



Published in final edited form as:

*J Occup Environ Med.* 2013 September ; 55(9): 1091–1099. doi:10.1097/JOM.0b013e31829b27bf.

## Work-Related Knee Injuries Treated in Emergency Departments in the United States

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### Abstract

**Objective**—To characterize work-related knee injuries treated in U.S. emergency departments (EDs).

**Methods**—We characterized work-related knee injuries treated in EDs in 2007 and examined trends from 1998 to 2007 by using the National Electronic Injury Surveillance System—occupational supplement (NEISS-Work).

**Results**—In 2007, 184,300 ( $\pm$  54,000, 95% confidence interval) occupational knee injuries were treated in U.S. EDs, accounting for 5% of the 3.4 ( $\pm$  0.9) million ED-treated occupational injuries. The ED-treated knee injury rate was 13 ( $\pm$  4) injuries per 10,000 full-time equivalent workers. Younger workers and older female workers had high rates. Strains/sprains and contusions/abrasions were common—frequently resulting from falls and bodily reaction/overexertion events. Knee injury rates declined from 1998 through 2007.

**Conclusions**—Knee injury prevention should emphasize reducing falls and bodily reaction/overexertion events, particularly among all youth and older women.

Work-related knee injuries are common and often result in significant loss of productivity and health care expenditures. Most published knee injury data have focused on state-based workers' compensation data, establishment-based studies, specific types of knee injuries, or ergonomic evaluations. National surveillance of occupational knee injuries is limited primarily to two systems: the Bureau of Labor Statistics (BLS) Survey of Occupational

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The findings and conclusions in this report are those of the authors and do not necessarily represent the views of the National Institute on Minority Health and Health Disparities, the National Institute for Occupational Safety and Health, the Centers for Disease Control and Prevention, or the US Department of Health and Human Services. Any mention of trade names, commercial practices, or organizations is for descriptive purposes only and does not imply endorsement by the U.S. Government.

### Conflicts of Interest

The authors declare no conflict of interest.

Injuries and Illnesses (SOII) and the National Institute for Occupational Safety and Health (NIOSH) emergency department (ED) surveillance. Neither system has been used to systematically describe knee injuries in the United States. The latter data covering knee injuries and disorders are the subject of this report.

In 2010, the BLS SOII reported that knees were the second (9%) most commonly injured body part that resulted in one or more days away from work (DAFW) among private industry and state/local government employees.<sup>1</sup> Only back injuries (19%) exceeded knee injuries involving DAFW. The overall knee DAFW injury rate was 10.9 cases per 10,000 full-time equivalent workers (FTE). State (16.7) and local government workers (19.6) had nearly twice the knee DAFW injury rate as private industry workers (9.6). These knee injuries required a median of 15 DAFW compared with eight DAFW for all types of injuries. In 2007–2008, “total incurred costs” per workers’ compensation claim for knee injuries averaged \$28,993.<sup>2</sup>

Within private industry sectors in 2010, the BLS reported that the Transportation and Warehousing Sector had the highest knee injury DAFW rate (21.7/10,000 FTE) followed by the Utilities Sector (17.0) and the Construction Sector (13.2).<sup>3</sup> Among state government workers, which are primarily service providing and public administration, the health care and social assistance sector had a knee DAFW injury rate of 34.1/10,000 FTE. Justice, Public Order, and Safety Activities workers had a rate of 35.9/10,000 FTE.<sup>4</sup> Most local government workers had similar rates, but Police and Fire Protection workers had particularly high DAFW knee injury rates (39.4 and 63.8/10,000 FTE, respectively).<sup>5</sup> Others have also reported knee injury estimates and issues in various industry sectors and occupations including construction,<sup>6–8</sup> emergency responders,<sup>9</sup> healthcare,<sup>10</sup> mining,<sup>11</sup> and utilities.<sup>12,13</sup>

Two reports have detailed injury claims involving work-related musculoskeletal disorders (WMSD) of the knee in monopolistic (single payer) state workers’ compensation systems. Washington State experienced nearly 25,000 knee-WMSD claims at a cost of \$494 million from 1999 through 2007.<sup>14</sup> WMSD-knee claims had an average total direct cost of \$20,222 and median cost of \$1,900. Forty-nine percent of the claims involved indemnity payments for >3 days of lost work time. Whereas Ohio had about 90,000 knee-WMSD claims in the period 1999–2004 with an average total cost of \$4,957 and median cost of \$515.<sup>15</sup> Only 29% of the knee WMSD claims included indemnity payments in Ohio, a state that requires >7 days of lost work time for indemnity payments. Despite the significant difference in waiting period for indemnity payments, data from both states illustrate the economic burden to employers from knee WMSD. These studies focused on WMSD involving the knee such as meniscal/ligamentous disruption, sprain/strain, tendinitis/bursitis/enthesopathy, chondromalacia patellae, ganglion/cyst, and synovitis. Except for meniscus or cartilage tears and sprains and strains, other claims for acute knee injuries were excluded.

Acute knee injuries are often secondary to direct blunt trauma or excessive tension applied to the joint. Collateral ligament sprains, cruciate ligament sprains, meniscal damage, contusion, and patellar dislocation or subluxation are commonplace.<sup>16</sup> Overuse injuries such as patellar tendinopathy, iliotibial band syndrome, cartilage disorders, medial plica

syndrome, and bursitis are frequently caused by cumulative micro-trauma from repetitive knee flexion and extension.<sup>17</sup> In 2010, sprains, strains and tears were the leading diagnoses for knee injuries resulting in DAFW among private industry (56%)<sup>18</sup> and state and local government (51% each).<sup>19,20</sup> Contusions and abrasions were also common (13–16%) as was general soreness and knee pain (14–17%). General knee pain has been found to arise from knee-straining work, but older age, overweight, and previous knee injuries are also risk factors.<sup>21</sup> The cumulative effects of occupational knee strain over a worker's career also places men and women at increased risk of osteoarthritis.<sup>22</sup>

