



Published in final edited form as:

Am J Ind Med. 2022 July ; 65(7): 589–603. doi:10.1002/ajim.23366.

Safe Patient Handling Legislation and Musculoskeletal Disorders Among California Healthcare Workers: Analysis of Workers' Compensation Data, 2007-2016

Soo-Jeong Lee, RN, PhD^{1,*}, Joung Hee Lee, RN, PhD^{1,3}, Robert Harrison, MD, MPH²

¹School of Nursing, University of California, San Francisco, San Francisco, California

²School of Medicine, University of California, San Francisco, San Francisco, California

³Department of Nursing, Chodang University, Jeollanamdo, South Korea

Abstract

Background: California requires general acute care hospitals to have a comprehensive plan to prevent patient handling injuries (PHIs) among employees. The safe patient handling (SPH) law took effect in 2012. This study assessed the impact of the SPH law on workers' compensation claims for musculoskeletal disorders (MSDs) among California hospital workers.

Methods: We used California Workers' Compensation Information System data from 2007-2016 and analyzed claims for MSDs that occurred in acute care hospitals compared with nursing and residential care facilities. MSD claims were classified into PHI and non-PHI claims.

Results: We identified 199,547 MSD claims that occurred during 2007-2016 in acute care hospitals (62.8%) and nursing and residential care facilities (37.2%). MSDs accounted for 42.8% of all claims. Of the MSD claims, 81.0% were strains or sprains and 33.5% of MSDs were related to patient handling activities. From 2011 to 2016, MSD claim rates showed significant reductions among both hospital and nursing/residential care workers. However, the MSD-PHI claim rate showed a significant reduction only among hospital workers (7.3% per year, Incidence Rate Ratio [IRR]=0.927, 95% CI 0.903-0.952). There was no significant change among nursing/residential care workers (IRR=0.990, 95% CI 0.976-1.005). The non-PHI claim rate showed no significant change among hospital workers (IRR=0.982, 95% CI 0.956-1.009).

* **Correspondence to:** Soo-Jeong Lee, Department of Community Health Systems, School of Nursing, University of California San Francisco, 2 Koret Way, N505, Box 0608, San Francisco, CA 94143. soo-jeong.lee@ucsf.edu.

Institution at which the work was performed: University of California, San Francisco

Authors' Contributions: Dr. SJ Lee conceptualized and designed the study, conducted data analysis, and wrote the manuscript. Dr. JH Lee participated in the data analysis and interpretation, and contributed to critical revision of the manuscript. Dr. Harrison contributed to study design, data interpretation and critical revision of the manuscript. All authors approved the final version to be published and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Institution and Ethics approval and informed consent: The study was approved by the Institutional Review Board at the University of California, San Francisco (UCSF) and the California State Committee for the Protection of Human Subjects (CPHS).

Disclosure: The authors declare no conflicts of interest.

Disclaimer: None

Conclusions: Our study identified significant reductions of PHI claims among California hospital workers after the passage of the SPH legislation, suggesting that SPH legislation played a crucial role in reducing the risk of injury among healthcare workers.

Keywords

Healthcare worker; musculoskeletal disorder; patient handling injury; safe patient handling legislation; workers' compensation

INTRODUCTION

The healthcare industry is the fastest-growing sector in the U.S. and employs over 18 million workers, accounting for 11.6% of the U.S. workforce.^{1,2} The healthcare industry has relatively high rates of work-related injuries and illnesses. In 2018, approximately 156,000 workers in the healthcare and social assistance private sector required time away from work due to occupational injury or illness.³ Musculoskeletal disorders (MSDs) are a major occupational health problem among healthcare workers. Between 2008 and 2015, 30,000-38,000 nurses or nursing assistants lost a median of 5-9 workdays annually because of work-related MSDs.⁴ Such injuries and illnesses not only compromise the well-being and quality of work life of individual workers, but also pose a challenge in maintaining optimal staffing levels to provide high-quality and timely care.

The primary risk factor for MSDs among healthcare workers is patient handling activities such as lifting, transferring, repositioning, and helping patients with mobility.⁵⁻⁶ Patient handling accounts for 31-72% of musculoskeletal injuries⁵⁻⁷ and 27-53% of workers' compensation costs among healthcare workers.^{7,8} A study analyzing injury reports from 112 U.S. healthcare facilities reported a patient handling injury incidence rate of 11.3 per 10,000 worker-months.⁹ Another study showed that work-related low back pain prevalence was two times higher among nurses who performed patient handling than among nurses without patient handling duty.¹⁰ The current increase in obesity and related hospital admissions of bariatric patients are expected to further elevate the risk of MSDs among healthcare workers.¹¹

In recognition of the substantial problem of injuries from unsafe patient handling and the critical need for effective workplace interventions, state laws have been promulgated to protect healthcare workers. Since 2005, 11 states have passed safe patient handling (SPH) legislation and most states require implementation of comprehensive safe patient handling policy and programs.¹² At the national level, federal bills, including the 2015 Nurse and Health Care Worker Protection Act (H.R.4266), have been introduced but have not yet passed.^{13,14} In California, the SPH law (AB1136 Hospital Patient and Health Care Worker Injury Protection Act) was enacted effective January 1, 2012. This law applies only to general acute care hospitals and requires them to adopt and implement a safe patient handling policy and programs including replacement of manual patient handling with powered mechanical equipment, training on safe patient handling, and provision of lift teams or trained staff to assist with patient handling. Subsequently, the California Division of Occupational Safety and Health (Cal/OSHA) developed specific regulations to

implement the law (General Industry Safety Orders §5120. Health Care Worker Back and Musculoskeletal Injury Prevention), which became effective on October 1, 2014.^{15,16} There have been studies examining the effectiveness and outcomes of SPH at the institutional level,¹⁷⁻²⁴ but research evaluating the statewide impact of legislation has been limited. Research is needed to identify whether the laws and regulations are effective in preventing MSDs among healthcare workers.

