

# An Analysis of Permanent Work Disability Among Construction Sheet Metal Workers

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**Background** *Causes of permanent work disability in the sheet metal industry are not well characterized.*

**Methods** *Pension records were used to compare causes of disability among sheet metal workers and the U.S. working population. Subgroup analysis examined the major causes of sheet metal worker disability.*

**Results** *Musculoskeletal disorders (MSDs), circulatory disease, and injuries were leading causes of sheet metal worker disability (47.2%, 13.7%, 10.9% of awards, respectively). Award distribution differed from the U.S. working population ( $P < 0.0001$ ); MSDs and injuries accounted for higher proportions of sheet metal worker awards, particularly at spine, shoulder, and knee.*

**Conclusions** *Higher proportions of awards caused by MSD or injury among sheet metal workers may reflect higher rates of work-related injuries and MSDs, a high likelihood of disability with construction work given the same impairment, or higher prevalence of other conditions in the general population. Prevention requires task-specific ergonomic innovations and proven participatory interventions.* Am. J. Ind. Med. 59:186–195, 2016.

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**KEY WORDS:** *construction; sheet metal; disability; social security; musculoskeletal*

## BACKGROUND

Sheet metal workers install, repair, and maintain ventilation, heating and air conditioning units, and work with other materials containing sheet metal such as signs, rain gutters, and roofs. Over 134,000 sheet metal workers are employed in the U.S. construction and manufacturing industries [Bureau of Labor Statistics, 2014]. Most sheet metal workers (64%) work in the construction industry with specialty trade contractors involved in heating, air-conditioning, plumbing, and roofing. Sheet metal workers have a high rate of nonfatal work-related

injuries, many related to working at height and overexertion secondary to manual material handling [CPWR, 2013]. From 2008 to 2010, the rate of non-fatal lost-time injuries among construction sheet metal workers was 401.9 per 10,000 Full-Time Equivalents compared to 160.6 among all construction workers [CPWR, 2013]. The physically demanding, repetitive tasks in sheet metal work can result in musculoskeletal disorders (MSDs) involving the nerves, muscles, tendons, and supporting structures of the body [Punnett and Wegman, 2004; da Costa and Vieira, 2010]. Despite these physical demands, researchers have yet to examine the nature of permanent work disability among this occupational cohort.

With this study we aim to (i) identify the leading causes of permanent work disability among sheet metal workers and compare these to the leading causes of permanent disability among the U.S. workers, and (ii) further characterize the single most prevalent cause of permanent work disability among sheet metal workers. Characterizing the conditions that lead to disability may ultimately lead to a change in workplace practices to prevent work-related injury and

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illness and also to facilitate working with impairment. Protecting the health of older workers is especially relevant now because as these workers retire shortages of qualified and skilled workers are expected [Silverstein, 2008; Schwatka et al., 2012].

## MATERIALS AND METHODS

### Study Population Definition and Medical Record Abstraction

Data were gathered from the Sheet Metal Workers' National Pension Fund (SMWNPF) between 1990 and 2007. The SMWNPF is a nation-wide program for members of the Sheet Metal Workers International Union Association. Local unions may have plans that complement the national plan or have a separate plan; roughly 50% of all union sheet metal workers in the United States are eligible for benefits from SMWNPF. From 1990 to 1999, a sheet metal worker received disability pension from the pension fund if the fund's medical advisor determined that the worker was totally and permanently disabled for sheet metal work; 90% of awardees during this period also received Social Security Disability Insurance (SSDI) within 2 years. After 2000, sheet metal workers were required to have been accepted by SSDI to receive disability pension from the SMWNPF. To qualify for disability benefits from Social Security, an applicant must have a physical or mental impairment severe enough to keep him/her from "substantial" work for at least a year [Social Security Administration, 2014b]. The requirements consider not only whether the individual is unable to do work previously performed, but also if he or she is able to do any other type of work. An individual's age, education, past experience, and transferable skills are all considered in determining eligibility for Social Security disability benefits. Second, in addition to the medical requirement of the law, an individual must have worked long enough and recently enough to be eligible for benefits [Social Security Administration, 2014b].

