HHS Public Access

Author manuscript

J Safety Res. Author manuscript; available in PMC 2017 January 24.

Published in final edited form as:

J Safety Res. 2016 September ; 58: 21–30. doi:10.1016/j.jsr.2016.06.001.

Prevalence of work-site injuries and relationship between obesity and injury among U.S. workers: NHIS 2004–2012☆, ,☆☆,,★, ,★★

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Abstract

Introduction—Studies have reported associations between obesity and injury in a single occupation or industry. Our study estimated the prevalence of work-site injuries and investigated the association between obesity and work-site injury in a nationally representative sample of U.S. workers.

Methods—Self-reported weight, height, and injuries within the previous three months were collected annually for U.S. workers in the National Health Interview Survey (NHIS) from 2004–2012. Participants were categorized as normal weight (BMI: 18.5–24.9 kg/m^2), overweight (BMI: 25.0–29.9), obese I (BMI: 30.0–34.9), and obese II (BMI: 35+). The prevalence of injury and prevalence ratios from fitted logistic regression models was used to assess relationships between obesity and injury after adjusting for covariates. Sampling weights were incorporated using SUDAAN software.

Results—During the 9-year study period from 2004 to 2012, 1120 workers (78 workers per 10,000) experienced a work-related injury during the previous three months. The anatomical sites with the highest prevalence of injury were the back (14.3/10,000 ± 1.2), fingers (11.5 ± 1.3), and knees (7.1 ± 0.8). The most common types of injuries were sprains/strains/twists (41.5% of all injuries), cuts (20.0%), and fractures (11.8%). Compared to normal weight workers, overweight and obese workers were more likely to experience work-site injuries [overweight: PR = 1.25 (95% CI = 1.04–1.52); obese I: 1.41 (1.14–1.74); obese II: 1.68 (1.32–2.14)]. These injuries were more

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☆Author contributions: Ja K. Gu: study conception and design, drafting of manuscript, data analysis, interpretation of data Luenda E. Charles: study conception and design, critical revision, interpretation of data Michael E. Andrew: data analysis Claudia C. Ma: acquisition of data Tara A. Hartley: assistance with questions related to the accuracy or integrity of the data John M. Violanti: critical revision. Cecil M. Burchfiel: critical revision, final approval of the version to be published.

☆☆Conflicts of interest: None of the authors have any conflicts of interest.

★Grant funding: No

★★Disclaimer:The findings and conclusions in this report are those of the authors and do not necessarily represent the views of the National Institute for Occupational Safety and Health.

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likely to affect the lower extremities [overweight: PR = 1.48, (95% CI = 1.03–2.13); obese I: 1.70 (1.13–2.55); obese II: 2.91 (1.91–4.41)] and were more likely to be due to sprains/strains/twists [overweight: PR = 1.73 (95% CI=1.29–2.31); obese I: PR = 2.24 (1.64–3.06); obese II: PR = 2.95 (2.04–4.26)].

Conclusions—Among NHIS participants, overweight and obese workers were 25% to 68% more likely to experience injuries than normal weight workers.

Practical applications—Weight reduction policies and management programs may be effectively targeted towards overweight and obese groups to prevent or reduce work-site injuries.

Keywords

Occupational incident; Overweight; Obese; Body mass index; United States

1. Introduction

The prevalence of overweight (body mass index (BMI) 25.0–29.9 kg/m^2) and obesity (BMI 30.0+ kg/m^2) in the United States and in several developed countries has gradually increased since the beginning of the 1980s (Ogden & Carroll, 2012; Puska, Nishda, & Porter, 2003). Recent data from the National Health and Nutrition Examination Survey (NHANES) show that more than 78 million U.S. adults (35%) were obese in 2011–2012, with approximately 40% of middle-aged (40–59) adults and 56% of African-American women in the obese category (Ogden, Carroll, Kit, & Flegal, 2012). This increased prevalence of obesity and overweight is a major public health concern. Obesity is linked to an increased risk of a number of diseases including hypertension, metabolic syndrome, diabetes, coronary heart disease, stroke, sleep apnea, osteoarthritis, and some cancers (colon, breast, endometrial, and gallbladder; NHLBI, 2012). The prevalence of obesity has also escalated to one of the top workplace health concerns both in the United States and in other countries (Hertz, Unger, McDonald, Lustick, & Biddulph-Krentar, 2004; Kuehl et al., 2012; Østbye, Dement, & Krause, 2007; Pollack et al., 2007; Poston, Jitnarin, Haddock, Jahnke, & Tuley, 2011; Rodbard, Fox, & Grandy, 2009; Shuford & Restrepo, 2010). Workers' obesity levels could have work-related consequences such as injuries and disabilities (Pollack et al., 2007; Shuford & Restrepo, 2010), increased workers' compensation (Kuehl et al., 2012; Østbye et al., 2007), decreased work productivity (Rodbard et al., 2009), more absenteeism (Poston et al., 2011), and work limitations (Hertz et al., 2004).

In the National Health Interview Survey (NHIS) 1997–1999, work-related injuries comprised more than a quarter of all injuries. In one-third of men and one-fifth of women, the annual rate of work-related injuries was 4.3 per 100 U.S. workers (Smith, Sorock, Wellman, Courtney, & Pransky, 2006). Many studies have investigated the risk of injuries among workers who are obese (Hertz et al., 2004; Kuehl et al., 2012; Østbye et al., 2007; Pollack et al., 2007; Poston et al., 2011; Rodbard et al., 2009; Shuford & Restrepo, 2010). In a manufacturing company, the odds of workplace injury among obese workers were significantly higher than that among healthy workers (Pollack et al., 2007). This study also found that most injuries occurred to the hands/wrists and legs/knees among the obese workers. Truck drivers who are obese may be much more likely to be involved in traffic

collision-related fatalities than non-obese occupants since many of these accidents are associated with seatbelt use, a practice that may be less prevalent among those with higher adiposity levels (Jehle, Doshi, Karagianis, Consiglio, & Jehle, 2014; Rice & Zhu, 2014). Obese workers in a Finnish hospital (Kouvonen et al., 2013) were reported to have a higher risk of bone fractures, dislocations, sprains and strains, and upper and lower extremities. Pollack and colleagues also reported a higher number of injuries to the back, hands/wrists, and legs/knees in the obese group. However, in a systematic review study, it was reported that although the risk of injury among obese persons was slightly increased, many of the estimates were not statistically significant (Pollack & Cheskin, 2007). Another study conducted among workers in Washington State indicated that obese women with occupational back injuries showed significant weight gain after one year of the occurrence (Keeney et al., 2013). The relationship between obesity and injury appears to be bidirectional, with one impacting the risk of the other.

Most of the previous studies that have reported associations between obesity and injury conducted their investigations in a single occupational or industrial site. There may be advantages to these single-site studies in that one can develop interventions that are specific to an occupation or industry. However, research incorporating a wide variety of occupations and industries is also useful in that they can provide general estimates of associations between obesity and injury on a national level. Even when studies were conducted on large samples, very few of those studies investigated associations among a nationally representative group of workers across all occupational groups. The objectives of this study, which was conducted among a nationally representative sample of U.S. workers, were to: (a) estimate the prevalence of work related injury by several factors: anatomical sites of injury, nature of injury, external causes, treatment location, number of nights in hospital, and days of work missed; and (b) examine the association between obesity and injury.

2. Materials and methods

2.1. Source of data

Injury was assessed using data from the National Health Interview Survey (NHIS), which was developed and administered by the National Center for Health Statistics (NCHS) in the U.S. Centers for Disease Control and Prevention (CDC) to track health status, health care access, and progress toward achieving national health objectives since 1957. The NHIS is a nationally representative cross-sectional survey of in-person household interviews conducted annually and is based on a multistage clustered area probability sample. Individuals who belong to racial/ethnic minority backgrounds (e.g., Blacks, Hispanics, and Asians) and adults aged ≥ 65 years are oversampled to allow for the precise estimation of health in minority populations and elders. Extensive details about the questionnaire, methodology, data and documentation are available on the NHIS website (NCHS, 2014).