The purpose of this study was to assess the impact of the California SPH law and Cal/OSHA regulations by investigating changes in all MSD claims among California healthcare workers in 2007-2016. This study compared all MSD, patient handling injury (PHI) and non-PHI claims, between general acute care hospitals and nursing and residential care facilities (NRCF), where SPH regulations do not apply. This study had three hypotheses:

Hypothesis 1. The annual numbers and rates of MSD and PHI claims among hospital workers will decrease from the pre-legislation period (2007-2011) to the post-legislation period (2012-2016).

Hypothesis 2. Changes in MSD and PHI claim rates from 2011 to 2016 will differ between hospital workers and NRCF workers (external comparison).

Hypothesis 3. Among hospital workers, changes in MSD claim rates from 2011 to 2016 will differ between PHI and non-PHI claims (internal comparison).

METHODS

Study Design

This study employed a retrospective, interrupted time-series design with both internal (PHI vs. non-PHI claims) and external (hospital vs. NRCF not covered under legislation) comparisons. We analyzed California workers' compensation (WC) claims data for hospitals and NRCFs from 2007 to 2016. The year of cases was based on the date of injury of the claim. Claims in 2007-2011 were injuries that occurred in the pre-legislation period; claims in 2012-2016 were injuries that occurred in the post-legislation period. The post-legislation period was further divided into the pre-Cal/OSHA regulation period (2012-2014) and the post-Cal/OSHA regulation period (2015-2016).

Data Source

This study used data from the California Workers' Compensation Information System (WCIS) in the California Department of Industrial Relations (DIR). In California, occupational injury or illness that results in lost time beyond the date of the incident or that requires medical treatment beyond first aid must be reported by WC insurance carriers to the California DIR.²⁵ The WCIS collects claims data on employee, employer, industry, occupation, accident, injury, claims status, benefits, and payments using an electronic data interchange system.²⁶ It should be noted that WCIS covers only state employers and does not collect information from federal employers (e.g., Veterans Affairs healthcare system or US Postal Service), self-employed, or military. For the data access, a Memorandum of Understanding was established between the DIR and the University of California San

Francisco. The DIR extracted data for healthcare worker cases using a broad definition of those who were employed or worked in the healthcare industry. WCIS has two data elements related to industry: Industry Code and Class Code.²⁷ For Industry Codes, prior to 2018 WCIS used both the North American Industry Classification System (NAICS, <https://www.census.gov/eos/www/naics/>) and the Standard Industrial Classification (SIC, <https://www.osha.gov/pls/imis/sicsearch.html>). After March 2018, only NAICS codes are accepted. Class Codes are California-specific 4-digit codes from the Workers' Compensation Insurance Rating Bureau of California. NAICS, SIC, and WCIS Class codes relevant to identifying healthcare cases are presented in Appendix 1. In addition to these codes, we also used employer name, occupation description, and injury description to capture healthcare worker cases that were not identified by Industry or Class Codes for the following reasons: (1) cases in government healthcare facilities, which are generally coded as government industry (not healthcare); (2) contractors (NAICS 5613 Employment Services; SIC 736: Personnel Supply Services); and (3) cases with erroneous or missing codes. Using a broad approach for initial case identification presented in Appendix 2, the Division of Workers Compensation extracted 959,292 potential healthcare worker cases in 2007-2016 from the WCIS. We further reviewed Industry Code, Class Code, employer name, occupation description, injury description, and, if needed, Zip Codes of employer and injury sites to determine healthcare worker cases. Based on the strength of the evidence, reviewed cases were classified into definite, possible, and not likely or not categories (Appendix 2).

Case Definitions and Study Variables

Hospital and NRCF Cases—Our case definition included various types of workers in acute care hospitals or NRCF facilities regardless of their job titles; contractors and trainees were also included. For hospital cases, we defined a case as follows: (1) *Definite*: Both Industry Code (SIC 80, NAICS 622) and Class Code (9043) indicate a hospital without opposing evidence, or its employer name definitely indicates a hospital, and (2) *Possible*: Either Industry Code or Class Code, not both, indicate a hospital with additional evidence (e.g., employer name or occupation description), or the combination of other information (e.g., employer name, Zip Code, occupational description, injury description) indicates a possible government hospital case (See Appendix 2). We excluded hospitals within the Department of Corrections and Rehabilitation or the State Department of Developmental Services, following the stipulation of exceptions to the Cal/OSHA SPH regulation.¹⁶ NRCF cases were identified using Industry Codes (SIC 805, 8361 or NAICS 623) and Class Codes (8823, 8829, 8851, 9070, 9085), and employer names and occupation descriptions were further reviewed for additional capture or exclusion of cases.