Information was abstracted on age and gender of workers, date of disability pension, years in the sheet metal trade, and medical conditions contributing to the disability. Two members of the study team (CT and RN) read narrative reports and transcribed all medical conditions noted. The study director (LW) assigned a code from the 2009 International Classification of Diseases, ninth Revision, Clinical Modification (ICD-9-CM) for each condition that contributed to the disability. Where possible a four or five digit code was assigned; in some cases, the medical information only permitted classification using a three digit ICD-9 code. Each worker was then assigned a primary diagnosis if he had multiple conditions contributing to disability, and that primary diagnosis was used to assign a

primary diagnostic grouping for each individual. The study population included 6,066 diagnoses (ICD-9 codes) among 4,037 male, unionized, construction sheet metal workers awarded long-term disability pension from 1990 to 2007. Data exclusions are illustrated in Figure 1. The study was approved by the Institutional Review Board of CPWR—The Center for Construction Research and Training.

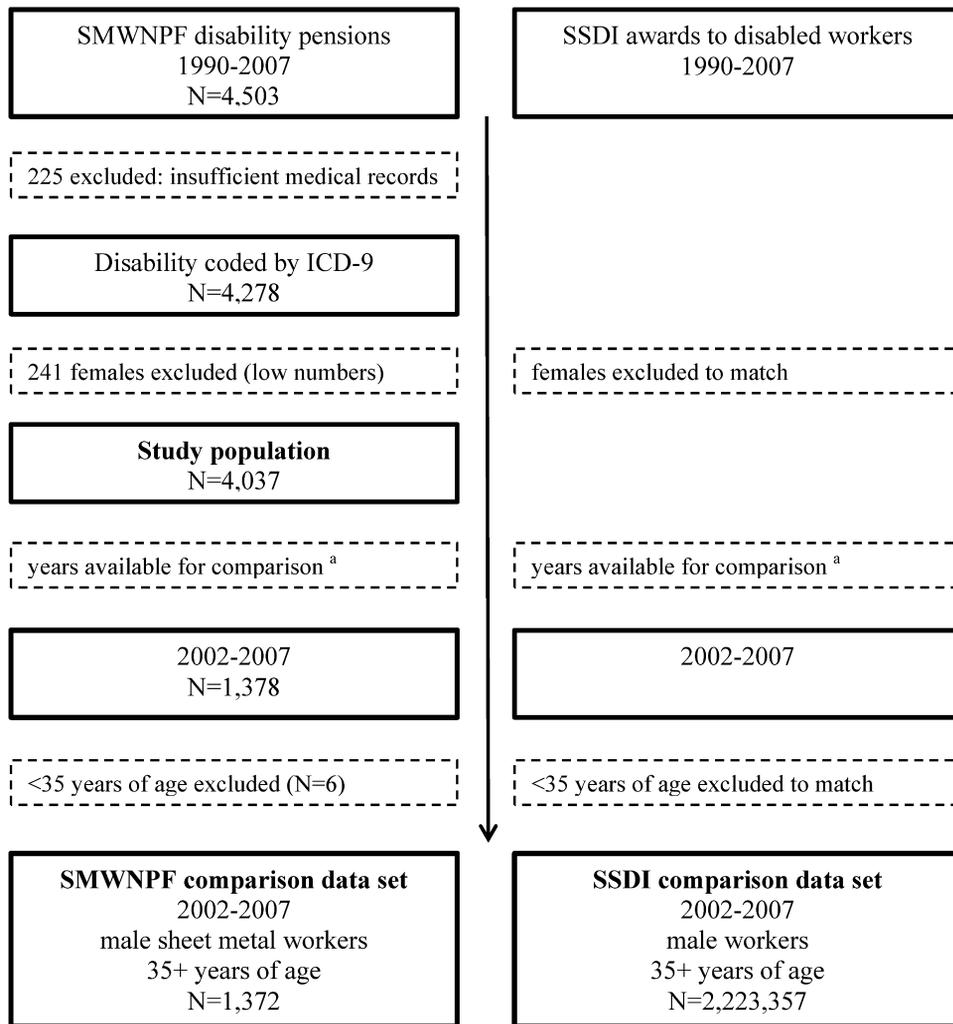
### Comparison to the U.S. Working Population