Data from the NHIS core questionnaires (Sample Adults, Family) for 2004–2012 were analyzed for this study. Written informed consent was obtained from all subjects. All procedures in each NHIS were approved by the NCHS Research Ethics Review Board (NCHS, 2012a). We included paid workers aged 18 years and older who were ‘working at a job or business’ or ‘with a job or business but not at work’ during the week prior to their

interview. The total number of the combined 2004–2012 NHIS adults was 254,630 with average response rate of 79.8% (Table 1). From this population, our study included 141,235 working adults, after excluding those who were pregnant or missing the BMI variable.

The Sample Adults questionnaire in the NHIS elicited information from participants on demographics and socio-economic factors (age, sex, race/ethnicity, education, marital status, lifestyle, employment, income, occupation) and lifestyle characteristics (smoking status, alcohol intake, sleep duration, physical activity). The injury and poisoning questionnaire in the Family core questionnaire collected information on participants' injuries, medical care, external causes of injury, activity at time of injury, and the number of work days missed due to injury.

2.2. Body mass index (BMI)

In the Sample Adults questionnaire, participants were asked their height in inches ("How tall are you without shoes?") and their weight in pounds ("How much do you weigh without shoes?"). Height was converted to meters and weight was converted to kilograms. BMI was used to assess obesity, and was calculated as weight in kilograms divided by height in meters squared. We used BMI as both a continuous variable and a categorical variable (BMI: 18.5–24.9 kg/m^2 for normal weight, 25.0–29.9 kg/m^2 for overweight, 30.0–34.9 kg/m^2 for obese I, and 35.0+ kg/m^2 for obese II). BMI was used as a continuous variable when assessing trends in injury prevalence with increasing BMI and was also categorized into commonly used groups when assessing whether injury-related characteristics were associated with obesity. We excluded persons who were underweight (BMI < 18.5 kg/m^2) because the number of injuries in that group was too small.

2.3. Work-site-injury

For our study, self-reported injury was collected during a limited period at the place of work. Injured workers were defined as those who answered that they were 'working at a paid job' to the question, "What activity were you involved in at the time of the injury?" Beginning in 2004, NCHS decided to retain all injury episodes that reportedly occurred during the three months (91 days) prior to the date of the injury in question (NCHS, 2012b) to reduce the recall bias of less serious injury. The NHIS Injury file contains information about the external causes and the nature of the injury episode, what the person was doing at the time of the injury, where the person received medical advice and treatment, whether the person was hospitalized, and whether the person missed any days from work due to the injury, with the Ninth Revision of the International Classification of Diseases (ICD-9-CM) diagnostic codes and ICD-9-CM external cause codes. Each person with injury has been classified according to the nature of injury codes 800–909.2, 909.4, 909.9, 910–994.9, 995.5–995.59, and 995.80–995.85 in ICD-9-CM and one external cause of injury code of E800–E848, E850–E869.9, E880–E929.9, or E950–E999 (NCHS, 2012b). The nature of injuries was categorized on the questionnaire as fracture, sprain/strain/twist, cut, scrape, bruise, burn, bite, and other. The anatomical sites of injuries were as grouped feet/toes/ankles, legs/knees/hip (included lower legs and thighs), hands/fingers/wrists, arms/shoulders (included forearms, elbows, upper arms), back/buttocks, head/neck, and others. The external causes of injuries were listed as fall, overexertion/strenuous movement, struck by object, cut/pierce,

burn/scald/poisoning/bite, transportation, machinery, and others. For analysis purposes, a worker was considered injured if he/she had one or more injury episodes reported, so we are reporting number of workers with one or more injuries.

2.4. Covariates

Identification of covariates as potential confounders was determined based on the significant association of these variables with both main exposure (obesity) and outcome (injury), and based on previous research. The potential confounders included in the analyses were age, gender, race/ethnicity (Non-Hispanic white, Non-Hispanic black, Hispanic, all other), marital status (single, married, divorced), education level (less than or equal to high school graduate, less than four years of college, four or more years of college), smoking status (never, former, current), alcohol intake, length of employment (<1 year, 1–4 years, 5+ years), employment status (full-time with 35 or more hours per week, part-time), and sleep duration (inadequate sleep: <7 h per day, enough sleep: 7 or more hours per day). Alcohol intake was categorized by frequency of consumption: never or former, current drinkers who have three or fewer drinks per week, current drinkers who have four or more drinks per week. To assess leisure-time physical activity, participants were asked to summarize their usual physical activity both in terms of frequency and duration while engaging in aerobic physical activity or muscle-strengthening activity. Hours of leisure-time vigorous physical activity per week were calculated based on the frequency and duration.

2.5. Data analyses

Sample weights were used in calculating point estimates in all analyses since the NHIS data are obtained through a complex, multistage sample design that involves stratification, clustering, and oversampling of specific population subgroups. The standard errors were estimated using Taylor series linearization with the sample weights and sample design. Analyses were performed using SUDAAN software version 11.0.

The prevalence of injury (per 10,000 workers) was calculated by dividing the estimated number of injured workers by the estimated population, and then multiplying by 10,000. Some of the prevalence values that are indicated by the symbol (†) in the tables are unreliable since the relative standard error of the estimate is larger than 30% (Klein, Proctor, & Boudreault, 2004). The prevalence ratios adjusted for covariates were obtained from average marginal predictions in the fitted logistic regression model (Bieler, Brown, William, & Brogan, 2010). Adjustments were made for the following potential confounders: gender, age, race/ethnicity, marital status, education, smoking status, alcohol intake status, employment, sleep duration, physical activity, and occupation. Effect modification (i.e., interaction) was assessed for all of these variables in the association between obesity and injury but none were found to be significant (p-value < 0.05). Associations were assessed for covariates with work-site-injury and BMI (Table 2) using Chi-square and Analysis of Variance (ANOVA) respectively. Multivariable-adjusted prevalence ratios (PR) and 95% confidence intervals for the main associations were calculated. All reported p-values were two-sided and a p-value of <0.05 was considered statistically significant.

3. Results

The estimated number and prevalence of injuries by calendar year are shown in Table 1. During the 9-year study period from 2004 to 2012, 1,120 workers (78 workers per 10,000, 0.78%) experienced a work-related injury during the previous three months. There were only 30 workers (2.7%) among 1,120 injured workers who had two injury episodes. A lower prevalence of injury was observed during 2006–2010 compared to the other years.

Table 2 shows the description of workers, the prevalence of injury during the past three months, and the mean BMI by demographics and lifestyle characteristics. The mean age of all workers during 2004–2012 was 41.3 (±0.07) years, with female workers comprising 44.7% of the study sample. The majority of workers in this study were non-Hispanic Whites (69%), followed by Hispanics (14%), and non-Hispanic Blacks (11%). Slightly over half (58%) of the sample was married. Half of the workers had an income of less than $35K per year and 36% attained a high school education or less. The average length of employment was about 8 years, and 80% of workers were full-time employees.

3.1. Injury

The prevalence of injury decreased by age and work experience. Male (96.2/10,000) and Black non-Hispanic (87.4/10,000) workers had a significantly higher prevalence of injury than females and workers of other racial/ethnic groups, respectively. Married workers (62.8/10,000) had a significantly lower prevalence than unmarried workers (94.2/10,000 for single and 103.5/10,000 for divorced; $p < 0.001$). The prevalence of injury differed based on socioeconomic status and lifestyle behaviors. Workers who reported a shorter mean sleep duration, current smokers, those who currently consumed more alcohol, and lower income workers had a higher prevalence of injury.

3.2. BMI

The mean BMI for U.S. workers was 27.6 kg/m^2. A high proportion of U.S. workers were either overweight (37%), obese I (17%), or obese II (10%). Twenty-seven percent of injuries occurred among workers in the normal BMI range, 38% in the overweight, 21% in the obese I, and 14% in the obese II category (data not shown). The prevalence of injury by BMI category was 58.6 (per 10,000 workers) for the normal weight group, 79.9 for the overweight, 93.8 for obese I, and 111.4 for obese II workers.