MSD Cases—MSDs refer to injuries or illnesses of muscles, nerves, tendons, joints, cartilage, and supporting structures of the upper and lower limbs, neck, and back that were caused, precipitated, or exacerbated by sudden exertion or prolonged exposure to physical factors such as repetition, force, vibration, or awkward posture.²⁸ Our MSD case definition was based on the combination of Cause of Injury, Nature of Injury, and Part of Body Injured, using a case definition modified from the California Department of Public Health (See Appendix 3).

MSD cases were classified into PHI and non-PHI cases. PHIs were defined as injuries that occurred from or during patient handling activities such as lifting, transferring, repositioning, and helping patient mobility. In this study, PHIs also included injuries from patient care activities that involved moving or holding a body part or assisting a patient's body movement (e.g., dressing/bathing a patient, holding a leg during wound care, making an occupied bed) and transporting a patient. PHIs were identified from narrative injury descriptions. We used various combinations of specific terms or specific phrases to identify PHI cases; for example, ("patient" or "pt" or "resident" or "client") AND ("reposition" or "transfer" or "lift" or "transport" or "handling"). We excluded from PHI cases injuries where patients' violent or combative behaviors were likely to be the main cause. Some examples of violence case search terms include "assault", "attack", "altercation", "aggressive", "agitate", "harass", "resist", and "violent."

Demographic and Job Characteristics—For demographic and job characteristics, this study included the following four variables available from the data source: gender, age at the time of injury, occupation (nursing or other), and job tenure (time from hire to injury). For occupation, only narrative data are available in the WCIS; it was not always possible to separate nurse and nursing assistant/aide titles from the occupation descriptions. Thus, we combined all nursing-related job titles (e.g., nurse, nurse manager, nursing assistant, patient care assistant) into nursing occupation. Job tenure was calculated as the time interval between the date of hire and the date of injury and categorized into 12 months or less, 13 months to 2 years, 3-4 years, 5-9 years, and 10+ years, referring to the Bureau of Labor Statistics.²⁹

Data Analysis

Data analysis was performed using the SAS 9.4 program (SAS Institute Inc., Cary, NC). MSD claims in hospitals and NRCFs were described by demographic, job, and injury characteristics (PHI or non-PHI, nature of injury, and body part). Data were described with frequency, percent, mean, median, standard deviation (SD), and interquartile range (IQR). Annual data were based on the year of injury. The changes of claim numbers between pre- and post-legislation periods (2007-2011 vs. 2012-2016) and percent changes (difference in the numbers between the two periods divided by the number for the pre-SPH legislation period) were calculated for MSD and MSD-PHI claims by setting. The post-legislation period was further divided into pre- and post-Cal/OSHA regulation periods (2012-2014 vs. 2015-2016). Annual incidence rates of MSD and MSD-PHI claims were calculated using the denominators of the annual average numbers of employees in California hospitals and NRCFs obtained from the BLS Quarterly Census of Employment and Wages (QCEW, <http://www.labormarketinfo.edd.ca.gov/qcew/cew-select.asp>). Average annual incidence rates in the pre- and post-SPH legislation periods (2007-2011 vs. 2012-2016) and percent changes were compared between the two time periods. We also modeled rates over time using SAS PROC GENMOD. We included data only from 2011 to 2016 for this analysis because, theoretically, we did not expect rate reductions related to the SPH law during the pre-legislation period and including the data before 2011 might dilute the estimates of changes over time during the post-legislation period. Goodness-of-fit tests that compared the deviance with Pearson's chi-square statistics indicated overdispersion of the data,³⁰ thus, we

used a negative binomial model. The growth curve model was fitted to the data to compare change over time between groups (i.e., PHI vs. non-PHI, and hospitals vs. NRCFs). Overall F test was used to compare the growth curves between the groups. Incidence rate ratios (IRR) and 95% Confidence Intervals (CI) were calculated.

RESULTS

MSD Claims and Case Characteristics

Figure 1 shows the flow of the identification of MSD and PHI cases in acute care hospitals and NRCFs in this study. Between 2007 and 2016, there were 5,781,856 WC claims reported to the California WCIS. There were 285,166 hospital claims and 180,739 NRCF claims identified as definite or possible cases. MSD accounted for 43.9% (n=125,237) of the hospital claims and 41.1% (n=74,310) of the NRCF claims. Table 1 presents demographic, job, and injury characteristics of 199,547 MSD claims in 2007-2016 by setting. Of the MSD claims, 33.5% (n=66,771) were identified as PHIs, representing 28.8% of MSD hospital claims and 41.4% of NRCF claims. MSD cases were predominantly female (79.7%), with similar patterns between hospitals and NRCFs, and nursing occupations accounted for 40.2% of the MSD claims. The proportion of MSD claims by age was highest in the age group 45-54 years (26.8%); NRCF cases included a higher proportion of younger workers aged 16-34 years than hospital cases (37.4% vs. 24.1%). For the time from hire to injury, different patterns were observed between hospital and NRCF claims. In hospital settings, MSD claims were most common among workers with greater job tenure (5 or more years, 54.1%) whereas in NRCFs, 57.8% of claims were among workers with job tenure of 2 or less years; the median job tenure of MSD claims was 5.8 years (IQR 2.3-11.3) in hospitals and 1.8 years (IQR 0.6-4.8) in NRCFs. For injury characteristics, most injuries were strains (64.6%) or sprains (16.4%); the most common body part injured was upper extremities (29.5%) for hospital claims and lower back (32.8%) for NRCF claims.