Publicly accessible data tables showing annual awards to newly disabled workers among the general U.S. working population, stratified by diagnostic group, sex, and age were obtained from Annual Statistical Reports [Social Security Administration, 2014a] on the Social Security Disability Insurance Program (SSDI). The diagnostic groups included endocrine, nutritional, and metabolic diseases; congenital anomalies, infectious and parasitic diseases, injuries, mental disorders, neoplasms, other, and diseases of the blood and blood-forming organs, circulatory system, digestive system, genitourinary system, musculoskeletal system and connective tissue, nervous system and sense organs, respiratory system, skin, and subcutaneous tissue. Eligibility requirements for SSDI awardees are described above. Data sets used for comparison among sheet metal workers and the general working population are illustrated in Figure 1; variables available for comparison are presented in Table I.

### MSD Subgroup Analysis

MSD was determined to be the leading cause of disability among sheet metal workers, consequently additional analyses were performed to characterize the nature of these conditions among a subset of sheet metal workers with any MSD diagnosis contributing to disability. This subgroup more accurately represents the true burden of MSD among the study population. Analyses described in the methods above consider only the primary diagnostic grouping for each individual, but a worker in the cardiovascular diagnostic group, for example, may still have had an MSD contributing to disability.

As has been done elsewhere [Park et al., 1992; Yuan et al., 2011; Dale et al., 2015; Washington State Department of Labor and Industries, 2014], an expanded list of ICD-9 codes was used to classify MSD for this subgroup analysis: 354.XX (carpal tunnel syndrome and other nerve disorders), 710-739 (MSD), and 840-848 (sprains and strains of joints and adjacent muscles). A primary part of body affected by MSD was assigned for each individual; if an MSD diagnosis was the primary disabling diagnosis, primary part of body was assigned using that diagnosis. If more than one MSD diagnosis



**FIGURE 1.** SMWNPf study population and SSDI comparison data set. <sup>a</sup>SMWNPf records were obtained through 2007. Prior to 2002, SSDI data tables obtained were based on a 1% sample of the SSA Annual Award and Termination Transaction file and contained incomplete data. From 2000 onward, sheet metal workers were required to have been accepted by SSDI to receive disability pension from the SMWNPf.

affecting the same body part contributed to disability but were not the primary cause of disability, primary body part affected was assigned using these diagnoses. Remaining workers with MSD were assigned to one of three categories: multiple diagnoses affecting multiple parts of the body, osteoarthritis at multiple or unspecified sites, or chronic infections and systemic disorders where primary part of body could not be assigned.

### Statistical Analysis

Univariate analysis was used to characterize demographic factors. Stratified analyses were used to examine sheet metal worker disability awards by primary diagnostic category, year of award, and age of awardees at time of

disability pension. Two-tailed Cochran Armitage tests for trend were used to determine if proportions of sheet metal worker disability awards by primary diagnostic category changed over time.  $\chi$ -square tests were used to determine if older sheet metal workers were more likely to have multiple conditions contributing to disability and to determine if causes of permanent work disability differed by distribution within age strata for sheet metal workers compared to the general working population. Additional stratified analyses among the subset of sheet metal workers with MSD were used to examine MSDs and spinal MSDs by primary body part affected, age, and years worked in the sheet metal trade. Alpha level ( $P \leq 0.05$ ) was used for hypothesis testing. SAS version 9.2 [SAS Institute Inc., 2011] was used for all statistical analyses.

**TABLE I.** Available Data to Compare Disability Between Sheet Metal Workers and the U.S. Working Population

Variables	SMWNPF <sup>a</sup>	SSDI <sup>b</sup>
Age (years)	Continuous values	<35, 35–49, 50+
Years worked	Continuous values	Unavailable
Gender	Male/female	Male/female
Occupation	Sheet metal worker	Any
Disability diagnosis	One to three ICD-9 diagnoses per individual; ICD-9 diagnostic groupings	SSA diagnostic groupings <sup>c</sup>
Diagnostic groupings used for comparison <sup>d</sup>	Neoplasms (140–239)	Neoplasms
	Mental disorders (290–319)	Mental disorders
	Injury and poisoning <sup>e</sup> (800–999)	Injuries
	Diseases of the—nervous system and sense organs (320–389), circulatory system (390–459), respiratory system (460–519)	Diseases of the—nervous system and sense organs, circulatory system, respiratory system

<sup>a</sup>Sheet Metal Worker National Pension Fund data set (1990–2007).