Table 3 presents descriptive statistics of injuries experienced during the previous three months and mean BMI among injured workers. The anatomical sites with the highest occurrence of injury were back (N = 202, 18.5%), finger (N = 154, 14.8%), knee (N = 120, 9.1%), hand (N = 99, 8.3%), and shoulder (N = 97, 7.4%). Approximately 40% of all injuries occurred in the upper extremities. Workers with injuries in the lower extremities tended to have the highest mean BMI; 30.8 kg/m^2 for foot injuries, 30.6 kg/m^2 for those with injuries in the lower leg, and 30.2 kg/m^2 for those with knee injuries.

The most common types of injuries were sprains/strains/twists (41.5% of all injuries), cuts (20.0%), and fractures (11.8%). The workers with fractures, sprains/strains/twists, bruises, and burns had higher mean BMI than the workers with cuts, scrapes, and bites. Almost a

half (43.5%) of workers with fractures had injuries in the hands/fingers/wrists, and a third (35.2%) of workers with sprains/strains/twists had injuries in the back or buttocks, where the prevalence of injury (11.3/10,000) was the highest. Among the workers with fractures, those with injuries in the feet/toes/ankles had the highest mean BMI (32.3 kg/m^2). Among the workers with sprains/strains/twist, those with injuries in the legs/knees/hips had the highest mean BMI (31.3 kg/m^2).

Major external causes of injury were due to overexertion or strenuous movements (26.9%), falls (20.9%), being struck by objects (13.8%), and cuts or piercings (12.8%). More than half (57.4%) of the falls involved the lower extremities. The back/buttocks (20.3%) and arm/shoulder (43.5%) were the most common locations of injuries affected by overexertion or strenuous movements. After being injured, 42.7% of workers went to the emergency room, and more than three-fourths of workers (78.2%) visited doctors' offices or clinics. Less than 3% of injured workers were admitted to hospitals. If they were admitted to the hospital, the approximate duration of the hospital stay was four days. Almost half of injured workers (48.1%) missed at least one day of work.

The prevalence of injury during the previous three months is reported by obesity categories in Table 4. The highest injury prevalence occurred in the hands and wrists (N = 313, 28%) and were due to sprains/strains/twists (N = 479, 42%), falls (N = 244, 22%) and overexertion/strenuous movements (N = 299, 27%). We observed that the prevalence of injury gradually increased as obesity increased. For example, the prevalence of injury in the back/buttocks was 10.1/10,000 for those with normal weight, 12.5 for those who were overweight, 19.9 for obese I, and 28.9 for obese II workers. The prevalence of injury due to fall was 16.2 for those with normal weight, 16.9 for those who were overweight, 19.3 for obese I, and 30.5 for obese II workers. The prevalence of treatment at the doctor's office/clinic after injury was 42.2/10,000 for those with normal weight, 64.9 for those who were overweight, 74.3 for obese I, and 90.1 for obese II workers.

Table 5 shows that obesity was associated with an increased risk of occupational injuries after controlling for gender, age, race/ethnicity, marital status, education, smoking status, alcohol intake, employment, sleep duration, physical activity, and occupation. Higher BMI levels were associated with a higher prevalence of all occupational injuries combined: prevalence ratio (PR) = 1.25 (95% confidence interval (CI): 1.04–1.52) for overweight; PR = 1.41 (CI: 1.14–1.74) for obese I; and PR = 1.68 (CI: 1.32–2.14) for obese II. For every one unit increase in BMI, the prevalence of injury increased by 3% [PR = 1.03 (CI: 1.01–1.04)]. BMI was strongly associated with injury to the feet/toes/ankles (PR = 1.05; CI: 1.03–1.08), legs/knees/hips (PR = 1.04; CI: 1.02–1.07), arm/shoulder (PR = 1.05; CI: 1.02–1.07), and back/buttocks (PR = 1.04; CI: 1.02–1.07). BMI was significantly associated with a higher prevalence of injuries in the lower extremities (PR = 1.05; CI: 1.03–1.07) and posterior surface (PR = 1.04; CI: 1.01–1.06). Compared to workers with normal BMI, workers in the obese II category had a higher prevalence of fractures (PR = 2.93; CI: 1.36–6.31) and sprains/ strains/twists (PR = 2.95; CI: 2.04–4.26) whereas workers in the obese II group did not have a significantly high prevalence of cuts (PR = 0.91; CI: 0.51–1.65) or scrapes/bruises/burns (PR = 1.58; CI: 0.91–2.76). Regarding external causes of injury, falls (PR = 1.04; CI: 1.02–1.07) and overexertion/strenuous movements (PR = 1.04; CI: 1.02–1.07)

showed a 4% increase in injury for every unit increase in BMI. Workers who were overweight did not have a significantly increased prevalence of injury from falls (PR = 1.46; CI: 0.97–2.20) and overexertion/strenuous movements (PR = 1.32; CI: 0.92–1.89) compared to those of normal weight. Employees in the obese II category were more than two times as likely to a visit doctor's office/clinic (PR = 2.01; CI: 1.52–2.64) or to call a medical professional (PR = 2.19; CI: 1.43–3.35) compared to those of normal weight. As BMI increased, the number of work days missed after injury significantly increased for those who missed one to five day(s) and six or more days of work (PR = 1.06, CI: 1.03–1.08; PR = 1.04, CI: 1.01–1.06).

4. Discussion

Our study sought to examine the prevalence of work-site injuries and the association between obesity and injuries. Our results showed that the highest prevalence of injuries was observed in the joints (ankles, knees, fingers, back) and was due to sprains/strains/twists. The injured workers were treated in the emergency room or in a doctor's office, and approximately half of them missed one or more days of work. Our results also showed that increased levels of obesity were associated with an increase in workplace injuries. Overweight and obese workers experienced injuries that were approximately 25% to 68% higher than normal weight workers after adjustment for gender, age, race/ethnicity, marital status, education, smoking status, alcohol intake, employment, sleep duration, physical activity, and occupation.

4.1. Site of injury

The prevalence of injuries to the hands/wrists was almost two times greater than that of the feet/ankles (21.8 and 11.3 respectively). However, the injuries in the feet/ankles were significantly related to obesity. We observed that the workers with foot/ankle injuries were much heavier than those with hand and wrist injuries (BMI were 30.0 and 27.9 respectively). The prevalence ratio of injury also increased significantly in the lower extremities, arm/shoulder, and back/buttocks (Table 5). More substantial elevations of injury were observed among workers in the obese II category. Our finding that injuries to the back/ buttocks showed the highest prevalence among obese II workers did not agree with that of studies among municipal workers and hospital workers (Kouvonen et al., 2013; Myers et al., 1999). The study by Kouvonen and colleagues found that obesity was weakly associated with a risk of back injuries. However, the current study showed that obesity was strongly associated with back/buttocks injury prevalence as well as legs/knees/hip injury prevalence. Overweight and obese employees might have a more delicate musculoskeletal system since obesity accelerates the wear on the joints and spine, especially for the knees, hip, back, ankles, and feet (Wearing, Hennig, Byrne, Steele, & Hills, 2006). The force on the knees is about three times that of the body's weight while walking and six times while stair climbing (Taylor, Heller, Bergmann, & Duda, 2004). For example, a worker who weighs 100 kilograms while carrying 50 kg puts about 450 kg of pressure on his/her knees just by walking. We found that the sites with a high prevalence of injuries were also the same sites with musculoskeletal disorders (Taylor et al., 2004; Wearing et al., 2006). It would have

been useful to be able to investigate injury sites by job but we were unable to do so in this study.