Annual MSD and MSD-PHI Claims in 2007-2016 and Changes between the Pre- and Post-SPH Legislation Periods

Table 2 presents annual case counts and changes between the pre-legislation period (2007-2011) and the post-legislation period (2012-2016) for MSD and MSD-PHI claims by setting. The results show that our hypothesis 1 (reduction of MSD and PHI claim numbers among hospital workers) was supported. In hospitals, the annual number of MSD claims was highest in 2007 (n=13,103) and lowest in 2015 (n=10,932), and the annual number of MSD-PHI claims was highest in 2009 (n=3,975) and lowest in 2016 (n=2,736). Comparing the numbers between the pre-legislation period (2007-2011) and the post-legislation period (2012-2016), MSD claims decreased by 3.97% in hospitals, whereas MSD claims increased by 6.32% in NRCFs. Considering injury type in hospitals, PHI claims decreased by 13.6%, whereas non-PHI claims increased by 0.22%. In NRCFs, PHI claims increased by 7.89% and non-PHI claims increased by 5.24%.

Table 3 presents annual claim rates and changes over time for MSD and MSD-PHI claims by setting during 2007-2016. The trends of claim rates are visually displayed in Figure 2. Among hospital workers, the annual MSD claim rate showed fluctuations until 2014

(2.60-2.88 per 100 employees) and then showed apparent reductions during 2015-2016 (2.37-2.43 per 100 employees). Compared to the pre-legislation period, the 5-year average claim rate showed a 2.9% reduction during the post-legislation period, but a greater reduction by 12.7% during the post-Cal/OSHA regulation period (data not shown in table). During 2011-2016, the MSD claim rate among hospital workers decreased by 3.3% per year (IRR=0.967, 95% CI 0.943-0.991, $p=0.0086$). This rate change tended to be greater than the changes of MSD claim rates in NRCF workers (IRR=0.986, 95% CI 0.980-0.991, $p<0.0001$), but the difference was not statistically significant ($p>0.05$). These results show that our hypothesis 1 (reduction of MSD and PHI claim rates among hospital workers) and hypothesis 2 (different trends of rates between hospital and NRCF workers) were supported.

The annual MSD-PHI claim rate among hospital workers was highest in 2010 (0.88 per 100 employees) and lowest in 2016 (0.58 per 100 employees). Between the pre- and post-legislation periods, the 5-year average PHI claim rate among hospital workers decreased by 12.0%. During 2011-2016, the PHI rate significantly decreased by 7.3% per year (IRR=0.927, 95% CI 0.903-0.952, $p<0.0001$) while annual non-PHI rates fluctuated with little change (IRR=0.982, 95% CI 0.956-1.009). The trends of rate changes were significantly different between PHI and non-PHI claims ($p=0.003$). Therefore, our hypothesis 3 (internal comparison) was supported. Moreover, the hospital PHI rate change over time was significantly different from the trend of PHI rates among NRCF workers ($p<0.0001$), which had little change during 2011-2016 (IRR=0.990, 95% CI 0.976-1.005). This result shows that our hypothesis 2 (external comparison) was supported.

Changes of MSD and MSD-PHI Claims by Injury Characteristics

Table 4 presents injury characteristics of MSD and MSD-PHI claims and changes between the pre- and post-legislation periods among California hospital workers. During the post-legislation period, trunk injury claims showed the largest reductions for MSD (-25.7%) and PHI (-33.3%) cases compared to the claims in the pre-legislation period. Multiple body part (-28.3%) and upper extremity (-18.5%) claims showed the next largest reductions for PHI cases. Lower back PHI claims decreased by 5.8% during the post-legislation period. This relatively smaller reduction was because the annual number of claims was highest in 2012 (n=1,382). Since 2012, it has shown apparent reductions every year and the number of lower back claims in 2016 (n=836) decreased by 39.5% from 2012. On the other hand, shoulder claims increased for MSD (21.2%) and PHI (10.3%) cases, and neck claims increased by 17.1% for MSD cases during the post-legislation period. There was a significant increase in the annual rate of shoulder MSD claims over time during 2007-2016 (IRR=1.033, 95% CI 1.012-1.055; data not shown in table). Among PHIs, strains and sprains decreased by 34.2% during the post-legislation period.

DISCUSSION

This study examined changes in MSD and PHI WC claims among California healthcare workers during 2007-2016 to assess the impact of California's SPH legislation. We identified significant reductions in the numbers and rates of the MSD and PHI claims among acute care hospital workers during the post-legislation period, and particularly greater

reductions during the post-OSHA regulation period. PHI claims among hospital workers showed significantly different patterns of changes over the time from non-PHI claims. We also found different patterns in the changes in the numbers and rates of claims between hospitals and NRCFs. Our findings of greater reductions of PHI claims in hospitals suggest positive impacts of the SPH law and regulations on PHI prevention. Consistent with these study findings, recent studies of California nurses that analyzed data from statewide surveys in 2013 and 2016 found significant improvements in SPH policies, programs, and practices of California hospitals, and also a significant reduction of the prevalence of work-related musculoskeletal symptoms by 22% among hospital nurses.^{31,32}