<sup>b</sup>Annual statistical reports on the Social Security Disability Insurance Program (2002–2007).

<sup>c</sup>A representative of the Social Security Administration (SSA) confirmed that almost all individual SSA impairment codes are based on ICD-9 coding and that the ICD-9 and SSA diagnostic groupings compared in this study do align and include the same range of diagnosis codes.

<sup>d</sup>The diagnostic groupings shown in the table accounted for 89.7% of awards to sheet metal workers over the years used for comparison to SSDI (2002–2007).

<sup>e</sup>Poisoning did not contribute to disability for any sheet metal worker in the study population.

## RESULTS

### Characterizing Disability Among Sheet Metal Workers

The mean age of 4,037 male, unionized, construction sheet metal workers at the time of disability pension was 52.6 ± 5.8 years; mean number of years worked in the sheet metal industry was 21.8 ± 6.3 years. Most sheet metal workers had only one disabling condition, but nearly 40% (N = 1,560) had two or more conditions contributing to disability. Compared to workers younger than 50 years of age, older workers were more likely to have more than one condition contributing to disability (odds ratio 1.37; 95%CI: 1.18–1.58).

Leading causes of long-term work disability among the study population, using the primary diagnosis for each worker, are presented in Figure 2. The five specified ICD-9 diagnostic groups shown in Figure 2 accounted for roughly

86% of all SMWNPF disability awards from 1990 to 2007. MSDs were the most common primary cause of disability, accounting for nearly half (47.2%) of all awards over the 18 year study period. Circulatory disease and injuries were the second and third leading causes of disability, representing 13.7% and 10.9%, respectively, of all awards to sheet metal workers. Causes of sheet metal worker disability shown in Figure 2 were stable over time, with the exception of diseases of the circulatory system, which decreased as a proportion of annual awards over the study period (Cochran–Armitage trend test  $Z = 2.0, P = 0.04$ ).