4.2. Type of injury, external cause of injury

We found that fracture injuries and injuries due to falls were both significantly associated with obesity (Table 5). Studies conducted among hospital workers (Kouvonen et al., 2013) and manufacturing workers (Pollack et al., 2007) reported a significant association between fracture and obesity. Bouchard, Pickett, and Janssen (2010) revealed that excessive fat would protect the risk of fracture in older adults when falling because of greater cushioning. However, our study found obese workers had a significant excess risk of fracture and falling. Dimitri, Bishop, Walsh, and Eastell (2012) reported that obesity protects against hip and vertebral fractures, but is a risk factor for fractures of the humerus and ankle. Unfortunately, we could not conduct analyses to determine the relationship between obesity and location of fracture due to the limitation in the number of fracture injuries. Consistent with prior studies (Finkelstein, Chen, Probhu, Trogdon, & Corso, 2007; Janssen, Bacon, & Pickett, 2011; Ren et al., 2014), we found that injuries due to falls among obese workers were significantly higher compared to falls among normal-weight workers. Workers who are obese probably have more problems with gait and balance perhaps due to lower limb weakness, poor vision due to diabetes, and postural hypotension (Hertz et al., 2004; Taylor et al., 2004; Wearing et al., 2006). These could result in the obese workers having more injuries due to falls in the lower extremities than in any other site. We also found that sprain/strain/twist injuries and injuries due to overexertion/strenuous movements were significantly related to obesity. Wearing et al. (2006) explained that obesity may have a profound effect on musculoskeletal disorders involving the back, hip, knee, ankle, and foot, and connective tissues such as tendons, fascia, and cartilage, due to excessively compressive loads.

4.3. Treatment, missing days

We investigated the facilities where the injured workers were treated and the number of missing days after injury by obesity category. Treatments in emergency vehicles and emergency rooms tended to increase by level of obesity, but not significantly so. Heavier workers were more likely to visit doctors' offices or call medical professionals for treatment. In previous studies, obese workers missed work days more frequently, missed a higher number of work days, had higher medical expenses, and lost more productivity than workers of normal weight (Cawley, Rizzo, & Haas, 2007; Poston et al., 2011; Tucker & Friedman, 1998). Therefore, our study supports previous studies that showed that obesity was strongly related to days of work missed (i.e. 1–5 missing days).

4.4. Mechanism of injury

Reasons given by some authors for the increased prevalence of injury among obese workers include poorer overall health and sleepiness due to sleep apnea, fatigue, or stress (Kouvonen et al., 2013; Pollack et al., 2007). In our study, we took some of these factors into consideration by adjusting for sleep duration but results were essentially unchanged. Obesity could limit workers' physical functioning, and therefore may increase work-related injuries. Another possible reason for the increase in injury prevalence among obese workers may be medication use by these workers who might be experiencing conditions such as

hypertension, arthritis, diabetes, heart disease, and gastrointestinal disease to a greater extent. Although illness for workers was not considered in the current study, one study reported a high prevalence of chronic conditions in overweight and obese workers (Hertz et al., 2004). Using the NHIS data, Hertz et al. (2004) reported that obese workers have somewhat elevated levels of hypertension (35%), dyslipidemia (36%), type 2 diabetes (12%), and metabolic syndrome (54%).

Shift work and long work hours are other risk factors for work-site injury. Studies show that shift or rotating workers such as nurses, truck drivers, police officers, and fire fighters have a high prevalence of obesity (Caban, Lee, Fleming, Gomez-Marin, & Pitman, 2005; Gu et al., 2014), and there is evidence showing associations between shift work and obesity, and between long work hours and obesity (Chen, Lin, & Hsiao, 2010; Gu et al., 2012; Marquezea, Lemosa, Soaresa, Lorenzi-Fihob, & Morenoa, 2013; Zhao, Bogossian, & Turner, 2012). Studies of workers in North America have shown that workers on the night shift or those working 12 or more hours per day have a higher risk of work injury with feelings of decreased alertness, increased fatigue, lower cognitive function, and declines in vigilance on task measures (Caruso, Hitchcock, Dick, Russo, & Schmit, 2014; Salminen, 2010; Violanti et al., 2013; Wong, McLeod, & Demers, 2011).

4.5. Limitations

One of the limitations of the current study is that small sample sizes prevented us from estimating the prevalence of injury at some anatomical sites. Another limitation is that due to NHIS investigating injuries only over the previous three months, the current analysis only takes into account acute injuries and does not account for injuries that were fatal which may have led to an underestimation of injury. Prevalence of injury may have been slightly underestimated during the period of 2006–2010; the distribution of both site of injury and type of injury were similar for this period compared with the other years included in this study (data not shown). An additional limitation of our study is that other factors that relate to injuries, for example, job demands, job control, job strain, and overtime work, were not controlled for in the analysis. Unfortunately, these variables were not available in the NHIS 2004–2012 dataset so we were unable to take them into consideration in our analyses. In addition, our results are from a cross-sectional study, and the association between injury and obesity cannot provide evidence of causality, whether obese status precedes the work-related injury, or vice versa. BMI measurements in our study may have been underestimated because the NHIS survey used self-reported weight and height rather than measures for weight and height taken by a research staff member using a standardized protocol. Furthermore, BMI, which was used as a measure of obesity in this study, may not be an accurate representation of obesity since it cannot distinguish between fat and lean mass. Nye et al. (2014) suggested that waist circumference is a better measure than BMI for estimating musculoskeletal injury risk. The NHIS, unfortunately, has not collected waist circumference. Nevertheless, BMI is highly correlated with waist circumference and is commonly applied as the definition of obesity.

4.6. Strengths

Despite the limitations presented, the current study has a large sample size, information was obtained from a nationally representative dataset that was able to provide estimates of occupational injury prevalence by demographic and lifestyle characteristics, specific anatomical sites of injury, types of injury, external causes of injury, treatment locations after injury, and missed days of work. Furthermore, the current results reporting injury for the past 3-month period may have minimized recall bias, which prevented or at least decreased the potential for underestimating injury prevalence. To our knowledge, this is one of a very few studies investigating associations between obesity and work-related injury among U.S. workers.

4.7. Recommendations

Our study has shown that obese workers are more likely to sustain injuries on the job. This is an important finding because obese workers who are injured may experience long-term adverse mental and physical outcomes (Keeney et al., 2013; Schulz & Sherwood, 2008). To reduce obesity-related workplace injury, employers could implement work risk assessments such as evaluating physical demands and sequence of tasks, identifying occupational stressors (excessive workload, overtime, workplace conflict) and organizational stressors (difficult relationships with coworkers, lack of support, lack of motivation) in the workplace, and appropriate implementation of a job rotation program (if the job is required for 24 h). Management and labor personnel could implement appropriate job counseling and work-related social support by coworkers and supervisors, injury prevention education, and they may also provide initiatives to encourage healthy food choices and exercise programs for their employees. Networking with communities to obtain their support of healthy lifestyle choices may help to facilitate reductions in work-site injuries. This study focused on the prevalence of injury characteristics and the relationship between BMI and injuries, but not by specific occupational groups. The prevalence of obesity is different by occupation and gender (Nye et al., 2014; Schulz & Sherwood, 2008), and each occupational group is likely to have different characteristics of injury. It would be worthwhile to investigate the prevalence of injuries by occupational group and gender.

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Table 1

Sample size, estimated population, and injury prevalence during the past three months, NHIS 2004–2012

Survey Year	No. interviewed[a]	Response rate[b]	No. of workers	No. of injured workers	Estimated population	Estimated injured workers	Injury prevalence[c]
Total	254,630	79.8%	141,235	1,120	130,674,744	1,014,216	77.6
2004	31,326	83.8%	17,860	147	14,147,580	124,758	88.2
2005	31,428	80.1%	17,986	152	14,437,309	130,173	90.2
2006	24,275	81.4%	13,878	100	14,622,845	105,992	72.5
2007	23,393	78.3%	13,230	104	14,665,601	106,723	72.8
2008	21,781	74.2%	12,289	91	14,864,516	107,865	72.6
2009	27,731	80.1%	15,104	108	14,406,324	106,401	73.9
2010	27,157	77.3%	14,528	94	14,368,717	101,519	70.7
2011	33,014	81.6%	17,724	164	14,442,593	111,828	77.4
2012	34,525	79.7%	18,636	160	14,719,257	118,955	80.8

[a] Number of the adults completely interviewed.