Data clearly suggest that the risk and burden of occupational knee injuries are high and that these injuries may have long-term adverse effects. Yet, information is sparse about knee injuries across all employee groups and about injuries not involving DAFW and/or injuries with medical costs paid by sources other than workers' compensation. For example, the BLS SOII data are based on employer reports. In 2007, SOII only accounted for injuries among an estimated 73% of FTE in the U.S. labor force.<sup>\*</sup> At that time SOII excluded government workers, self-employed workers, persons working for private households, and workers on farms with fewer than 11 employees.<sup>†</sup> Also, SOII only provides detailed case information for DAFW cases—29% of SOII total recordable cases in 2007.<sup>23</sup> Finally, SOII is impacted by underreporting of occupational injuries.<sup>24</sup>

Although most U.S. workers are covered by workers' compensation insurance<sup>25</sup> including most of the injured workers captured in SOII, their SOII-reportable injuries may not have been compensable under each state's workers compensation regulations and workers may not have filed claims. A 2007 survey in 10 states indicated that workers' compensation paid medical claims for only 47%–77% of the injured workers.<sup>26</sup> Hence knee injury profiles derived from SOII data and workers' compensation claims such as from Washington and Ohio each provide a unique injury perspective.

To provide an additional perspective and address some of the gaps, we used the National Electronic Injury Surveillance System occupational supplement (NEISS-Work) to describe work-related knee injuries treated in hospital EDs. NEISS-Work does not have inherent employment or medical payer restrictions.<sup>27</sup> However, NEISS-Work only accounts for nonfatal occupational injuries and illnesses treated in U.S. hospital EDs—crudely estimated to be 34% of occupational cases requiring medical treatment.<sup>28</sup> National occupational injury data from other medical settings are not generally available. In this study we describe worker demographics, nature of the injury, and injury circumstances for occupational knee injuries treated in U.S. EDs in 2007 and trends in ED-treated knee injury incidence rates from 1998 through 2007.

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\*Percentages were derived from BLS Current Population Survey and Quarterly Census of Employment and Wages FTE estimates for 2007 (NIOSH unpublished data).

†SOII excluded federal, state, and local government workers on a national basis prior to 2008. Beginning in 2008, national estimates for state and local government workers became available, although federal worker injuries are still not reported.

## MATERIALS AND METHODS

### Data Source

We obtained national estimates of work-related knee injuries along with all injuries from 1998 to 2007 through NEISS-Work under a data use agreement with the NIOSH. NIOSH maintains NEISS-Work to collect data on ED-treated work-related injuries and illnesses from a geographically stratified probability sample of 67 U.S. hospitals having a 24-hour ED.<sup>27</sup> Each case is assigned a probability weight based on the treating hospital's assigned stratum to appropriately account for variability in hospital size and the probability of selection to be nationally representative. We calculated national estimates of the number of injuries by summing the individual case weights. Because 90–95% of NEISS-Work cases are injuries with the rest being illnesses, for simplification we refer to all cases in this study as injuries only.<sup>27</sup>

For NEISS-Work, a work-related case is defined as any injury incurred by a civilian non-institutionalized worker who was working for pay or other compensation, doing agricultural production activities, or working as a volunteer for an organized group.<sup>27</sup> Work-related cases were identified from admission information and emergency department chart review by hospital records abstractors. The NEISS-Work database includes demographics of injured workers, a short narrative description of the injury, body part involved, diagnosis, event or exposure, source of the injury, disposition from ED and employment information. We used the NEISS-Work "Part of Body Injured" variable to identify knee injuries.

NIOSH used injury narratives and business/employment information captured by the medical records abstractors to uniformly classify injury events and the industry of the injured worker. The event, source, and secondary source were coded using the BLS Occupational Injury and Illness Classification System (OIICS).<sup>29</sup> Event or exposure was defined as the manner in which the injury or illness was produced or inflicted. Source of injury was defined as the object, substance, bodily motion, or exposure which directly produced or inflicted the injury. Secondary source of injury was defined as the object, substance, or person that generated the source of the injury or that contributed to the event or exposure. Industry was coded using the Census Bureau 2002 industry codes.<sup>30</sup> Complete industry coding is only available currently for NEISS-Work 2007 data.

We derived employment estimates from the BLS Current Population Survey (CPS) of civilian non-institutionalized workers as full-time equivalent (FTE) workers, where one FTE equals to 2,000 hours worked per year.<sup>31</sup> The FTE estimates account for hours worked in all jobs reported to CPS for workers aged 15 years. We calculated the injury rate as the number of injuries per 10,000 FTE. Rate estimates by industry were based on FTE in the CPS industry assigned for a worker's primary job only.

We crudely estimated total occupational knee injuries requiring medical treatment by extrapolating the NEISS-Work ED-treated knee injury estimate by assuming that (1) the same proportion of knee injuries are treated in EDs as are all work-related injuries; and (2) 34% of all work-related injuries are treated in an ED.<sup>28</sup> Somewhat similarly, we crudely extrapolated the SOII estimate for knee injuries involving DAFW in 2007 to all occupational

knee injuries by using total reportable case and DAFW case data for 2007<sup>32,33</sup> and 2008.<sup>34–37</sup> For this extrapolation we assumed that (1) for private industry and state/local government workers the proportions of knee injuries among total injuries were equal to the proportions of DAFW knee injuries among all DAFW injuries; (2) for 2007, the number of total reportable cases and DAFW knee injury cases for state and local government workers were proportional to 2008 results;<sup>‡</sup> and (3) that private industry and state/local government workers represented 86% of the total employed labor force in 2007.\*

### Statistical Analysis

The rate ratios (RR) with confidence intervals were calculated using aggregated data for 1998–2007. The rate ratio variance was approximated by summing the variance for the individual rates composing the ratio.