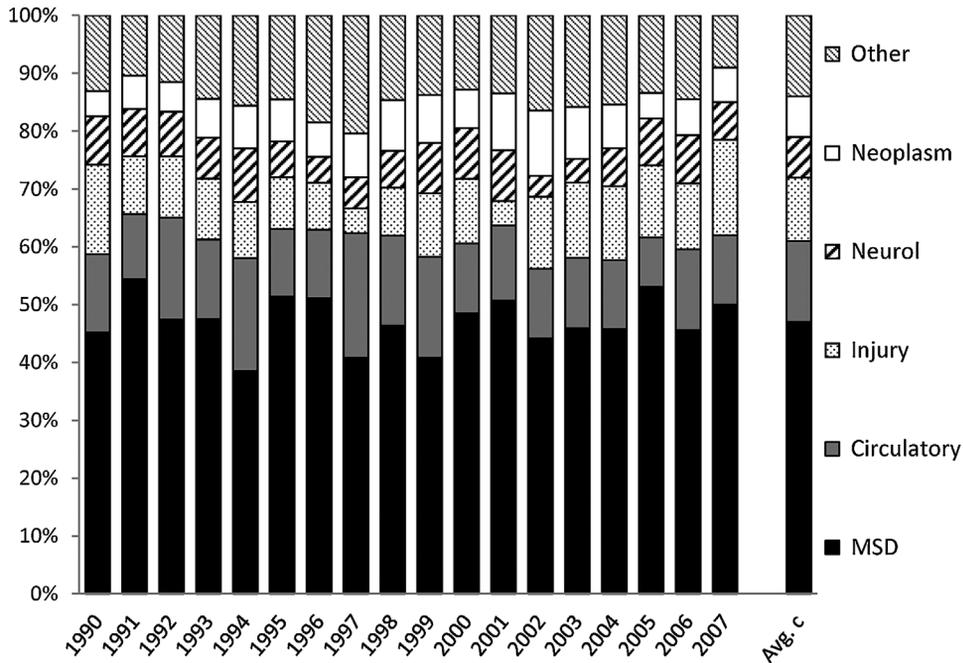
### SSDI Comparison

Primary causes of long-term work disability were distributed differently among workers awarded a pension from SMWNPF compared to those awarded one from SSDI, with statistically significant differences observed among both the 35–49 year old age group ( $P < 0.0001$ ) and the workers 50 years and older ( $P < 0.0001$ ). Table II illustrates the higher proportion of disability due to MSD and injury among sheet metal workers compared to the general working population, particularly for younger workers. MSDs and injuries accounted for more than 60% of disability awards among sheet metal workers 35–49 years of age compared to fewer than 30% for SSDI awardees in this age group. Diseases of the circulatory system accounted for a lower proportion of sheet metal worker disability awards among workers 50 and older (13%) compared to SSDI awards among the same age group (19%). Similarly, cancers accounted for a lower proportion of awards to older sheet metal workers. Mental disorders were a notable cause of disability in the general working population but infrequently the cause of disability among sheet metal workers.

### MSD Subgroup Analysis

MSD as defined by ICD-9 (710–739) was the primary cause of disability for 47.2% (N = 1,860) of the study population for whom a primary disabling diagnosis could be assigned. Using an expanded case definition of ICD-9 MSD codes and considering all diagnoses, the majority of awardees (58.0%) had at least one MSD that contributed to disability. A total of 3,340 MSDs affected these 2,343 workers. More than two-thirds of this subgroup with MSD was permanently disabled before 56 years of age.

Body locations most affected by MSD were the spine (46.3%), shoulder (11.7%), multiple sites afflicted by distinct MSDs (11.1%), and the knee (8.6%). Conditions affecting the rotator cuff were frequently indicated among MSDs of the shoulder. For all age and work duration strata examined, spinal disorders were the most frequent manifestation of MSD (Table III). Nearly one third of the overall study



**FIGURE 2.** Percentage of permanent work disability awards by primary cause<sup>a</sup> and year of award among male unionized sheet metal workers (N = 3,937)<sup>b</sup>. <sup>a</sup>Neurol, diseases of the nervous system and sense organs; Circulatory, diseases of the circulatory system; MSD, diseases of the musculoskeletal system and connective tissue. <sup>b</sup>Figure excludes 100 workers for whom primary cause of disability could not be distinguished. <sup>c</sup>Average from 1990 to 2007.

population (N = 1,313; 32.5%) had at least one spinal disorder that contributed to permanent work disability. Among this sub-population, there were 1,566 spinal MSDs, comprised mostly of lumbar (57%) and cervical disorders (22%). On average, disabled sheet metal workers with a spinal MSD contributing to disability retired at 52.1 ± 5.8 years of age, after 22.0 ± 6.1 years of sheet metal work.

Differences in body part affected were observed across age and years worked strata for the subgroup of sheet metal workers with MSD (Table III). MSDs primarily affecting the spine accounted for a higher proportion of awards among younger workers (54.3%) compared to those in their 50s (44.3%) and those 60 years or older (34.5%). The proportion of workers with two or three MSDs affecting different body parts was highest among sheet metal workers aged 60 or more at disability retirement; a similar excess is seen for the subgroup with 30+ years of work. The proportion of MSDs affecting the foot, ankle, or lower leg increased as workers aged.

## DISCUSSION

Permanent work disability due to an MSD or an injury accounts for a higher proportion of disability awards among sheet metal workers than among the general working population of the United States, whereas cancer, neurologic and cardiovascular diseases are proportionally less likely.