[b] The response rate was calculated by dividing the number of interviews by the total number of eligible adults.

[c] Injury prevalence per 10,000.

J Safety Res. Author manuscript; available in PMC 2017 January 24.

Table 2

Injury prevalence during the past three months and mean BMI by demographics and lifestyle characteristics.

	Workers		Injury			BMI	
	No. of workers	%[a]	No. of injured workers	Pre[a] ± SE	p-value[b]	Mean[a] ± SE	p-value[b]
All	141,235	100.0	1120	77.6 ± 2.8		27.6 ± 0.02	
Sex							
Men	72,214	55.3	674	96.2 ± 4.6	<0.001	27.9 ± 0.03	<0.001
Women	69,021	44.7	446	54.7 ± 2.9		27.1 ± 0.04	
Race/ethnicity							
Non-Hispanic White	85,597	69.1	704	80.2 ± 3.6	<0.001	27.4 ± 0.03	<0.001
Non-Hispanic Black	20,648	11.3	178	87.4 ± 7.8		29.1 ± 0.06	
Hispanic	26,240	14.1	190	68.8 ± 5.5		28.0 ± 0.05	
All other	8,750	5.4	48	47.3 ± 8.2		25.4 ± 0.08	
Age							
18–34	46,869	34.4	397	90.6 ± 5.8	<0.001	26.6 ± 0.04	<0.001
35–44	34,271	23.5	282	79.3 ± 5.5		28.0 ± 0.04	
45–54	32,664	24.1	259	72.6 ± 5.3		28.1 ± 0.04	
55–64	20,870	14.1	147	60.1 ± 5.8		28.2 ± 0.05	
65+	6,561	3.9	35	46.5 ± 10.0		27.5 ± 0.07	
Mean ± SE	41.3 ± 0.07						
Marital status							
Single	41,529	26.7	373	94.2 ± 6.5	<0.001	26.9 ± 0.4	<0.001
Married	67,508	57.6	429	62.8 ± 3.5		27.8 ± 0.3	
Divorced	31,712	15.7	316	103.5 ± 7.1		28.0 ± 0.5	
Education							
≤HS/GED	51,649	36.2	504	98.0 ± 5.2	<0.001	28.1 ± 0.03	<0.001
<4 years college	38,359	27.4	386	101.2 ± 6.4		27.9 ± 0.04	
≥4 years college	50,103	36.3	222	39.8 ± 3.2		26.8 ± 0.03	
Income							
<35K	59,098	50.8	552	97.2 ± 5.7	<0.001	27.6 ± 0.04	<0.001
35–65K	33,803	30.7	281	84.5 ± 6.2		27.9 ± 0.04	

	Workers		Injury			BMI	
	No. of workers	%[a]	No. of injured workers	Pre[a] ± SE	p-value[b]	Mean[a] ± SE	p-value[b]
65K+	18,859	18.5	98	40.0 ± 4.8		27.5 ± 0.05	
Length of work							
<1 year	22,398	16.3	247	112.6 ± 9.6	<0.001	27.0 ± 0.05	0.001
1–4 years	45,407	32.4	349	79. ± 5.2		27.2 ± 0.04	
5+ years	71,506	51.3	518	66.1 ± 3.4		28.0 ± 0.03	
Mean ± SE	7.9 ± 0.04						
Employment status							
Full-time (>=35 h/week)	110,035	79.8	978	87.2 ± 3.4	<0.001	27.7 ± 0.03	<0.001
Part-time	27,565	20.2	140	49.7 ± 5.5		26.9 ± 0.05	
Sleep duration							
Inadequate sleep	43,682	30.4	470	105.8 ± 5.8	<0.001	28.3 ± 0.04	0.023
Enough sleep	97,087	69.6	645	64.8 ± 3.1		27.3 ± 0.03	
2nd Job							
Yes	12,200	8.7	104	87.4 ± 10.7	0.151	27.6 ± 0.07	0.589
No	128,464	91.3	934	71.1 ± 2.9		27.6 ± 0.02	
Smoke status							
Never	85,535	60.2	535	61.1 ± 3.3	<0.001	27.5 ± 0.03	<0.001
Former	26,431	19.3	234	86.6 ± 7.2		28.3 ± 0.05	
Current	28,934	20.5	351	118.6 ± 8.2		27.0 ± 0.04	
Alcohol							
Never/Former	40,576	27.9	300	72.8 ± 4.9	0.004	27.9 ± 0.04	<0.001
Current (≤3 drks/week)	66,489	48.6	494	70.8 ± 3.9		27.7 ± 0.03	
Current (4+ drks/week)	31,886	23.5	307	95.9 ± 6.7		26.9 ± 0.04	
Vigorous physical activity							
Low (PA<1.5 h/week)	93,060	65.2	756	79.7 ± 3.5	0.273	28.0 ± 0.03	<0.001
High (PA≥1.5 h/week)	47,012	34.8	351	72.6 ± 5.1		26.8 ± 0.03	
Occupation[c]							
Management/professional	39,298	29.4	188	43.5 ± 3.8	<0.001	27.2 ± 0.04	<0.001
Services	34,804	23.7	297	83.1 ± 5.9		27.5 ± 0.04	

	Workers		Injury			BMI	
	No. of workers	**%[a]**	**No. of injured workers**	**Pre[a] ± SE**	**p-value[b]**	**Mean[a] ± SE**	**p-value[b]**
Sales/office Adm.	32,446	23.6	164	46.9 ± 4.3		27.6 ± 0.04	
Construction/Prod./Trans.	31,032	23.3	460	151.0 ± 9.0		28.2 ± 0.04	
BMI							
Normal (18.5–<25)	51,310	36.3	319	58.6 ± 4.1	<0.001	N/A	N/A
Overweight (25.0–<30)	51,879	36.9	417	79.9 ± 5.2			
Obese I (30–<35)	23,901	17.0	232	93.8 ± 7.1			
Obese II (35+)	14,145	9.7	152	111.4 ± 10.3			

[a]Weighted value of column percent, and prevalence of injury weighted per 10,000 (= [estimated injury / estimated population] × 10,000) , and weighted mean of BMI.

[b]p-value from Chi-square for injury, and p-value from ANOVA for BMI.

[c]Management/Professional include management, business, financial, computer, mathematical, architecture, engineering, life/physical/social science, legal, arts/design/entertainment/ sports/media; Services include health care, personal care, protective service, food business, building maintenance and cleaning; Sales/Office Adm. Include Sales and office administrative; Construction/Prod./Trans. include construction, production, transportation, farm, fishing, forestry.

Table 3

Descriptive characteristics of injury during the last three months among injured workers N=1120

	No. of injured workers	% of injured individuals weighted	Prevalence of injury	BMI
	N	% ± SE	Prev.[a] ± SE	Mean ± SE
All injury	**1120**	**100%**	**77.6 ± 2.8**	**28.8 ± 0.2**
Site of injury (anatomical sites)[b]				
Toe	14	1.1 ± 0.3	0.8 ± 0.3	28.9 ± 1.3
Foot	68	6.7 ±1.1	5.2 ± 0.8	30.8 ± 1.2
Ankle	75	7.0 ± 1.0	5.4 ± 0.8	29.4 ± 0.6
Lower leg	29	2.4 ± 0.5	1.9 ± 0.4	30.6 ± 1.4
Knee	120	9.1 ± 0.9	7.1 ± 0.8	30.2 ± 0.7
Thigh	16	1.8 ± 0.5	1.4 ± 0.4	30.6 ± 2.6
Groin	7	†0.9 ± 0.4	†0.7 ± 0.3	†26.0 ± 2.2
Hip	23	2.0 ± 0.4	1.6 ± 0.3	28.0 ± 1.5
Finger	154	14.8 ± 1.5	11.5 ± 1.3	27.4 ± 0.6
Hand	99	8.3 ± 1.0	6.4 ± 0.8	28.4 ± 0.6
Wrist	64	5.3 ± 0.9	4.1 ± 0.7	28.4 ± 0.6
Forearm	31	2.8 ± 0.7	2.2 ± 0.5	29.4 ± 0.8
Elbow	39	3.5 ± 0.7	2.7 ± 0.5	28.5 ± 1.1
Upper arm	12	1.0 ± 0.3	0.8 ± 0.3	26.1 ± 1.7
Shoulder	97	7.4 ± 0.8	5.7 ± 0.6	30.5 ± 1.1
Buttocks	6	†0.4 ± 0.2	†0.3 ± 0.1	†29.3 ± 3.0
Back	202	18.5 ± 1.5	14.3 ± 1.2	29.4 ± 0.5
Chest	13	†0.8 ± 0.3	†0.6 ± 0.2	†30.1 ± 1.2
Stomach	7	†0.6 ± 0.3	†0.5 ± 0.2	†27.0 ± 3.1
Jaw	3	†0.2 ± 0.1	†0.2 ± 0.1	†24.5 ± 1.3
Mouth	5	†0.6 ± 0.4	†0.4 ± 0.3	†29.4 ± 1.1
Teeth	0	n/a	n/a	n/a
Nose	6	†0.6 ± 0.3	†0.4 ± 0.2	†25.3 ± 2.6