We used a negative binomial regression model to assess injury trends by sex and age from 1998 to 2007. To account for the error in the annual rate values when building the regression model, we used a crude approximation based on using the upper and lower 98% confidence bounds for individual years as regression points. We fitted individual models based on the injury rate data stratified by sex, age group and year to determine whether the injury trends were significant over years, between the sexes, or among age groups. All statistical tests were 2-sided with a 5% level of significance. We used SAS<sup>®</sup> (Release 9.2 TS1M0, SAS Institute Inc. Cary, NC, USA) for statistical analyses.

## RESULTS

### Characteristics of work-related knee injuries, 2007

In 2007, there were an estimated 3.4 million ( $\pm 0.9$  million (95% CI)) occupational injuries treated in U.S. hospital EDs. The overall injury rate was 237 ( $\pm 60$ ) incidents per 10,000 FTE. Among these injuries, upper extremities were most commonly injured (41%), followed by the trunk/pubic region (20%), lower extremities (18%), head/neck (18%), and other body parts (4%). Knee injuries accounted for 5% of all injuries. A similar proportion was found for several other joint injuries involving the shoulder (5%), ankle (4%), and wrist (4%). Knee injuries were less common than finger (18%) and hand (8%) injuries and more frequent than elbow (2%) injuries.

There were 184,300 ( $\pm 54,000$ ) knee injuries at a rate of 13 ( $\pm 4$ ) per 10,000 FTE (Table 1). Men accounted for 60% of knee injuries, but men and women had knee injury rates that were statistically similar (Table 1). Although workers aged at 15–19 years accounted for only 4% of all knee injuries, men and women in this age group had the highest knee injury rates (23 ( $\pm 9$ ) per 10,000 FTE and 15 ( $\pm 5$ ), respectively). Among men, knee injury rates decreased with increasing age to 8 ( $\pm 3$ ) per 10,000 FTE at age 50 years (Table 1).

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<sup>‡</sup>National SOII data for state and local government workers are not available for 2007. To account for higher injury rates among state and local government workers compared to private industry workers, the 2008 proportion of DAFW knee injuries to DAFW total injuries and the total number of reportable cases for state and local government workers were used to adjust the 2007 data by assuming that various proportions were equal for 2007 and 2008.

Whereas for women, younger workers aged 15–24 years and older workers aged 50 years had similar high injury rates (13–15 per 10,000 FTE).

The two most common knee injury diagnoses included strains or sprains (46%) and contusions and abrasions (30%) (Table 2). Workers aged 25–44 incurred about half of all knee strains or sprains (51%) and knee contusions and abrasions (49%). Strain or sprain injury rates were highest among workers aged 15–24 years and gradually decreased with increasing of age (Figure 1). In contrast, the injury rates of contusions and abrasions were approximately equal across age groups. The vast majority of workers with knee injuries were treated and released. Only 2% of knee injuries resulted in the worker being hospitalized in the same facility or a higher level trauma hospital (Table 2). Overall, workers with all types of hospitalized injuries accounted for 2% of cases.

The leading event associated with knee injuries involved a fall (38%). Among all fall-related knee injuries, falls on same level (64%) and falls or jumps to lower level (23%) accounted for the most injuries (Table 2). Younger men tended to have the higher rates of fall-related knee injuries than older men, whereas the opposite was true among women (Figure 2). Bodily reaction and overexertion<sup>§</sup> (34%), and contact with objects and equipment (19%) were the next most common major event categories after falls. Together, slips and trips without a fall (included in bodily reactions) and falls on the same level accounted for 33% of the knee injuries. As would be expected, 80% of events involving bodily reaction or overexertion resulted in a strain or sprain, but 36% of falls and 16% of contact events resulted in sprains and strains as well (Table 3). Most contact with object/equipment events resulted in contusions, abrasions, and lacerations (75%). Most fractures arose from falls and dislocations from bodily reaction and overexertion events.

Common sources of knee injuries included structures and surfaces (40%); persons, plants, animals and minerals (34%); parts and materials (5%); and tools, instruments, and equipment (4%) (Table 2). Of these sources, several subcategories stood out: bodily motion or position of injured, ill worker (28% of total knee injuries); floors (17%); and floors, walkways, ground surfaces, unspecified of building (16%). A secondary source was indicated in 30% of knee injury incidents. The common secondary sources were structures and surfaces such as floors, walkways, and ground surfaces (5% of total knee injuries); tools, instruments, and equipment such as ladders (4%); vehicles such as motorized highway vehicles (4%); persons other than injured or ill worker, plants, animals and minerals (3%); and containers (2%).

Services industries accounted for one third of the ED-treated occupational knee injuries (Table 4). Within the Services sector, the Health Care and Social Assistance subsector was the largest contributor at 19% of all knee injuries, incurring more knee injuries than any other major Services subsector. Public Administration, which includes law enforcement and firefighting, and Health Care and Social Assistance had the highest rates of knee injuries followed by the Agriculture and Construction sectors. Men had high injury rates in these

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<sup>§</sup>Event or exposure, “usually non-impact, in which injury or illness resulted from *free bodily motion, from excessive physical effort, from repetition of a bodily motion, from the assumption of an unnatural position, or from remaining in the same position over a period of time.*”<sup>29</sup>

same sectors. Women had higher apparent rates than men in the Health Care and Social Assistance and Accommodation and Food Services subsectors, although the differences were not statistically significant.

The total number of occupational knee injuries is not known. However, using our estimate of approximately 184,000 ED-treated knee injuries, we crudely extrapolated this ED estimate to knee injuries treated in all types of medical venues. This extrapolation suggests that about 540,000 occupational knee injuries required medical treatment in 2007. Among private industry workers in 2007, the BLS SOII reported that 8% (94,500) of DAFW injuries were knee injuries.<sup>33</sup> Overall in that year, DAFW cases accounted for 29% of the 4 million total reportable cases.<sup>32</sup> By assuming that the proportion of knee injuries among total cases equaled the proportion among DAFW cases, we estimate that private industry workers had about 330,000 knee injuries overall that year. Based on further refinement of this estimate to account for injuries of state and local government workers and workers not included in SOII (see methods), we extrapolated to a total of 510,000 knee injuries. The two independent extrapolations suggest that U.S. workers incurred on the order of half a million knee injuries in 2007.