This higher proportion of disability due to either an injury or an MSD could be caused by higher rates of work-related injury and chronic MSDs among the sheet metal workers, by the fact that the physical demands of the job in a construction trade create disability from an impairment that might not cause disability in a worker with a less physically demanding job, or due to a higher frequency of other conditions, such as mental disorders among the general working population. Even without being able to determine the precise reason for the differences, the results presented here clearly show that MSDs are by far the leading cause of permanent work disability among sheet metal workers, accounting for approximately half of all awards over the 18 year study period. Leading causes of sheet metal worker disability were stable over time, aside from circulatory diseases, which accounted for a decreasing proportion of disability awards over the study period. This finding is likely explained by a coincident increase in smoking cessation reported among this cohort [Welch and Haile, 2009] and is consistent with observed declines in cardiovascular disease among developed nations since the 1960s [O’Flaherty et al., 2013].

Recognized risk factors for disability retirement include age, having an MSD, the severity of injury, greater pain and functional disability, a low score on the Work Ability Index (WAI) [Ilmarinen et al., 1997], missing more than 7 days of work, physically demanding work, working in construction, lack of job accommodation, and psychosocial factors related

**TABLE II.** Primary Causes of Long-Term Work Disability Among Working Male SSDI<sup>a</sup> and SMWNPF<sup>b</sup> Awardees Aged 35 Years and Older (2002–2007)

Diagnostics category	Awards to workers 35–49 years (n, %) <sup>c</sup>		Awards to workers 50+ years (n, %) <sup>d</sup>	
	SMWNPF	SSDI	SMWNPF	SSDI
Circulatory	31 (7.7)	63,177 (8.6)	126 (13.0)	283,652 (19.0)
Injuries	67 (16.7)	39,294 (5.4)	108 (11.1)	59,169 (4.0)
MSD <sup>e</sup>	176 (43.9)	172,794 (23.6)	454 (46.8)	445,879 (29.9)
Mental disorders	21 (5.2)	213,171 (29.2)	23 (2.4)	178,726 (12.0)
Neoplasms	27 (6.7)	56,581 (7.7)	73 (7.5)	171,852 (11.5)
Neurologic	34 (8.5)	61,861 (8.5)	46 (4.7)	107,721 (7.2)
Other	38 (9.5)	108,937 (14.9)	104 (10.7)	161,682 (10.8)
Respiratory	7 (1.8)	15,314 (2.1)	37 (3.8)	83,547 (5.6)
Total	401 (100)	731,129 (100)	971 (100)	1,492,228 (100)

<sup>a</sup>Social security disability insurance.

<sup>b</sup>Sheet Metal Worker National Pension Fund.

<sup>c</sup> $\chi$ -square = 253, 7 df,  $P < 0.0001$ .

<sup>d</sup> $\chi$ -square = 338, 7 df,  $P < 0.0001$ .

<sup>e</sup>Diseases of the musculoskeletal system and connective tissue (710–739).

to coworker support and expectations of recovery [Krause et al., 1997; Burkhauser and Butler, 1999; Borg et al., 2001; Karpansalo et al., 2002; Salonen et al., 2003; Nordlund and Ekberg, 2004; Pransky et al., 2005; Steenstra et al., 2005; Seland et al., 2006; Polvinen et al., 2014].

Prior studies show that construction workers stop working at an earlier age than do other workers [Brenner and Ahern, 2000; Siebert et al., 2001; Arndt et al., 2005; CPWR, 2007]. Physical work load is an important determinant of work ability among construction workers [Alavinia et al., 2007], and work ability is highly predictive of disability among construction workers specifically [Liira et al., 2000; Kujala et al., 2006; Alavinia et al., 2007]. Burdorf et al. [2005] estimated that a construction worker between the ages of 45 and 54 with a low WAI score and severe low back pain has a 40-fold increased probability of disability retirement compared to a construction worker without those risk factors. MSDs specifically increase the risk for retirement among construction workers [Vingard et al., 1992; Arndt et al., 2005; Burdorf et al., 2005].