	No. of injured workers	% of injured individuals weighted	Prevalence of injury	BMI
	N	% ± SE	Prev.[a] ± SE	Mean ± SE
All injury	**1120**	**100%**	**77.6 ± 2.8**	**28.8 ± 0.2**
Eye	34	†3.2 ± 0.6	†2.5 ± 0.5	†27.0 ± 0.7
Ear	2	†0.2 ± 0.1	†0.1 ± 0.1	†33.9 ± 2.8
Face	25	2.5 ± 0.7	1.9 ± 0.5	27.2 ± 1.0
Head	43	3.7 ± 0.8	2.8 ± 0.6	27.2 ± 1.0
Neck	37	3.4 ± 0.7	2.7 ± 0.6	27.9 ± 1.3
Other	42	3.1 ± 0.6	2.4 ± 0.4	27.6 ± 0.8
Site of injury (grouped sites)[b]				
Foot, toe, ankle	155	14.6 ± 1.3	11.3 ± 1.1	30.0 ± 0.6
Leg, knee, hip	184	15.2 ± 1.3	11.8 ± 1.0	29.7 ± 0.6
Hand, finger, wrist	313	28.1 ± 1.9	21.8 ± 1.8	27.9 ± 0.4
Arm, elbow, shoulder	168	13.7 ± 1.3	10.6 ± 1.0	29.6 ± 0.7
Back, buttocks	206	18.6 ± 1.5	14.5 ± 1.2	29.4 ± 0.5
Head, neck	140	13.0 ± 1.3	10.1 ± 1.0	27.6 ± 0.5
Others	62	4.5 ± 0.7	3.5 ± 0.6	27.9 ± 0.7
Site of injury (general)[b]				
Lower extremity	332	29.3 ± 1.7	22.7 ± 1.5	29.9 ± 0.4
Upper extremity	467	40.7 ± 1.9	31.6 ± 2.0	28.4 ± 0.4
Posterior	243	22.0 ± 1.6	17.0 ± 1.3	29.1 ± 0.5
Anterior	123	11.2 ± 1.2	8.7 ± 0.9	27.9 ± 0.5
Type of injury (how injured)[b]				
Fracture[b]	132	11.8 ± 1.2	9.1 ± 1.0	29.3 ± 0.7
Foot, toe, ankle	35	30.7 ± 5.9	2.8 ± 0.7	32.3 ± 1.2
Leg, knee, hip	15	8.7 ± 2.6	0.8 ± 0.2	30.0 ± 1.3
Hand, finger, wrist	54	43.5 ± 6.0	4.0 ± 0.8	27.6 ± 0.6
Arm, shoulder	17	12.2 ± 3.4	1.1 ± 0.3	30.5 ± 2.0
Back, buttocks	12	9.0 ± 3.0	0.8 ± 0.3	29.0 ± 1.5
Head, neck	12	†12.1 ± 4.4	1.1 ± 0.4	†27.6 ± 1.5

	No. of injured workers	% of injured individuals weighted	Prevalence of injury	BMI
	N	% ± SE	Prev.[a] ± SE	Mean ± SE
All injury	**1120**	**100%**	**77.6 ± 2.8**	**28.8 ± 0.2**
Others	14	7.6 ± 2.2	0.7 ± 0.2	27.3 ± 1.4
Sprain/strain/twist[b]	479	41.5 ± 1.8	32.2 ± 1.7	29.8 ± 0.4
Foot, toe, ankle	76	18.5 ± 2.2	6.0 ± 0.8	30.2 ± 0.8
Leg, knee, hip	97	19.3 ± 2.2	6.2 ± 0.7	31.3 ± 0.8
Hand, finger, wrist	77	14.7 ± 2.1	4.7 ± 0.7	28.3 ± 0.6
Arm, shoulder	91	17.9 ± 2.0	5.8 ± 0.7	29.9 ± 1.0
Back, buttocks	168	35.2 ± 2.7	11.3 ± 1.1	29.4 ± 0.6
Head, neck	41	7.7 ± 1.4	2.5 ± 0.5	28.5 ± 1.3
Others	17	2.3 ± 0.7	0.7 ± 0.2	31.4 ± 1.2
Cut	223	20.0 ± 1.4	15.5 ± 1.3	27.5 ± 0.6
Scrape	27	2.6 ± 0.6	2.0 ± 0.4	27.4 ± 1.2
Bruise	138	11.3 ± 1.1	8.7 ± 0.9	29.0 ± 0.7
Burn	24	2.0 ± 0.4	1.6 ± 0.3	29.3 ± 0.9
Bite	21	2.0 ± 0.5	1.6 ± 0.4	26.7 ± 1.3
Others	165	15.5 ± 1.3	12.1 ± 1.2	28.2 ± 0.5
External causes[b]				
Fall[b]	244	20.9 ± 1.4	16.2 ± 1.2	29.7 ± 0.4
Foot, toe, ankle	54	27.8 ± 3.7	4.5 ± 0.8	30.6 ± 0.8
Leg, knee, hip	81	29.6 ± 3.2	4.8 ± 0.6	29.4 ± 0.8
Hand, finger, wrist	40	15.5 ±3.0	2.5 ± 0.5	28.7 ± 0.8
Arm, shoulder	48	19.2 ± 3.0	3.1 ± 0.5	28.6 ± 0.9
Back, buttocks	39	16.9 ± 2.4	2.7 ± 0.4	30.5 ± 1.2
Head, neck	26	9.4 ± 2.5	1.5 ± 0.4	28.7 ± 0.8
Others	19	6.5 ± 1.7	1.1 ± 0.3	28.1 ± 1.1
Overexertion/strenuous move[b]	299	26.9 ± 1.7	20.9 ± 1.4	29.2 ± 0.4
Foot, toe, ankle	23	10.0 ± 2.5	2.1 ± 0.6	29.7 ± 1.8
Leg, knee, hip	48	15.9 ± 2.7	3.3 ± 0.6	29.9 ± 1.2