### Trends in work-related knee injuries, 1998 to 2007

Over the 10-year period from 1998 to 2007 an estimated annual average of 3.6 million ( $\pm 0.8$  million) work-related injuries were treated in U.S. hospital EDs at an average annual injury rate of 270 ( $\pm 60$ ) injuries per 10,000 FTE. During this period, there was an estimated annual average of 198,600 ( $\pm 50,600$ ) work-related knee injuries at an average annual rate of 15 ( $\pm 4$ ) knee injuries per 10,000 FTE.

Knee injuries were a consistent proportion of all injuries across these years averaging 5.5% of all work-related injuries (range equaled 5.2% to 5.8%). Although the proportion of knee injuries stayed constant, from 1998–2007, knee injuries declined an average of 0.3 knee injuries per 10,000 FTE per year ( $P = 0.02$ ) (Figure 3). Knee injuries mimicked the general downward trend observed for all types of work-related injuries across the 10 years. Injury rates for men consistently appeared to be higher than for women, although the men's rate was not statistically higher (RR = 1.2; 95% CI = 0.8–1.6).

## DISCUSSION

Contrasting the ED-treated, employee-reported data and SOII employer-reported data offers two national perspectives on occupational knee injuries. For example, we estimate that 184,300 work-related knee injuries (5% of all injuries) were treated in U.S. EDs in 2007 across all industries, employment arrangements, and ages  $\geq 15$  years. For the same year, the BLS reported 94,500 knee injuries involving DAFW, 8% of DAFW injuries among private industry workers.<sup>33</sup> When taking into account the system differences, our crude extrapolations suggest that both systems produce relatively similar estimates for total occupational knee injuries—on the order of half a million per year.

Our incidence rates for total, men, and women's knee injuries (13, 13, and 12 incidents per 10,000 FTE, respectively) were slightly higher than observed for private industry DAFW

cases in 2007 (i.e., 10.0, 10.9, and 8.6 for total, men, and women's incidents per 10,000 FTE, respectively).<sup>38</sup> The SOII results suggest that men may incur a somewhat higher rate of DAFW knee injuries than women, but a statistically significant sex difference was not found for ED-treated cases independent of age characteristics. The ED data are consistent with workers' compensation observations from West Virginia (a monopolistic state at the time)<sup>39</sup> as well as an electrical utility worker study.<sup>13</sup> Reasons that SOII may indicate an overall sex rate difference in contrast to the ED results are not clear. It may arise from men doing heavier labor or working in more hazardous jobs in some industries resulting in more DAFW cases than among women.

Younger workers had about twice the rate of ED-treated knee injuries as workers 55 years and older (Table 1). As previously reported for NEISS-Work 2007 data, younger workers, particularly young men, aged 15–24 had higher rates of ED-treated injuries of all kinds.<sup>40</sup> The same factors that generally are thought to contribute to higher overall rates of injuries among younger workers such as lack of job knowledge, skills and safety awareness<sup>41,42</sup> likely contribute to increased risk of knee injuries among younger workers. However, the very nature of jobs in food service, grocery stores, healthcare, construction, and agriculture<sup>43,44</sup> that many younger workers have expose them to slip, trip, fall, and overexertion hazards that may contribute to higher knee injury risk.

The present ED data also suggest that knee injury rates may increase as women age from their mid-30's to 55 years and older. Among older workers ( > 55) we found that women had higher knee injury rates than men. Slips, trips, and falls were common among these injured workers. Others have reported that beginning with women aged 50 (i.e., approximate age of menopause), there was a sharp rise in non-occupational slip, trip, and fall injuries (fracture and non-fracture injuries) in contrast to older men.<sup>45</sup> In that study, deleterious changes in balance, muscle strength, and reaction time were suggested as critical factors for both men and women, but particularly among postmenopausal women who experience a greater rate of change.

In 2007, sprains and strains were the primary diagnoses for ED-treated knee injuries (46%) and for DAFW cases (55%).<sup>46</sup> Contusions and abrasions were more common among the present ED-treated injuries (30%) than among the DAFW cases (14%). General knee pain/soreness (12–13%) and fractures (3%) represented about equal proportions of ED-treated and DAFW injuries. Lacerations and punctures accounted for a higher proportion of ED-treated injuries (6%) compared to DAFW cases (2%). The observed differences between ED and SOII results are likely accounted for in the increased proportion of ED-treated contusions/abrasions and lacerations/punctures that would not result in a DAFW and sprains and strains that may have been treated in an out-patient setting instead of the ED.

The events leading to knee injuries for the present ED-treated and DAFW cases exhibited very similar patterns. Falls accounted for 38% of the knee injuries for both case types (ED and DAFW) with most falls occurring on the same level (64% ED and 72% DAFW).<sup>47</sup> Bodily reaction and exertion led to 34% of ED-treated and 41% of DAFW cases. Three fourths of these cases arose from bodily reactions such as bending, climbing, crawling, reaching, twisting, and slip or trip without a fall. In general, the repetitive nature of these

actions is not easily identifiable in source data. For 2007, ED-treated knee injuries involving repetitive motion events did not meet NEISS-Work minimum reporting requirements. The BLS reported less than 2% of the DAFW knee injuries involving bodily reaction and exertion resulted from repetitive motion events.<sup>47</sup> Most of the other knee injury events involved contact with objects or equipment (18–19% of both case types).