While SPH laws have been implemented in 11 states in the US, there has been only limited research assessing the impact of legislation on reducing MSDs. Washington State (legislation in 2006) reported that hospital-compensable incidence rates decreased by 10.1% for work-related MSDs.³³ This reduction was greater than the change observed for nursing homes with a 5.8% reduction³³ (similar to California, nursing homes are not covered by the SPH law in Washington). A recent Minnesota study examined the effect of the SPH law (enacted in 2007) on WC indemnity claims in nursing homes and found significant reductions in PHI claims rates compared to pre-legislation period.³⁴ The study observed that the PHI claim rate decreased by 25% in post-legislation years 4 through 5 and by 38% in post-legislation years 7 through 9, indicating sustained and greater impacts of the SPH law over time.³⁴ All available evidence, along with our study, supports the positive effect of SPH laws on the prevention of PHIs among healthcare workers.

During the post-legislation period, we observed a 14% reduction in PHI claim numbers and a 12% reduction in PHI claim rates among hospital workers. These reductions are considered relatively modest effects, indicating the need for further intervention efforts using additional strategies on the one hand; conversely, the modest effects may be partially due to previous intervention efforts for reducing MSD and PHIs among some hospitals during the pre-legislation period.³⁵ Additionally, it takes considerable time until new legislation or regulations get passed and also until new or improved programs are implemented following the mandates. Indeed, California's SPH legislation was finally passed four years after the previous bill was vetoed and Cal/OSHA SPH regulations were published three years after the SPH law was passed. This may cause some diffusion of intervention efforts during the pre-legislation period and dilute the legislative effect in measuring the impact.

In our study, 29% to 41% of MSD claims were identified as PHI claims in hospital and NRCF settings, which is on the lower end of estimates from other studies (31% to 72%)^{6-8,33} and provides a more conservative estimate. Concerning injury characteristics, about 80% of the MSD claims in our study were strains or sprains and 52% occurred in upper extremities or lower back. We found that the upper extremity was the most commonly affected body part among overall MSD claims in hospital workers; the lower back was the most common affected body part within PHI claims. During the post-legislation period, we observed the greatest reductions in the numbers of PHI claims in lower back (40% from 2012 to 2016), trunk (33%) and upper extremities (19%). These findings suggest that SPH programs implemented in hospitals have been more beneficial in reducing the risk of injuries, particularly, to the back, trunk and upper extremities. In contrast, we found that

among hospital workers, the number of MSD claims in shoulders and neck increased by 21% and 17%, respectively, and the number of PHI claims in shoulders increased by 10% during the post-legislation period. One possible reason for these findings may have to do with the introduction and greater use of engineering controls. Specifically, a qualitative study reported that some nurses expressed concerns about shoulder and neck injuries related to more frequent use of ceiling lifts.³⁶ In the Minnesota study,³⁴ the PHI indemnity claims rate for shoulder injuries showed an initial increase during the first 3 years of post-legislation periods and then showed gradual decreases, which were statistically significant; however, the study observed little change for the PHI claim rate for neck injuries.

Methodological Considerations and Limitations

In interpreting the study findings, our case definitions and limitations in case identification methods from the WC data system and data quality issues should be considered. For healthcare worker claims, we used the broad definition of claims involving those who were employed or working in the healthcare industry regardless of their occupation or employment types. Our study did not capture claims in federal facilities because federal employers are not included in the California WCIS system. As noted earlier, government cases are generally reported using government industry codes; thus, not all healthcare worker cases can be captured by class code and industry code. Additionally, there were considerable discrepancies between class and industry codes. For example, among cases with either hospital class codes or industry codes, 36% had discrepancies between the two codes and 15% had missing data for one of the two codes. Although we conducted numerous manual data reviews for validation of our case coding programs, our findings may be subject to misclassification. In addition, our PHI case identification was based entirely on the injury description record, which may have incomplete or limited narratives. As such, the PHI case counts are likely to be underestimates.

We calculated claim rates using the BLS QCEW data for denominators. The data source provides the total employment size by industry, which consists of both full-time and part-time employees. Using this denominator data, we calculated claim rates per employees, not per full-time equivalents. While the BLS QCEW uses NAICS codes, the WCIS uses NAICS, SIC, and Class codes. Therefore, there can be potential mismatches between the numerators based on the three industry codes and the denominators based on NAICS only. Furthermore, we included contractors, trainees, or students in the cases. As these groups are not included in the denominator for healthcare workers, this may lead to overestimation of rates.

In assessing the impact of the SPH law and regulations, our study used WC data, which reflect more severe cases involving medical treatments or lost worktime. Thus, our study is not likely to capture changes in more minor conditions. Additionally, underreporting to the WC systems is a well-identified problem.³⁷ Therefore, our findings are likely to be underestimates of the true magnitude of MSDs and PHIs. Regarding the extent of underestimation, hospitals' SPH programs after the SPH law may have enhanced injury reporting of workers, which can dilute the intervention effect in comparing pre- and post-legislation periods. However, the level of underreporting during the post-legislation period may be similar; hence, this concern of underreporting may not be problematic in our

analyses comparing trends during 2011-2017 using the internal comparison group (PHI vs. non-PHI). Regarding analyses using the external comparison group (hospital vs. NRCF), we do not have evidence that the extent of underreporting was significantly different between the two settings. Also, if the extent of underreporting is similar per year within the setting, this non-differential bias would lead toward the null and further supports our significant findings obtained in a more conservative way.