We know that MSDs are prevalent among active construction workers [Hunting et al., 1994; Lemasters et al., 1998; Schneider, 2001; Merlino et al., 2003; Holmstrom and Engholm, 2003; Goldsheyder et al., 2004; Engholm and Holmstrom, 2005; CPWR, 2013]. Sheet metal workers spend significant amounts of time hanging duct work, which entails sustained and forceful overhead work [Anton et al., 2001; Rempel et al., 2010; Hunting et al., 2010], activities associated with increased shoulder pain and shoulder injuries [Engholm and Holmstrom, 2005; Roquelaure et al., 2011; Bodin et al., 2012]. Prospective cohort studies have shown that highly repetitive work predicts arm pain and heavy lifting predicts

back pain [Andersen et al., 2007]. Workers who repeatedly sustained postures with their arms above shoulder level (>2 hr./day) and who reported high perceived physical exertion were 3.3 times more likely to develop rotator cuff syndrome, compared to workers who reported neither repeated raised arm work nor high exertion [Bodin et al., 2012]. In line with these studies, we found the shoulder to be the second most common site for MSD among sheet metal workers. There are no studies of spinal loading and spinal disorders specifically among sheet metal workers, but it is well recognized that spinal loading contributes to lumbar disc disorders and other low back disorders [Marras et al., 1993; Hoogendoorn et al., 2000; Seidler et al., 2001; Krause et al., 2004; Mariconda et al., 2007; Seidler et al., 2009, 2011; Marras et al., 2010, 2014; Sorensen et al., 2011; Jager et al., 2013], and sheet metal workers frequently engage in manual material handling [Hunting et al., 2010].

For the MSD subgroup analysis, differences in body location of disability diagnoses were observed across job tenure and age strata. For example, MSDs primarily affecting the spine accounted for higher proportions of awards to younger workers, whereas two or more MSDs affecting different sites of the body accounted for higher proportions of awards among the oldest workers and those with the longest job tenure. It is possible to speculate that spinal MSDs tended to be more disabling than other forms of MSD, causing earlier exit from the workforce, and that older workers were more likely to acquire multiple but less severe MSDs over the course of a career, prolonging retirement until the cumulative effect of these conditions became manifest. Unfortunately, the results do not support any firm conclusions in this regard, and additional research is needed to

**TABLE III.** Primary Body Part Affected Among Sheet Metal Workers With MSD<sup>a</sup>, by Age and Years Worked in the Sheet Metal Trade

Primary body part affected by MSD	Number of awards (%) by age at pension (years)			Number of awards (%) by years worked		
	<50	50–59	60+	<20	20–29	30+
Foot/ankle/ lower leg	26 (4.1)	85 (5.5)	18 (10.7)	52 (6.0)	64 (5.3)	13 (5.1)
Hip/pelvis	14 (2.2)	51 (3.3)	7 (4.2)	20 (2.3)	34 (2.8)	18 (7.0)
Knee	51 (8.1)	136 (8.8)	14 (8.3)	66 (7.6)	110 (9.0)	25 (9.8)
Multiple diagnoses <sup>b</sup>	53 (8.4)	182 (11.8)	24 (14.3)	98 (11.3)	122 (10.0)	39 (15.2)
Osteoarthritis <sup>c</sup>	17 (2.7)	58 (3.7)	8 (4.7)	33 (3.8)	41 (3.4)	9 (3.5)
Other <sup>d</sup>	38 (6.0)	89 (5.8)	6 (3.6)	53 (6.1)	71 (5.8)	9 (3.5)
Shoulder/upper arm	59 (9.4)	191 (12.3)	25 (14.9)	102 (11.7)	139 (11.4)	34 (13.3)
Spine	342 (54.3)	684 (44.3)	58 (34.5)	402 (46.3)	576 (47.3)	106 (41.4)
Wrist/hand	30 (4.8)	69 (4.5)	8 (4.8)	43 (4.9)	61 (5.0)	3 (1.2)
Total	630 (100)	1,545 (100)	168 (100)	869 (100)	1,218 (100)	256 (100)

<sup>a</sup>Diseases of the musculoskeletal system and connective tissue (expanded case definition) contributed to disability, including non-primary diagnoses (N = 2,343 out of 4,037 individuals included in the study).

<sup>b</sup>Two or three MSD diagnoses contributed to disability, affecting distinct body parts; primary body part affected could not be discerned.

<sup>c</sup>Osteoarthritis at multiple sites or site not specified.

<sup>d</sup>Workers with MSD comprised of chronic infections and systemic disorders for whom primary part of body could not be assigned.

evaluate the significance and underlying causes of the differences observed.