Slips and trips without a fall (8%) and falls on the same level (25%) accounted for one-third of the ED-treated knee injuries. Slips and trips have been implicated as common precursors to falls on the same level where various environmental contaminants and other factors play a strong role.<sup>48–50</sup> Slips from floor contamination among food services workers are common.<sup>51–53</sup> During slips the heel-floor contact usually initiates the slip, but knee flexion plays a critical role in recovery from the slip.<sup>54</sup> Both the initiation and recovery attempt may place significant stress on the knee whereas the ankle joint is relatively passive. General efforts to address slip, trip, and fall hazards often focus on non-slip shoes, slip resistant flooring, and removal of floor contaminants.<sup>55</sup> Efforts to reduce muscle fatigue, a potential risk factor for slip-induced falls,<sup>56</sup> may also decrease acute knee injuries.

For knee injuries treated in an ED in 2007, our analysis by industry sector found high rates of knee injuries in the Public Administration sector. In 2010, the SOII local government data indicated that the fire services had the highest knee injury rates within Public Administration.<sup>5</sup> We did not assess knee injuries at this level of industry specificity in this work. We also found high rates in Health Care and Social Assistance, Agriculture, and Construction. The DAFW case data also indicated high knee injury rates for Agriculture and Construction and Transportation and Warehousing.<sup>3</sup> However, high knee injury rates for Transportation and Warehousing were not obvious from the ED data. In contrast to the DAFW data, the ED data also indicated a number of Services subsectors such as Management, Administrative, and Waste Management Services and Accommodation and Food Services that had moderately high knee injury rates. The ED data highlights some knee injury differences among ages and sexes that may help target prevention efforts in selected industries, for example, among younger workers and for women within the Services industry subsectors of Health Care and Social Assistance, Accommodation and Food Services, and Educational Services.

Across industries, few knee injury and WMSD prevention strategies have been evaluated.<sup>57,58</sup> Nevertheless, at least two knee-related work activity or discomfort scales have been developed that help put various work demands or exposures into a formal perspective.<sup>59,60</sup> New tools and working methods for floor layers were found effective at reducing knee strain.<sup>61</sup> Similarly, carpet layers benefited from a redesigned knee kicker.<sup>62</sup> Additionally new knee pad designs that redistribute the pressure at the knee to a greater surface area have been recommended for low seam coal miners.<sup>63</sup> Among assembly plant workers proper selection of shoes reduced lower extremity fatigue<sup>64</sup>—a risk factor for falls and joint pain. Workplace exercise interventions have not been well studied, but exercise programs among older community members have been shown to improve balance and improve lower extremity strength.<sup>65</sup> Comprehensive occupational fall prevention programs have been effective in reducing slip, trip, and fall claims which account for a high proportion of lower extremity injuries.<sup>66</sup>

“Heavy physical work, prolonged kneeling or squatting, prolonged standing, frequent climbing, and frequent heavy loads lifting and carrying;” along with previous knee injury and high body mass index have been identified as common risk factors for WMSD involving the knee.<sup>67,68</sup> Knee bending work activities were specifically identified as a risk for cartilage damage in women that may lead to osteoarthritis which is commonly more prevalent in women than men.<sup>69</sup> Having a knee injury has been identified as a significant risk factor for osteoarthritic sequelae.<sup>57,59,70,71</sup> Reducing acute occupational knee injuries such as those treated in an ED may moderate such risk. Although osteoarthritis is not commonly compensable under workers’ compensation insurance in the U.S.,<sup>14</sup> many studies have documented the work relationship of osteoarthritis.<sup>58,72–77</sup> However, ergonomic interventions to reduce knee strain are not widely utilized across work environments.

Although these NEISS-Work knee injury data may help guide interventions, these data have several limitations. Work-related injuries may not be readily identifiable in the ED records (potentially owing to the worker or healthcare staff not reporting the work-relationship). Additionally, non-work-related cases may be misclassified as work-related. ED-treated knee injuries may have unique characteristics compared to knee injuries treated in other medical venues. For example, overuse injuries may be treated more commonly in other outpatient settings. Also, detailed diagnostic and anatomical classifications are not available through NEISS-Work. Complete diagnostic workup of knee injuries may not occur until after the ED records have been abstracted or may occur at a different medical venue. There is often a paucity of information about injury events and patient employment characteristics (e.g., occupation)—data seldom required for immediate treatment, but that may guide future prevention efforts. For example, the repetitive nature of work tasks that led to an injury is seldom recorded in the ED data. We found that 2% of the ED-treated knee injuries resulted in immediate hospitalization of the worker. Nevertheless, we could not determine the number of knee injuries that required surgical repair in the days to weeks following the injury. Neither NEISS-Work nor SOII systems account for the long term sequelae or potential disabilities resulting from occupational knee injuries.

In summary, the NEISS-Work knee injury data suggest that knee injuries have been a consistent fraction of ED-treated occupational injuries for at least a decade, despite recent declines in the number of knee injuries. This is underscored by the relatively high risk among younger workers and the aforementioned increased risk in osteoarthritic sequelae which raises the possibility of long-term reductions in quality of life and capacity to work. Additionally, the relatively increased risk of knee injury among older women shows that unique opportunities for prevention present themselves across the work-related life span. Furthermore, our overall estimate of more than half a million work-related knee injuries per year supports the need for a substantial effort to reduce the burden of this problem in the work force.

## Acknowledgments

The emergency department surveillance data are collected by the National Institute for Occupational Safety and Health through collaboration with the U.S. Consumer Product Safety Commission, Division of Hazard and Injury Data Systems.

### Source of Funding

Funding for this activity was made possible, in part, by award 5P20MD000516 from the National Institute on Minority Health and Health Disparities and award T03OH009406-04 from the National Institute for Occupational Safety and Health.