Our study findings suggest that the SPH law and regulations may have made a positive impact on the reduction of PHI claims among hospital workers, but we cannot determine a causal relationship due to the limitation of the observational study design. However, interrupted time-series analysis is one of the strongest designs for evaluating the effectiveness of population-level interventions such as health policies, public health programs, or legislation, where randomized controlled trials are not possible.³⁸ The interrupted time-series design has the following strength: The results are generally not affected by confounding variables that remain relatively constant over time such as population age distribution or socioeconomic status.³⁸ Thus, although our study did not conduct multivariable analyses when examining changes of rates calculated using aggregate data, our findings are less likely to be affected by those potential confounders. Along with this, there is a need to consider other types of time-varying confounders that may have changed during the study period; for example, physical workload or psychosocial stress related to practice or organizational changes and patient characteristics with increased acuity or obesity. There can be residual confounding by these kinds of time-varying confounders. Concerning such potential confounding, we used two types of comparison groups in examining the changes over time and between pre-legislation and post-legislation periods. We first considered an external comparison group where the SPH law and regulations do not apply and compared hospital cases with NRCF cases. We also considered the type of injury and compared PHI cases with non-PHI cases as an internal comparison group. From both comparison groups, we obtained consistent findings supporting our study hypotheses on the effect of the SPH law and regulations. Additionally, by using the comparison groups, we may be able to exclude regression to the mean effects in concluding that the reduction of PHI rates in hospitals is associated with the SPH law. Regression to the mean is a statistical phenomenon occurring when changes in repeated data result from natural variation or random errors in measurements, not from the intervention.³⁹⁻⁴⁰ Observed changes in the comparison groups in our study may indicate regression to the mean effects and, as shown in Figure 2, we observed a clearly different pattern and a significantly different slope in the PHI rate trend in hospitals from the data trends of the comparison groups. As such, our study has strengths of using robust approaches to produce evidence for legislative intervention effectiveness.

CONCLUSION

Our study found that MSD claims accounted for 41 to 44% of WC claims among hospital or NRCF workers in California in 2007-2016. These findings underscore prior evidence that MSDs present a major occupational health problem among US workers, with substantial health burden to individual workers and financial burden to the workplace and society. This study identified significant reductions in the numbers and rates of MSD and PHI WC claims

among California hospital workers during the post-SPH legislation period. These findings suggest that the SPH law and Cal/OSHA regulations have made a significant impact on preventing MSDs and PHIs among hospital workers. In contrast to improvements in hospital cases, our study also observed increased numbers of PHI claims in NRCFs. This finding suggests the need to expand California’s SPH law and Cal/OSHA standards to NRCFs. Further research is needed to assess the long-term effect of the SPH law and regulations in hospital settings and to address MSD and PHI risks in NRCF settings.

Acknowledgements:

We acknowledge the California Department of Industrial Relations, Division of Workers Compensation for providing the data for our study. The authors also thank Matthew Frederick and Rebecca Jackson for providing consultation.

Funding:

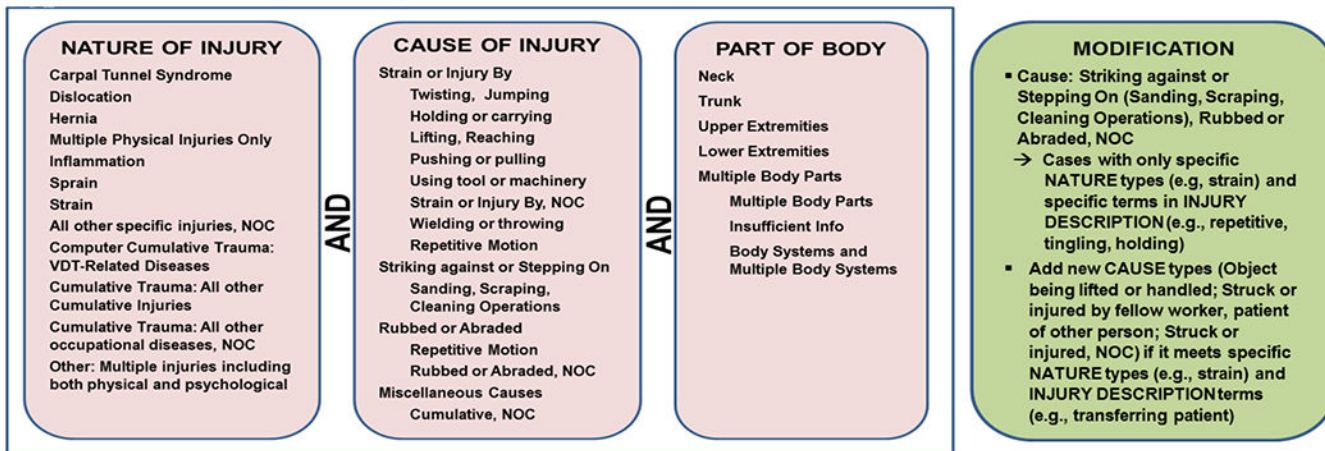
This study was supported by the following sponsors:

Grant sponsor:

1. National Institute for Occupational Safety and Health (R03OH010487).
2. U.S. Department of Labor Research and Evaluation Grant (EO-30270-17-60-5-6)

Appendix

Appendix



Appendix 3. MSD Case Definition and Search Methods

Appendix 1.

