Health, 1998, 88(11):1691-1695.

30. Zwerling, C., Whitten, P. S., Davis, C. S. and Sprince, N. L., Occupational injuries among workers with disabilities: the National Health Interview Survey, 1985-1994, JAMA, 1997, 278(24):2163-2166.

31. Brophy, M., Zhang, X. and Xiang, H., Injuries among US adults with disabilities, Epidemiology, 2008, 19(3):465-471.

32. Xiang, H., Leff, M. and Stallones, L., Non-fatal injuries among adults with activity limitations and participation restrictions, Inj Prev, 2005, 11(3):157-162.

33. Xiang, H., Stallones, L. and Chiu, Y., Nonfatal agricultural injuries among Colorado older male farmers, J Aging Health, 1999, 11(1):65-78.

34. Fujiura, G. T. and Rutkowski-Kmitta, V., Counting disabilities, In: Albrecht, G., Seelman, K. and Bury, M. (eds), Handbook of disability studies, Thousand Oaks, CA: Sage Publications, 2001.

35. World Health Organization, International classification of functioning, disability and health, Geneva, Switzerland: World Health Organization, 2001.

36. Statistical analysis software (SAS) [computer program], Cary, NC: SAS Insitute, 2004.

37. Software for the statistical analysis of correlated data [computer program], Research Triangle Park, NC: Research Triangle Institute, 2004.

38. Clark, D. E., Osler, T. M. and Hahn, D. R., ICDPIC: Stata module to provide methods for translating International Classification of Diseases (Ninth Revision) diagnosis codes into standard injury categories and/or scores, 2010.

39. Osler, T., Baker, S. P. and Long, W., A modification of the injury severity score that both improves accuracy and simplifies scoring, Journal of Trauma-Injury Infection and Critical Care, 1997, 43(6):922-925.

40. Barell, V., Aharonson-Daniel, L., Fingerhut, L. A., Mackenzie, E. J., Ziv, A., Boyko, V., Abargel, A., et al., An introduction to the Barell body region by nature of injury diagnosis matrix, Inj Prev, 2002, 8(2):91-96.

41. Agency for Healthcare Research and Quality, Medical Expenditure Panel Survey (MEPS).

42. Machlin, S. R., Health Care Expenditures for Injury-Related Conditions, 2002, Wahsington, DC: Agency for Healthcare Research and Quality, 2005.

43. Agency for Healthcare Research and Quality, Using appropriate price indices for analysis of health care expenditures of income across multiple years.

44. SAS/STAT, Cary, NC: SAS Insitute, 2014.

45. Duan, N., Manning, W. G., Moris, C. N. and Newhouse, J. P., A comparison of alternative models for the demand for medical care, J Bus Econ Statist, 1983, 1(1):115-126.

46. Zwerling, C., Whitten, P. S., Davis, C. S. and Sprince, N. L., Occupational injuries among workers with disabilities - The National Health Interview Survey, 1985-1994, JAMA, 1997, 278(24):2163-2166.

47. Zwerling, C., Sprince, N. L., Davis, C. S., Whitten, P. S., Wallace, R. R. and Heeringa, S. G., Occupational injuries among older workers with disabilities: A prospective cohort study of the health and retirement survey, 1992 to 1994, Am J Public Health, 1998, 88(11):1691-1695.

48. Tousignant, M., Rossignol, M., Goulet, L. and Dassa, C., Occupational disability related to back pain: Application of a theoretical model of work disability using prospective cohorts of manual workers, Am J Ind Med, 2000, 37(4):410-422.

49. Chi, C. F., Chen, C. L. and Lin, T. Y., Risk for occupational injury of handicapped workers in Taiwan, Percept Mot Skills, 2001, 93(1):89-94.

50. Sprince, N. L., Park, H., Zwerling, C., Lynch, C. F., Whitten, P. S., Thu, K., Burmeister, L. F., et al., Risk factors for animal-related injury among Iowa large-livestock farmers: A

case-control study nested in the agricultural health study, Journal of Rural Health, 2003a, 19(2):165-173.

51. Sprince, N. L., Zwerling, C., Lynch, C. F., Whitten, P. S., Thu, K., Gillette, P. P., Burmeister, L. F., et al., Risk factors for falls among Iowa farmers: A case-control study nested in the Agricultural Health Study, Am J Ind Med, 2003b, 44(3):265-272.

52. Chau, N., Mur, J. M., Benamghar, L., Siegfried, C., Dangelzer, J. L., Francais, M., Jacquin, R., et al., Relationships between certain individual characteristics and occupational injuries for various jobs in the construction industry: A case-control study, Am J Ind Med, 2004, 45(1):84-92.

53. Gauchard, G. C., Mur, J. M., Touron, C., Benamghar, L., Dehaene, D., Perrin, P. and Chau, N., Determinants of accident proneness: a case-control study in railway workers, Occup Med (Lond), 2006b, 56(3):187-190.