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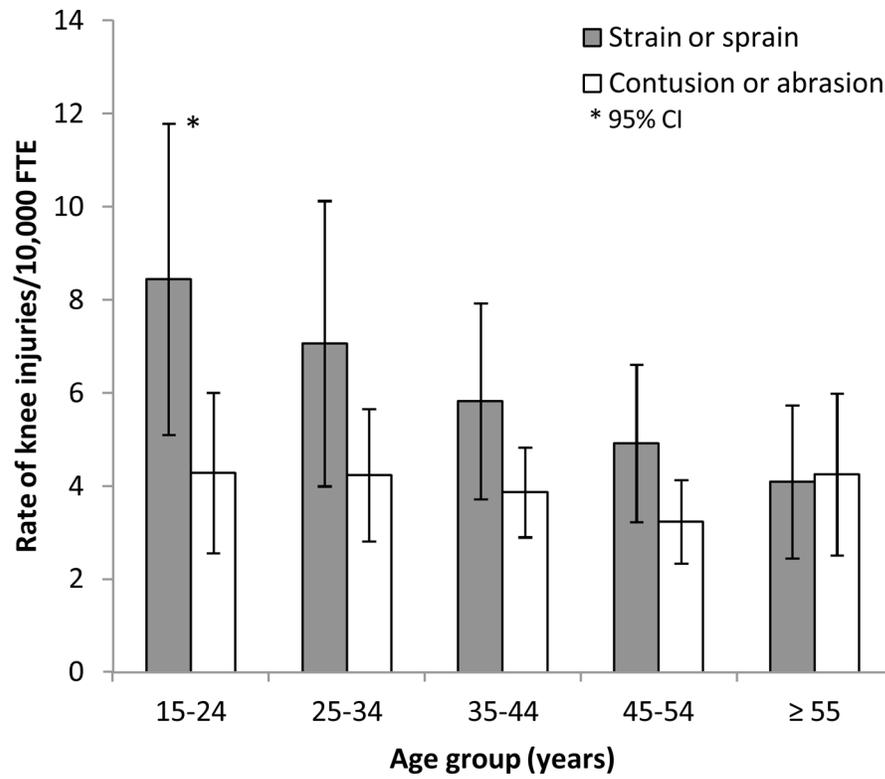
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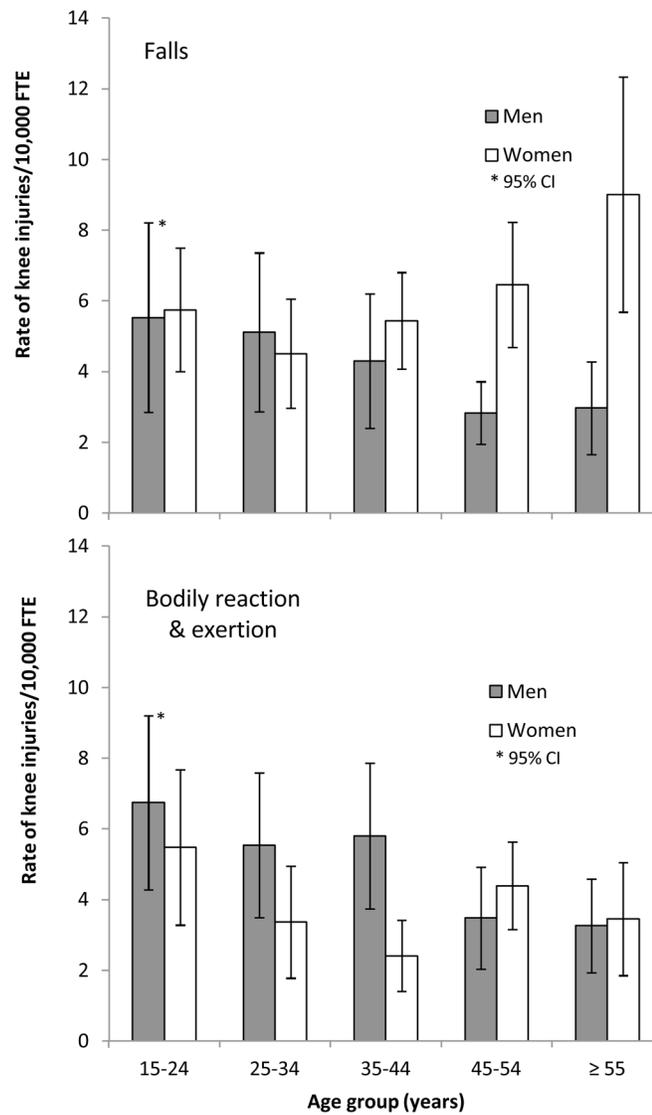
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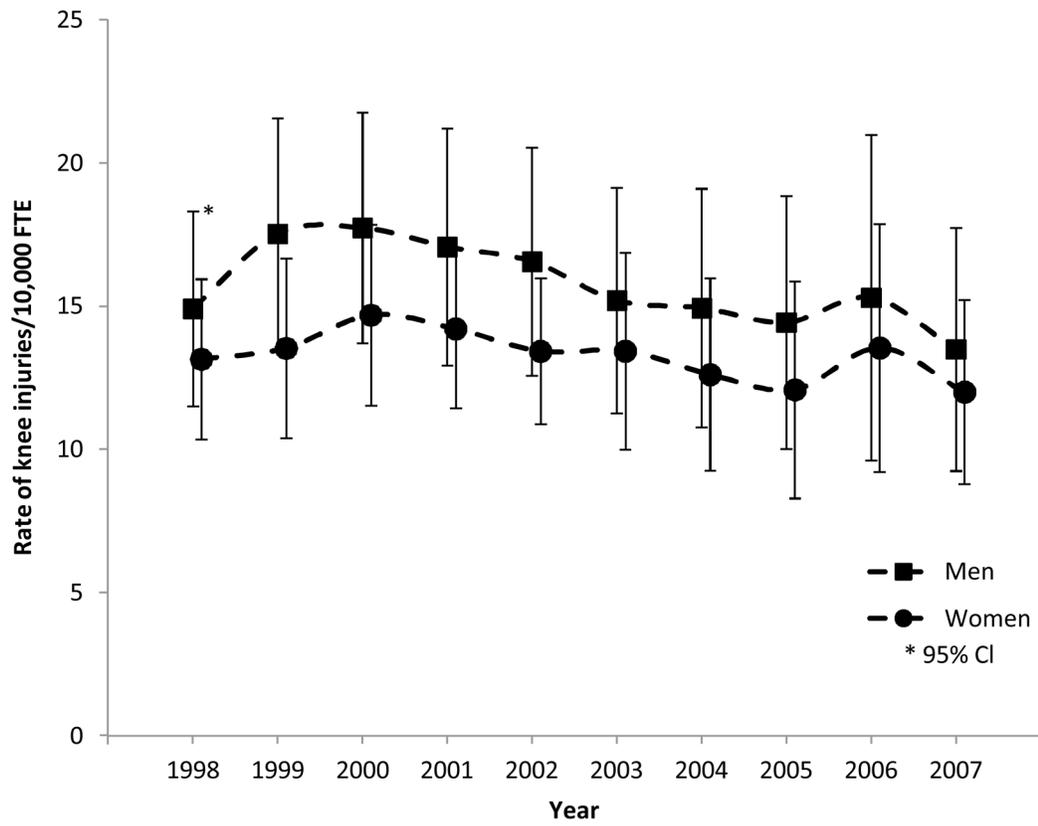
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**Figure 1.** Rate of nonfatal strain/sprain and contusion/abrasion work-related knee injuries treated in hospital emergency departments by age, 2007.