Industry Codes and WCIS Class Codes for healthcare worker case identification

Industry Code (NAICS)		Industry Code (SIC)		Class Code	
621	Ambulatory health care services	80	Health services	7332	Ambulance service

Industry Code (NAICS)		Industry Code (SIC)		Class Code	
6211	Offices of physicians	801	Offices and clinics of doctors of	8823	Residential care facilities for
6212	Offices of dentists		medicine		children
6213	Offices of other health practitioners	802	Offices and clinics of dentists	8827	Homemaker services
6214	Outpatient care centers	803	Offices and clinics of doctors of	8829	Nursing homes
6215	Medical and diagnostic laboratories		osteopathy	8830	Institutional employees
6216	Home health care services	804	Offices and clinics of other health	8831	Hospitals-veterinary
6219	Other ambulatory health care services		practitioners	8834	Physicians
622	Hospitals	805	Nursing and personal care facilities	8839	Dentists
6221	General medical and surgical hospitals	806	Hospitals	8851	Congregate living facilities for the
6222	Psychiatric and substance abuse hospitals	807	Medical and dental laboratories		elderly
6223	Specialty (excl. Psychiatric/ substance abuse) hospitals	808	Home health care services	8852	Home infusion therapists – all
623	Nursing and residential care facilities	809	Miscellaneous health and allied		employees
6231	Nursing care facilities (skilled nursing facilities)		services, NEC	9043	Hospitals
6232	Residential intellectual and developmental disability, mental health, and substance abuse facilities	8361	Residential care	9070	Residential care facilities for the elderly – NOC
6233	Continuing care retirement communities and assisted living facilities for the elderly			9085	Residential care facilities for the developmentally disabled
6239	Other residential care facilities				

Appendix 2.

Healthcare worker (HCW) case identification methods and categories

Initial HCW case extraction	
<ul style="list-style-type: none"> • Healthcare Industry and Class Codes (Appendix 1) • Employer Name search terms that can indicate healthcare employers (n=200: e.g., '%HOSP%', '% MED %', 'MD', '%SURGERY%', '% MENTAL %', '%DENTAL%', '%CLINIC%', '%HEALTH%', '%CARE%', '%AMBULA%'). • Occupation search terms that can indicate healthcare (n=182: e.g., RN, LVN, CNA, M.D., '%MED.%', '%NURSE%', '%CARE%GIVE%', '%HEALTH%', '%PATIEN%'). • Injury description indicating patient-related injuries: 'PATIENT' or 'PT' included in the middle of the narrative; 'PATIENT' or 'PT' repeated twice in the narrative; both 'PATIENT'/PT' and 'BED' are included in the narrative; 'PATIENT' or 'PT' included in the narrative and Cause of Injury code=74 (Struck or injured by fellow worker, patient or other person) 	
HCW case category	
Definite	<ul style="list-style-type: none"> • Healthcare by both Industry Code and Class Code • Healthcare by either Industry Code or Class Code (not both), plus any evidence

	indicating healthcare worker from employer name, occupation description, or injury description
Possible	<ul style="list-style-type: none"> • No healthcare Industry and Class Codes, but 2 or more evidence indicating healthcare worker from employer name, occupation description, or injury description • No healthcare Industry and Class Codes, but healthcare worker by employer name (definite by the narrative) • Healthcare by either Industry Code or Class Code (not both), but no evidence for healthcare worker from employer name, occupation description, or injury description • No healthcare Industry and Class Codes, but possibly healthcare worker by employer name, occupation description, or injury description (by only one info)
Not likely/Not	<ul style="list-style-type: none"> • Evidence indicating non-healthcare (e.g., veterinary, pharmacy (retail), medical instrument manufacturing, police, firefighter, public health assistant/investigator)
Hospital case category	
Definite	<ul style="list-style-type: none"> • Hospital by both Industry Code (SIC 80 & NAICS 622) and Class Code (9043) • Hospital by employer name (definite by the narrative)
Possible	<ul style="list-style-type: none"> • Hospital by either Industry Code or Class Code (not both), plus employer name possibly indicating hospitals • Hospital by either Industry Code or Class Code (not both), plus either hospital or ambulatory care is possible by employer name entry • Hospital by either Industry Code or Class Code (not both), plus HCW occupation • Hospital by either Industry Code or Class Code (not both), plus any information indicating contractor by Industry/Class code or employer name • Government hospital cases identified by the combination of Industry/Class Codes, employer name, zip code, occupational description, and injury description
Not likely/Not	<ul style="list-style-type: none"> • Non-hospital settings; state prison hospitals, developmental service facilities.