This study has both strengths and limitations. Strengths include large administrative data sets from both SMWNPF and SSDI, spanning a number of years, which included specific diagnoses. Although definitions of work disability often differ, the same criteria were used to determine disability for the great majority of workers in both datasets (all sheet metal workers since 2000 and 90% prior to 2000 met SSDI criteria), which allowed a subset of years to be used for direct comparison.

Two differences between the data sets exist. SMWNPF requires 5 years as a union member, whereas SSDI requires a minimum of 10 years of work, and the diagnostic groupings used by ICD-9 and SSDI are not identical. However, only a small number of sheet metal workers in our study population were awarded disability with fewer than 10 years of service (N = 179, 4.4%). The areas where the diagnostic groupings differed between the SSDI and SMWNPF should not affect the proportion of awards due to MSDs since the analysis was limited to men over age 35, while differences in the groupings are found in classification of diseases of pregnancy, childbirth, and the perinatal period.

The proportions could differ if underlying differences in transferable skills and education were more limited among sheet metal workers than in the general population. We do not think this is an explanation for our findings, since sheet metal work requires a college degree and good mathematical skills, while 75% of disabled workers overall have 12 or fewer years of education [Social Security Administration, 2001].

Other limitations include the lack of information in pension files on work-relatedness, and the lack of publically available comparison data in the United States for disability

due to ICD-9 codes beyond the large diagnostic groupings presented here. Demographic factors of race and socioeconomic status were also unavailable, as were denominator data to examine rates and relative risk.

In this study we have found an important interaction between the presence of either an injury or MSD and disability retirement among sheet metal workers. The heavy physical demands in this occupation can both cause MSD and cause early exit from the workforce in individuals who have an MSD; working conditions also cause injuries that may be disabling. To prevent disability among these workers, we do not need to determine whether the MSD is caused by work or if work prevents continued employment with diseases of aging; addressing work demands will improve both scenarios. To this point, a study by Alavinia et al. [2009] found that reducing manual materials handling and improving job control and work ability can keep construction workers successfully employed.

To reduce disability among sheet-metal workers and other construction workers, we can implement both rehabilitation programs for the injured worker and ergonomic programs to reduce MSDs. We know from research in other industries that job accommodation reduces disability, and that vocationally oriented multi-disciplinary rehabilitation programs reduce sickness absence and delay retirement [Lindh et al., 1997; Suoyrjo et al., 2009]. An intervention program for construction workers in the Netherlands demonstrated feasibility and efficacy in construction [de Boer et al., 2007], and a study from the United States [Welch et al., 2009] found that construction roofers who received job accommodation for an MSD or medical condition were significantly less likely to retire compared to workers with similar medical status without accommodation.

Preventing injury and reducing the physical demands on all workers in construction is essential. Success will require changing the culture of construction, developing new task-specific ergonomic innovations, and promoting participatory safety and ergonomics programs for this industry. Others have discussed the particular characteristics of the construction industry that challenge the application of ergonomic principles [van der Molen et al., 2005a, 2005c; Weinstein et al., 2007; Jaegers et al., 2014]. By understanding these challenges, researchers have developed effective interventions that can reduce physical demands in construction [Vink et al., 2002, 2006; Hess et al., 2004; van der Molen et al., 2004, 2005b; Albers and Estill, 2007; Entzel et al., 2007; Albers et al., 2005; Stafford and Rempel, 2007; Jensen and Friche, 2008; Rempel et al., 2009], and succeeded using a participatory approach [Hess et al., 2004; de Jong et al., 2003; van der Molen et al., 2004, 2005b]. Interventions that are more likely to succeed have a relative advantage, are compatible with prevailing norms or practices, can be tried before being implemented, and have a readily observable impact. Such interventions can reduce the high proportion of disability due to MSDs among sheet metal workers.

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## DISCLOSURE (AUTHORS)

The authors do not declare any competing interests or conflicts of interest.

## DISCLOSURE BY AJIM EDITOR OF RECORD

Steven Markowitz declares that he has no competing or conflicts of interest in the review and publication decision regarding this article.

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