**Figure 2.** Rate of nonfatal fall- and bodily reaction/exertion- work-related knee injuries treated in hospital emergency departments by age and sex, 2007.



**Figure 3.** Rate of nonfatal work-related knee injuries treated in hospital emergency departments by year and sex, 1998–2007 (data points for women are offset for visualization).

**Table 1**

Number and rate <sup>a</sup> of nonfatal work-related knee injuries treated in hospital emergency departments by sex and age group, 2007.

Age group (yrs)	Men			Women			Total		
	Number (±95%CI) <sup>b</sup>	% Men	Rate (±95%CI)	Number (±95%CI)	% Women	Rate (±95%CI)	Number (±95%CI)	% Total	Rate (±95%CI)
<b>Total</b>	111,200 (±34,900)	60%	13 (±4)	73,000 (±19,500)	40%	12 (±3)	184,300 (±54,000)	100%	13 (±4)
15-19	4,700 (±1,800)	4%	23 (±9)	2,700 (±900)	4%	15 (±5)	7,400 (±2,300)	4%	20 (±6)
20-24	14,600 (±6,000)	13%	21 (±9)	7,400 (±2,600)	10%	13 (±5)	22,100 (±7,800)	12%	18 (±6)
25-29	16,000 (±6,600)	14%	17 (±7)	7,100 (±3,200)	10%	10 (±5)	23,000 (±9,300)	12%	14 (±6)
30-34	15,500 (±4,500)	14%	17 (±5)	7,100 (±2,900)	10%	11 (±5)	22,600 (±7,000)	12%	15 (±5)
35-39	17,700 (±6,600)	16%	17 (±7)	7,500 (±2,700)	10%	11 (±4)	25,300 (±8,600)	14%	15 (±5)
40-44	12,900 (±3,600)	12%	12 (±3)	7,400 (±2,200)	10%	10 (±3)	20,200 (±4,600)	11%	11 (±3)
45-49	10,500 (±4,000)	9%	10 (±4)	7,800 (±2,400)	11%	10 (±3)	18,300 (±5,900)	10%	10 (±3)
50-54	8,700 (±2,500)	8%	9 (±3)	11,200 (±2,700)	15%	15 (±4)	19,800 (±4,600)	11%	12 (±3)
55-59	5,500 (±2,000)	5%	8 (±3)	7,500 (±3,000)	10%	13 (±5)	13,000 (±4,800)	7%	10 (±4)
60	5,000 (±1,900)	4%	8 (±3)	7,500 (±3,100)	10%	15 (±6)	12,500 (±4,300)	7%	11 (±4)

<sup>a</sup>Rate: injuries per 10,000 FTE for all jobs worked for workers aged 15 years and older; excluding cases with unknown age.

<sup>b</sup>95% confidence interval

**Table 2**

Number of nonfatal work-related knee injuries treated in hospital emergency departments by selected diagnosis, disposition, injury event, and injury source, 2007.

Characteristic	Number	%
<b>Total</b>	184,300 ( $\pm$ 54,000) <sup>a</sup>	100
<b>Diagnosis</b>		
Strain or sprain	84,300 ( $\pm$ 30,800)	46
Contusions and abrasions	56,000 ( $\pm$ 16,400)	30
Laceration	9,100 ( $\pm$ 2,500)	5
Dislocation	5,300 ( $\pm$ 2,100)	3
Fracture	5,000 ( $\pm$ 1,600)	3
Foreign body	1,600 ( $\pm$ 800)	1
Puncture	1,500 ( $\pm$ 800)	1
Other <sup>b</sup>	21,500 ( $\pm$ 7,100)	12
<b>Disposition</b>		
Treated and released <sup>c</sup>	180,600 ( $\pm$ 53,600)	98
Hospitalized or transferred <sup>d</sup>	3,100 ( $\pm$ 1,500)	2
<b>Injury event</b>		
Falls	70,700 ( $\pm$ 20,500)	38
Fall on same level	45,500 ( $\pm$ 14,100)	25
Fall or jump to lower level	16,600 ( $\pm$ 6,000)	9
Fall, unspecified	8,600 ( $\pm$ 2,700)	5
Bodily reaction and exertion	62,300 ( $\pm$ 20,000)	34
Bodily reaction <sup>e</sup>	46,900 ( $\pm$ 15,700)	25
Slip, trip, loss of balance without a fall	14,100 ( $\pm$ 4,800)	8
Overexertion <sup>f</sup>	10,500 ( $\pm$ 4,400)	6
Contact with objects and equipment	34,100 ( $\pm$ 12,000)	19
Assaults and violent acts	6,400 ( $\pm$ 2,500)	3
Transportation incidents	3,600 ( $\pm$ 1,000)	2
Exposure to harmful substances/environments	1,200 ( $\pm$ 600)	1
Nonclassifiable	4,800 ( $\pm$ 1,400)	3
<b>Source of knee injury <sup>g</sup></b>		
Structures and Surfaces	74,000 ( $\pm$ 22,200)	40
Floors	31,600 ( $\pm$ 9,700)	17
Floors, walkways, ground surfaces, unspec. of bldg.	30,000 ( $\pm$ 9,200)	16
Persons, plants, animals and minerals	62,400 ( $\pm$ 19,200)	34
Bodily motion or position of injured, ill worker	51,700 ( $\pm$ 16,500)	28
Person, other than injured or ill worker	6,600 ( $\pm$ 2,700)	4
Parts and materials	8,500 ( $\pm$ 3,400)	5
Vehicles	7,700 ( $\pm$ 2,200)	4
Tools, instruments, and equipment	6,700 ( $\pm$ 2,000)	4