54. Breslin, F. C. and Pole, J. D., Work injury risk among young people with learning disabilities and attention-deficit/hyperactivity disorder in Canada, Am J Public Health, 2009, 99(8):1423-1430.

55. Lysaght, R., Sparring, C., Ouellette-Kuntz, H. and Marshall, C. A., Injury incidence and patterns in workers with intellectual disability: A comparative study, J Intellect Dev Disabil, 2011, 36(4):280-284.

56. Clough-Gorr, K. M., Erpen, T., Gillmann, G., von Renteln-Kruse, W., Iliffe, S., Beck, J. C. and Stuck, A. E., Preclinical disability as a risk factor for falls in community-dwelling older adults, Journals of Gerontology Series a-Biological Sciences and Medical Sciences, 2008, 63(3):314-320.

57. Cox, C. R., Clemson, L., Stancliffe, R. J., Durvasula, S. and Sherrington, C., Incidence of and risk factors for falls among adults with an intellectual disability, J Intellect Disabil Res, 2010, 54(12):1045-1057.

58. Gauchard, G. C., Deviterne, D., Guillemin, F., Sanchez, J., Perrin, P. P., Mur, J. M., Ravaud, J. F., et al., Prevalence of sensory and cognitive disabilities and falls, and their relationships: A community-based study, Neuroepidemiology, 2006a, 26(2):108-118.

59. Grant, H. J., Pickett, W., Lam, M., O'Connor, M. and Ouellette-Kuntz, H., Falls among persons who have developmental disabilities in institutional and group home settings, Journal on Developmental Disabilities, 2001, 8(1):57-73.

60. Henry-Sanchez, J. T., Kurichi, J. E., Xie, D. W., Pan, Q. and Stineman, M. G., Do Elderly People at More Severe Activity of Daily Living Limitation Stages Fall More?, Am J Phys Med Rehab, 2012, 91(7):601-610.

61. Hsieh, K., Heller, T. and Miller, A. B., Risk factors for injuries and falls among adults with developmental disabilities, Journal of Intellectual Disability Research, 2001, 45:76-82.

62. Koski, K., Luukinen, H., Laippala, P. and Kivela, S. L., Risk factors for major injurious falls among the home-dwelling elderly by functional abilities - A prospective population-based study, Gerontology, 1998, 44(4):232-238.

63. Lamoureux, E. L., Chong, E., Wang, J. J., Saw, S. M., Aung, T., Mitchell, P. and Wong, T. Y., Visual impairment, causes of vision loss, and falls: the singapore malay eye study, Invest Ophthalmol Vis Sci, 2008, 49(2):528-533.

64. Leff, M., Stallones, L., Xiang, H. Y. and Whiteneck, G., Disability, environmental factors and non-fatal injury, Inj Prev, 2010, 16(6):411-415.

65. Poor, G., Atkinson, E. J., O'Fallon, W. M. and Melton, L. J., 3rd, Predictors of hip fractures in elderly men, J Bone Miner Res, 1995, 10(12):1900-1907.

66. Stevens, J. A., Powell, K. E., Smith, S. M., Wingo, P. A. and Sattin, R. W., Physical activity, functional limitations, and the risk of fall related fractures in community-dwelling elderly, Annals of Epidemiology, 1997, 7(1):54-61.

67. Price, J., Shi, J., Lu, B., Smith, G. A., Stallones, L., Wheeler, K. K. and Xiang, H., Nonoccupational and occupational injuries to US workers with disabilities, Am J Public Health, 2012, 102(9):e38-46.

68. Unger, D. D., Employers' attitudes toward persons with disabilities in the workforce: myths or realities? , Focus Autism Other Dev Disabl, 2002, 17(1):2-10.

69. Dewey, R., Promoting the health and safety of individuals with developmental disabilities employed in mainstream settings Berkeley: University of Caifornia at Berkeley, 2006.

70. Agran, M., Madison, D. and Bown, C., Teaching supported employees to prevent work injuries, J Vocat Rehabil, 1995, 5(1):33-42.

Publications

- ***Peer-review Journal Articles*** **(NIOSH Funding Were Acknowledged)**

1. Brophy M, Zhang X, and **Xiang H**. Unintentional injuries among U.S. adults with disabilities. Epidemiology 2008; 19(3):465-471.

2. **Xiang H**, Shi J, Wheeler K, and Wilkins III JR. Disability and employment among U.S. working-age immigrants. Am J of Ind Med 2010; 53(4):425-434.

3. Price J, Shi J, Lu B, Smith GA, Stallones L, Wheeler K, and **Xiang H**. Non-occupational and occupational injuries to U.S. workers with disability. Am J Public Health 2012; 102(9):e38-46.

4. **Xiang H**, Wheeler K, and Stallones. Disability status: an important risk factor in injury epidemiological research. Ann Epidemiol 2014; 24(1): 8-16.