	No. of injured workers	% of injured individuals weighted	Prevalence of injury	BMI
	N	% ± SE	Prev.[a] ± SE	Mean ± SE
All injury	**1120**	**100%**	**77.6 ± 2.8**	**28.8 ± 0.2**
Hand, finger, wrist	31	9.1 ± 2.1	1.9 ± 0.5	27.5 ± 0.8
Arm, shoulder	66	20.3 ± 2.8	4.2 ± 0.7	29.3 ± 0.8
Back, buttocks	128	43.5 ± 3.8	9.1 ± 1.0	29.3 ± 0.6
Head, neck	13	4.2 ± 1.3	0.9 ± 0.3	30.8 ± 2.2
Others	12	†3.5 ± 1.2	†0.7 ± 0.3	†27.0 ± 2.1
Struck by object	146	13.8 ± 1.3	10.7 ± 1.1	28.0 ± 0.5
Cut, pierce	142	12.9 ± 1.2	10.0 ± 1.1	27.8 ± 0.9
Burn, scald, poisoning, bite	67	6.1 ± 0.9	4.7 ± 0.7	27.5 ± 0.7
Transportation	40	3.7 ± 0.8	2.9 ± 0.6	28.3 ± 1.5
Machinery	37	3.2 ± 0.6	2.5 ± 0.5	27.8 ± 0.7
Others	145	12.7 ± 1.2	9.8 ± 1.0	28.8 ± 0.7
Treatment location after injury[b]				
Emergency vehicle	186	16.4 ± 1.4	12.7 ± 1.2	28.8 ± 0.5
Emergency room	481	42.7 ± 2.0	33.1 ± 2.0	28.4 ± 0.4
Doctor's office/clinic	885	78.2 ± 1.4	60.7 ± 2.4	29.0 ± 0.3
Call to medical prof	353	31.0 ± 1.6	24.0 ± 1.5	29.3 ± 0.5
Any place else	147	13.2 ± 1.2	10.2 ± 1.0	28.8 ± 0.6
Hospital admission	35	2.9 ± 0.7	2.2 ± 0.5	28.1 ± 0.7
No. of nights in hospital (mean)	35	3.9 ± 1.3		
Day of work missed				
None	480	43.5 ± 1.9	39.8 ± 2.1	28.3 ± 0.3
<1 day	89	8.3 ± 1.1	6.4 ± 0.9	26.4 ± 0.6
1–5 days	275	24.3 ± 1.6	18.6 ± 1.4	30.0 ± 0.6
6+ days	265	23.8 ± 1.6	18.3 ± 1.4	29.2 ± 0.5

†The estimate of the prevalence of injury is unreliable because the relative standard error of the estimate is larger than 30% (Klein et al., 2004).

[b]The frequencies of sub-level are not mutually exclusive.

[a]Prevalence of injury weighted per 10,000 (= [estimated injury / estimated population] × 10,000) .

J Safety Res. Author manuscript; available in PMC 2017 January 24.

Table 4

Prevalence of injury during the last three months by obesity category

	All	Normal (BMI: 18.5 –<25.0)		Overweight (BMI: 25.0 –29.9)		Obese I (BMI: 30.0 –34.9)		Obese II (BMI: 35.0+)	
No. at risk (=participants)	**141,235**	**51,310**		**51,879**		**23,901**		**14,145**	
Weighted population	**130,674,744**	**47,485,450**		**48,255,442**		**22,252,164**		**12,682,689**	
Weighted injury	**1,014,216**	**278,484**		**385,683**		**208,745**		**141,304**	
	N	**N**	**Prev[a] ± SE**	**N**	**Prev[a] ± SE**	**N**	**Prev[a] ± SE**	**N**	**Prev[a] ± SE**
All injury	1120	319	58.6 ± 4.1	417	79.9 ± 5.2	232	93.8 ± 7.1	152	111.4 ± 10.3
Site of injury (grouped sites)[b]									
Foot, toe, ankle	155	41	6.1 ± 1.2	59	11.9 ± 2.0	34	14.8 ± 2.8	21	22.9 ± 5.9
Leg, knee, hip	184	41	7.6 ± 1.5	75	11.8 ± 1.5	35	13.4 ± 2.6	33	25.1 ± 5.4
Hand, wrist	313	103	19.3 ± 2.7	120	25.0 ± 3.1	55	21.7 ± 3.3	35	19.5 ± 4.1
Arm, shoulder	168	43	7.3 ± 1.3	57	10.6 ± 1.7	43	14.9 ± 2.6	25	15.1 ± 3.8
Back, buttocks	206	54	10.1 ± 1.7	67	12.5 ± 1.9	47	19.9 ± 3.7	38	28.9 ± 4.9
Head, neck	140	42	8.8 ± 1.8	57	11.8 ± 1.9	30	11.5 ± 2.7	11	†5.9 ± 2.2
Site of injury (general)[b]									
Lower extremity	332	80	13.4 ± 1.9	131	23.1 ± 2.4	68	27.9 ± 3.8	53	46.9 ± 7.9
Upper extremity	467	144	26.2 ± 2.8	170	34.7 ± 3.6	94	34.7 ± 4.0	59	34.4 ± 5.6
Posterior	243	65	12.5 ± 2.0	80	14.7 ± 2.0	57	24.3 ± 4.3	41	30.2 ± 5.1
Anterior	123	36	7.3 ± 1.6	46	10.1 ± 1.8	30	10.5 ± 2.0	11	†5.7 ± 2.2
Type of injury (how injured)[b]									
Fracture	132	31	5.1 ± 1.0	54	10.4 ± 2.2	28	11.6 ± 2.5	19	15.1 ± 4.8
Sprain/strain/twist	479	119	18.7 ± 2.1	171	32.0 ± 3.1	113	45.4 ± 5.0	76	59.9 ± 7.3
Cut	233	76	15.3 ± 2.3	87	17.3 ± 2.3	37	13.0 ± 2.3	23	13.9 ± 3.6
Scrape,bruise,burn, bite	206	65	12.2 ± 1.9	73	13.2 ± 1.8	42	13.3 ± 2.4	26	20.9 ± 5.2
Others	165	47	9.9 ± 1.9	61	11.9 ± 1.8	33	16.7 ± 3.5	24	12.6 ± 2.8
External causes[b]									
Fall	244	62	16.2 ± 1.2	85	16.9 ± 2.3	55	19.3 ± 3.0	42	30.5 ± 4.3

	All	Normal (BMI: 18.5 –<25.0)		Overweight (BMI: 25.0 –29.9)		Obese I (BMI: 30.0 –34.9)		Obese II (BMI: 35.0+)	
No. at risk (=participants)	**141,235**	**51,310**		**51,879**		**23,901**		**14,145**	
Weighted population	**130,674,744**	**47,485,450**		**48,255,442**		**22,252,164**		**12,682,689**	
Weighted injury	**1,014,216**	**278,484**		**385,683**		**208,745**		**141,304**	
	N	**N**	**Prev[a] ± SE**	**N**	**Prev[a] ± SE**	**N**	**Prev[a] ± SE**	**N**	**Prev[a] ± SE**
Overexertion/strenuous move	299	83	14.3 ± 2.0	111	20.0 ± 2.4	65	30.4 ± 4.5	40	32.0 ± 5.4
Struck by object	146	44	8.4 ± 1.5	49	10.3 ± 1.9	40	17.3 ± 3.4	13	†9.3 ± 2.9
Cut, pierce	142	45	9.6 ± 2.0	57	11.3 ± 1.8	23	†8.1 ± 5.1	17	10.0 ± 3.1
Burn, scald, poisoning, bite	67	21	4.2 ± 1.2	25	5.1 ± 1.3	11	†4.4 ± 1.4	10	†5.5 ± 1.9
Transportation	40	13	†2.5 ± 1.0	14	†2.5 ± 0.8	7	†2.4 ± 1.0	6	†6.4 ± 3.8
Machinery	37	10	†1.6 ± 0.6	17	3.5 ± 1.1	6	†2.1 ± 1.0	4	†2.3 ± 1.4
Others	145	41	7.7 ± 1.5	59	10.4 ± 1.6	25	9.8 ± 2.2	20	†15.4 ± 5.1
Treatment location after injury[b]									
Emergency vehicle	186	52	9.6 ± 1.6	63	12.6 ± 2.1	42	16.2 ± 3.3	29	18.9 ± 4.4
Emergency room	481	152	27.5 ± 2.8	178	34.1 ± 3.6	94	38.4 ± 4.6	57	41.1 ± 7.0
Doctor's office/clinic	885	230	42.2 ± 3.4	344	64.9 ± 4.4	185	74.3 ± 6.6	126	90.1 ± 9.2
Call to medical prof	253	97	18.3 ± 2.3	130	23.2 ± 2.4	70	28.2 ± 4.0	56	41.5 ± 7.0
Any place else	147	47	8.6 ± 1.5	47	8.1 ± 1.4	36	16.8 ± 3.0	17	13.1 ± 4.3
Day of work missed									
None or <1 day	569	172	33.2 ± 3.3	214	42.9 ± 3.8	120	46.4 ± 5.1	63	41.3 ± 6.5
1–5 days	275	76	12.7 ± 1.8	98	19.2 ± 2.6	52	19.4 ± 3.2	49	37.3 ± 6.4
6+ days	265	68	12.2 ± 1.7	102	17.2 ± 2.1	59	27.4 ± 4.2	36	29.4 ± 6.6

†The estimate of the prevalence of injury is unreliable because the relative standard error of the estimate is larger than 30% (Klein et al., 2004).