Characteristic	Number	%
Containers	4,600 ( $\pm$ 2,300)	2
Furniture and fixtures	3,900 ( $\pm$ 1,700)	2
Machinery	3,800 ( $\pm$ 1,500)	2

<sup>a</sup> 95% confidence interval

<sup>b</sup> Other: includes predominantly general knee pain, effusion, tendonitis and unspecified knee injuries plus miscellaneous injuries such as burns, crushes, hematomas, and avulsions.

<sup>c</sup> Treated and released includes those cases treated and released and held for observation (i.e., not directly hospitalized or transferred).

<sup>d</sup> Hospitalized or transferred includes those cases hospitalized within the same hospital as the ED or transferred to another hospital (typically for higher level or specialized care).

<sup>e</sup> Results from free bodily motion imposing stress or strain upon the knee.

<sup>f</sup> Results from excessive physical effort such as lifting, pulling, or carrying.

<sup>g</sup> Source: the object, substance, bodily motion, or exposure which directly produced or inflicted the injury or illness.<sup>29</sup>

**Table 3**

Number of nonfatal work-related knee injuries treated in hospital emergency departments by selected diagnoses by leading injury events, 2007.

Diagnosis	Leading Injury Events		
	Fall	Bodily reaction and exertion	Contact with objects and equipment
<b>Sprain or strain</b>	25,500 ( $\pm 10,100$ ) <sup>a</sup>	49,300 ( $\pm 17,900$ )	5,600 ( $\pm 3,300$ )
<b>Contusions and abrasions</b>	32,600 ( $\pm 9,900$ )	2,300 ( $\pm 1,400$ )	15,400 ( $\pm 5,200$ )
<b>Laceration</b>	2,800 ( $\pm 1,200$ )	– <sup>b</sup>	6,000 ( $\pm 2,000$ )
<b>Dislocation</b>	–	2,900 ( $\pm 1,200$ )	–
<b>Fracture</b>	3,200 ( $\pm 1,400$ )	–	–
<b>Foreign Body</b>	–	–	1,500 ( $\pm 800$ )
<b>Other</b>	5,300 ( $\pm 2,500$ )	7,000 ( $\pm 2,800$ )	–

<sup>a</sup>95% confidence interval

<sup>b</sup>Do not meet minimum reporting requirements

Number and rate of nonfatal work-related knee injuries treated in hospital emergency departments by major industry sectors and sex, 2007.

**Table 4**

Industry	Total			Men		Women	
	Number	%	Rate <sup>a</sup>	Rate	Rate	Rate	Rate
Agriculture	4,300 (± 2,100) <sup>b</sup>	2%	19 (± 10)	21 (± 11)	— <sup>c</sup>	—	—
Mining	—	—	—	—	—	—	—
Construction	19,700 (± 8,000)	11%	17 (± 7)	18 (± 7)	—	—	—
Manufacturing	15,000 (± 5,900)	8%	9 (± 3)	10 (± 4)	5 (± 3)	5 (± 3)	5 (± 3)
Trade <sup>d</sup>	26,100 (± 15,700)	14%	13 (± 8)	15 (± 10)	11 (± 5)	11 (± 5)	11 (± 5)
Transportation, warehousing, utilities	11,000 (± 3,200)	6%	14 (± 4)	13 (± 4)	16 (± 6)	16 (± 6)	16 (± 6)
Services	63,400 (± 20,000)	34%	9 (± 3)	6 (± 2)	11 (± 3)	11 (± 3)	11 (± 3)
Management, administrative, waste management services	8,700 (± 4,100)	5%	14 (± 7)	18 (± 7)	—	—	—
Educational services	8,400 (± 4,800)	5%	8 (± 4)	6 (± 4)	9 (± 5)	9 (± 5)	9 (± 5)
Health care and social assistance	35,100 (± 10,400)	19%	21 (± 6)	17 (± 8)	22 (± 6)	22 (± 6)	22 (± 6)
Accommodation and food services	11,200 (± 3,100)	6%	14 (± 4)	12 (± 5)	16 (± 5)	16 (± 5)	16 (± 5)
Misc. other services <sup>e</sup>	12,400 (± 4,300)	7%	4 (± 1)	5 (± 2)	3 (± 1)	3 (± 1)	3 (± 1)
Public administration	15,400 (± 4,600)	8%	23 (± 7)	27 (± 9)	16 (± 7)	16 (± 7)	16 (± 7)

<sup>a</sup>Rate: injuries per 10,000 FTE for primary job hours only for workers aged 15 years and older; excluding cases with unknown age.

<sup>b</sup>95% confidence interval

<sup>c</sup>Do not meet minimum reporting requirements

<sup>d</sup>Includes wholesale and retail trade

<sup>e</sup>Includes information, finance, insurance, real estate, rental, leasing, professional, scientific, technical, arts, entertainment, recreation, and other services (except public administration).