5. Shi X, Wheeler K, Shi J, Stallones L, Ameratunga S, Shakespear T, and **Xiang H**. Increased risk of unintentional injuries in adults with disabilities: a systematic review and meta-analysis. Disability and Health (revised).

6. Shi J, Gardner S, Wheeler K, Thompson M, Lu B, Stallones L, and **Xiang H**. Characteristics of occupational injuries among U.S. workers with and without disabilities. Am J Ind Med (revised).

7. Shi, J, Wheeler K, Lu B, Bishai D, Stallones L, and **Xiang H**. Medical expenditures associated with nonfatal occupational injuries among U.S. workers reporting persistent disabilities. Disability and Health (revised).

- ***Related Peer-review Journal Articles*** **(NIOSH Funding Were not Acknowledged)**

1. Alhajj T, Wang L, Wheeler K, Zhao W, Sun Y, Stallones L, and **Xiang H**. Prevalence of disability among adolescents and adults in rural China. Disabil Health J 2010; 3(4): 282-288.

2. Leff M, Stallones H, **Xiang H**, and Whiteneck G. Disability, environmental barriers, and non-fatal injury. Inj Prevention 2010; 16 (6): 411-415.

3. Peng J. Lyu T, Shi J, Nagaraja H.N. and **Xiang H**. Models for injury count data from the National Health Interview Survey (NHIS). J of Scientific Research and Reports 2014; 3(17): 2286-2302.

- ***Invited Speeches***

1. "Disability status, an important factor in injury epidemiologic research" at the Third North America Congress of Epidemiology, Montreal, Quebec, Canada (June 21-24, 2011).

2. “Secondary Injuries among Individuals with Special Needs and Health People 2020 Objectives“ Invited presentation to researchers at the Chinese Center for Disease Control and Prevention (China CDC), Beijing, The People’s Republic of China. March 21, 2011.

3. “Grant Peer Review and Research Application Development” Invited presentation to researchers at the School of Public Health, Tongji Medical College, The People’s Republic of China, March 25, 2011.

4. “Secondary Injuries Among Individuals With Disabilities.” Invited presentation to researchers and faculty at the Chinese Hong Kong University School of Public Health, Hong Kong, China. July 30, 2011.

5. “Should “Disability Status” be a Covariate in Most Epidemiological Research?.” Invited speaker to a special seminar hosted by CDC Disability and Health Work Group, National Center on Birth Defects and Developmental Disability. CDC, Atlanta, Georgia, March, 2012.

6. “Injuries Among Individuals With Disabilities.” Invited presentation to researchers and graduate students at the School of Public Health, Tongji Medical College, The People’s Republic of China, July 22, 2013.

- ***Peer-review Conference Proceedings***

1. Zhao W, **Xiang H**, Wheeler K, Smith GA, Stallones L. Medical care utilization among U.S. adults with disabilities. The 138th APHA Annual Meeting, Denver, Colorado, November 6-10, 2010 (Poster presentation).

2. **Xiang H**. Disability status, an important factor in injury epidemiologic research. Third North America Congress of Epidemiology, Montreal, Quebec, Canada, June 21-24, 2011 (Invited oral presentation)

3. Zhao W, Wheeler K, Lu B, and **Xiang H**. Occupational injuries among US workers with disabilities. The 139th APHA Annual Meeting, Washington DC, October 29 -November 2, 2011 (Oral presentation).

4. Shi J, Wheeler K, Lu B, Stallones L, Bishai D, and **Xiang H**. Medical care utilization and expenditures associated with occupational injuries among U.S. workers with disabilities. The 140th APHA Annual Meeting, San Francisco, CA, October 27 – October 31, 2012 (Poster presentation).

5. Shi J, Gardner S, Wheeler K, and **Xiang H**. Characteristics of occupational injuries among US workers with and without disabilities. 2013 National Meeting of the Safe State Alliance & SAVIR. Baltimore, MD, June 5-7, 2013 (Oral presentation).

6. Yang J, Ding K, Welter T, Peek-Asa C, and **Xiang H**. Prevalence and type of violence among students with disabilities. The 141th APHA Annual Meeting, Boston, MA, November 2 – November 6, 2013 (Poster presentation).

7. Peng J. Lyu T, Shi J, Nagaraja H.N. and **Xiang H**. Models for injury count data from the National Health Interview Survey. Ordered Data Analysis, Models and Health Research Methods: An International Conference in Honor of H.N. Nagaraja for His 60th Birthday. Richardson, TX, March 7-9, 2014 (Oral presentation).

Inclusion of Gender and Minority Study Subjects

Our study used several national survey datasets. Women and minority subjects were included in our statistical analyses. However, we were unable to provide the gender and minority inclusion table due to the fact that sample size varied between our publications.

Inclusion of Children

Individuals aged 18 or above were included in our statistical analyses. Occupational status and work-related injuries were asked in the national survey datasets that were used for our study.

Materials Available for Other Investigators

None.