[b]The frequencies of sub-level are not mutually exclusive.

[a]Prevalence of injury weighted per 10,000 (= [estimated injury / estimated population] x 10,000) .

Table 5

Association between BMI and injury related characteristics during the last three months

Injury related characteristics	BMI continuous	BMI category			
		Normal (BMI: 18.5–24.9)	Overweight (BMI 25.0–29.9)	Obese I (BMI 30.0–34.9)	Obese II (BMI: 35.0+)
	PR (95% CI)[a]	PR (referent)	PR (95% CI)[a]	PR (95% CI)[a]	PR (95% CI)[a]
All injury	1.03 (1.01, 1.04)	1 (referent)	1.25 (1.04, 1.52)	1.41 (1.14, 1.74)	1.68 (1.32, 2.14)
Site of injury (grouped site)					
Foot, toe, ankle	1.05 (1.03, 1.08)	1 (referent)	1.92 (1.12, 3.29)	2.19 (1.21, 3.95)	3.35 (1.82, 6.17)
Leg, knee, hip	1.04 (1.02, 1.07)	1 (referent)	1.14 (0.71, 1.84)	1.29 (0.73, 2.25)	2.53 (1.42, 4.49)
Hand, wrist	1.01 (0.99, 1.03)	1 (referent)	1.23 (0.84, 1.79)	1.05 (0.69, 1.59)	1.04 (0.67, 1.62)
Arm, shoulder	1.05 (1.02, 1.08)	1 (referent)	1.37 (0.84, 2.23)	1.94 (1.20, 3.13)	1.98 (1.05, 3.74)
Back, buttocks	1.04 (1.02, 1.07)	1 (referent)	1.25 (0.81, 1.92)	1.88 (1.14, 3.11)	2.69 (1.56, 4.62)
Head, neck	1.01 (0.98, 1.04)	1 (referent)	1.46 (0.81, 2.63)	1.44 (0.75, 2.78)	†0.83 (0.35, 1.94)
Site of injury (general site)					
Lower extremity	1.05 (1.03, 1.07)	1 (referent)	1.48 (1.03, 2.13)	1.70 (1.13, 2.55)	2.91 (1.91, 4.41)
Upper extremity	1.02 (1.00, 1.04)	1 (referent)	1.26 (0.93, 1.71)	1.25 (0.91, 1.73)	1.32 (0.91, 1.92)
Posterior	1.04 (1.01, 1.06)	1 (referent)	1.17 (0.79, 1.75)	1.84 (1.10, 3.09)	2.32 (1.37, 3.92)
Anterior	1.02 (0.99, 1.05)	1 (referent)	1.60 (0.85, 2.98)	1.70 (0.93, 3.11)	†1.00 (0.42, 2.40)
Type of injury (how injured)					
Fracture	1.05 (1.01, 1.08)	1 (referent)	1.73 (0.94, 3.22)	2.07 (1.10, 3.88)	2.93 (1.36, 6.31)
Sprain/strain/twist	1.05 (1.04, 1.07)	1 (referent)	1.73 (1.29, 2.31)	2.24 (1.64, 3.06)	2.95 (2.04, 4.26)
Cut	1.00 (0.96 1.04)	1 (referent)	0.97 (0.64, 1.48)	0.77 (0.48, 1.24)	0.91 (0.51, 1.65)
Scrape, bruise, burn, bite	1.02 (0.99, 1.05)	1 (referent)	1.00 (0.62, 1.62)	0.99 (0.60, 1.65)	1.58 (0.91, 2.76)
Others	1.02 (0.99, 1.05)	1 (referent)	1.12 (0.69, 1.83)	1.55 (0.84, 2.84)	1.31 (0.72, 2.36)
External causes					
Fall	1.04 (1.02, 1.06)	1 (referent)	1.46 (0.97, 2.20)	1.59 (1.04, 2.43)	2.38 (1.51, 3.76)
Overexertion/strenuous move	1.04 (1.02, 1.06)	1 (referent)	1.32 (0.92, 1.89)	1.88 (1.24, 2.84)	2.06 (1.34, 3.17)
Struck by object	1.01 (0.98, 1.05)	1 (referent)	1.18 (0.68, 2.07)	2.01 (1.12, 3.59)	†1.17 (0.58, 2.39)
Cut, pierce	1.02 (0.96, 1.07)	1 (referent)	1.09 (0.62, 1.93)	†0.88 (0.47, 1.64)	1.18 (0.56, 2.51)

Injury related characteristics	BMI continuous	BMI category			
		Normal (BMI: 18.5–24.9)	Overweight (BMI 25.0–29.9)	Obese I (BMI 30.0–34.9)	Obese II (BMI: 35.0+)
	PR (95% CI)[a]	PR (referent)	PR (95% CI)[a]	PR (95% CI)[a]	PR (95% CI)[a]
Burn, scald, poisoning, bite	1.00 (0.96, 1.04)	1 (referent)	1.19 (0.55, 2.59)	†0.94 (0.37, 2.38)	†1.44 (0.61, 3.42)
Transportation	1.02 (0.96, 1.09)	1 (referent)	†1.20 (0.43, 3.37)	†1.05 (0.31, 3.58)	†2.57 (0.70, 9.46)
Machinery	1.00 (0.97, 1.03)	1 (referent)	†1.00 (0.64, 1.57)	1.00 (0.54, 1.84)	†1.00 (0.50, 2.00)
Others	1.03 (1.00, 1.07)	1 (referent)	1.26 (0.82, 1.94)	1.00 (0.59, 1.67)	†1.91 (1.03, 3.53)
Treatment location after injury					
Emergency vehicle	1.03 (1.00, 1.05)	1 (referent)	1.13 (0.68, 1.87)	1.41 (0.80, 2.48)	1.68 (0.89, 3.19)
Emergency room	1.02 (1.00, 1.04)	1 (referent)	1.17 (0.87, 1.58)	1.27 (0.92, 1.76)	1.48 (1.00, 2.18)
Doctor's office/clinic	1.04 (1.02, 1.05)	1 (referent)	1.41 (1.14, 1.75)	1.57 (1.22, 2.02)	2.01 (1.52, 2.64)
Call to medical prof	1.05 (1.02, 1.07)	1 (referent)	1.19 (0.84, 1.68)	1.36 (0.93, 2.00)	2.19 (1.43, 3.35)
Any place else	1.02 (0.99, 1.06)	1 (referent)	0.81 (0.49, 1.35)	1.64 (1.03, 2.63)	1.28 (0.63, 2.60)
Day of work missed					
None or <1 day	1.01 (1.00, 1.03)	1 (referent)	1.27 (0.97, 1.65)	1.32 (0.96, 1.82)	1.27 (0.87, 1.83)
1–5 days	1.06 (1.03, 1.08)	1 (referent)	1.39 (0.92, 2.09)	1.40 (0.89, 2.22)	2.65 (1.72, 4.07)
6+ days	1.04 (1.01, 1.06)	1 (referent)	1.19 (0.80, 1.77)	1.85 (1.16, 2.94)	2.14 (1.29, 3.55)

†The estimate of the prevalence ratio is unreliable because the relative standard error of the estimate of injury prevalence is larger than 30% (Klein et al., 2004).

[a]PR: prevalence ratios with 95% confidence interval are adjusted for gender, age, race/ethnicity, marital status, education, smoking status, alcohol intake status, employment, sleep duration, physical activity, and occupation. Prevalence ratios are obtained from marginal predictions in the fitted logistic regression model (Bieler et al., 2010).