References

1. Bureau of Labor Statistics. Labor Force Statistics from the Current Population Survey: Employed persons by detailed industry and age. 2020; <https://www.bls.gov/cps/cpsaat18b.htm>.
2. Bureau of Labor Statistics. Employment Projections: 2018-2028 Summary. 2019; <https://www.bls.gov/news.release/ecopro.nr0.htm>.
3. Bureau of Labor Statistics. Employer-Reported Workplace Injury and Illness, 2018. 2019; <https://www.bls.gov/news.release/osh.nr0.htm>.
4. Bureau of Labor Statistics. Case and demographic characteristics for work-related injuries and illnesses involving days away from work. 2020; <https://www.bls.gov/iif/oshcdnew.htm>.
5. Kim H, Dropkin J, Spaeth K, Smith F, Moline J. Patient handling and musculoskeletal disorders among hospital workers: analysis of 7 years of institutional workers' compensation claims data. *American Journal of Industrial Medicine*. 2012;55(8):683–690. [PubMed: 22237853]
6. Lipscomb HJ, Schoenfisch AL, Myers DJ, Pompeii LA, Dement JM. Evaluation of direct workers' compensation costs for musculoskeletal injuries surrounding interventions to reduce patient lifting. *Occupational and Environmental Medicine*. 2012;69(5):367–372. [PubMed: 22199366]
7. Pompeii LA, Lipscomb HJ, Schoenfisch AL, Dement JM. Musculoskeletal injuries resulting from patient handling tasks among hospital workers. *American Journal of Industrial Medicine*. 2009;52(7):571–578. [PubMed: 19444808]
8. Oregon Occupational Safety and Health Administration. Safe patient handling: A worthy investment. 2007; <http://www.slideserve.com/nia/safe-patient-handling-a-worthy-investment>.
9. Gomaa AE, Tapp LC, Luckhaupt SE, et al. Occupational traumatic injuries among workers in health care facilities - United States, 2012-2014. *MMWR Morbidity and Mortality Weekly Report*. 2015;64(15):405–410. [PubMed: 25905893]

10. Lee SJ, Lee JH, Gershon RR. Musculoskeletal Symptoms in Nurses in the Early Implementation Phase of California's Safe Patient Handling Legislation. *Research in Nursing and Health*. 2015;38(3):183–193. [PubMed: 25914203]
11. Cowley SP, Leggett S. Manual handling risks associated with the care, treatment and transportation of bariatric (severely obese) clients in Australia. *Work*. 2011;39(4):477–483. [PubMed: 21811036]
12. American Nurses Association. State legislative agenda: Safe Patient Handling and Mobility (SPHM). 2016; <http://www.nursingworld.org/MainMenuCategories/Policy-Advocacy/State/Legislative-Agenda-Reports/State-SafePatientHandling>.
13. Association of Safe Patient Handling Professional. U.S. Federal and state legislative summary: Safe patient handling/Ergonomics 2011; http://www.asphp.org/wp-content/uploads/2011/05/SPH_Legislation_Update_March_2011.pdf.
14. Congress. H.R.4266 - Nurse and Health Care Worker Protection Act of 2015. In:2015.
15. Californial Department of Industrial Relations. Safe Patient Handling. 2012; http://www.dir.ca.gov/dosh/Safe_Patient_Handling.htm.
16. California Department of Industrial Relations. Health Care Worker Back and Musculoskeletal Injury Prevention. In: California Department of Industrial Relations, ed. 8. Vol 51202014.
17. Garg A, Kapellusch JM. Long-term efficacy of an ergonomics program that includes patient-handling devices on reducing musculoskeletal injuries to nursing personnel. *Human Factors*. 2012;54(4):608–625. [PubMed: 22908684]
18. Theis JL, Finkelstein MJ. Long-term effects of safe patient handling program on staff injuries. *Rehabilitation Nursing*. 2014;39(1):26–35. [PubMed: 23780793]
19. Powell-Cope G, Toyinbo P, Patel N, et al. Effects of a national safe patient handling program on nursing injury incidence rates. *Journal of Nursing Administration*. 2014;44(10):525–534. [PubMed: 25280075]
20. Nelson A, Matz M, Chen F, Siddharthan K, Lloyd J, Fragala G. Development and evaluation of a multifaceted ergonomics program to prevent injuries associated with patient handling tasks. *International Journal of Nursing Studies*. 2006;43(6):717–733. [PubMed: 16253260]
21. Darragh AR, Shiyko M, Margulis H, Campo M. Effects of a safe patient handling and mobility program on patient self-care outcomes. *American Journal of Occupational Therapy*. 2014;68(5):589–596.
22. Schoenfisch AL, Lipscomb HJ, Pompeii LA, Myers DJ, Dement JM. Musculoskeletal injuries among hospital patient care staff before and after implementation of patient lift and transfer equipment. *Scandinavian Journal of Work, Environment and Health*. 2013;39(1):27–36.
23. Campo M, Shiyko MP, Margulis H, Darragh AR. Effect of a safe patient handling program on rehabilitation outcomes. *Archives of Physical Medicine and Rehabilitation*. 2013;94(1):17–22. [PubMed: 22960275]
24. Lim HJ, Black TR, Shah SM, Sarker S, Metcalfe J. Evaluating repeated patient handling injuries following the implementation of a multi-factor ergonomic intervention program among health care workers. *Journal of Safety Research*. 2011;42(3):185–191. [PubMed: 21855689]
25. California Department of Industrial Relations. Answers to frequently asked questions about the workers' compensation information system (WCIS) - first reports of injury and subsequent reports of injury 2011; <http://www.dir.ca.gov/dwc/WCISFAQ.htm#4>.
26. California Department of Industrial Relations. Workers' Compensation Information System: California EDI implementation guide for first and subsequent reports of injury (FROI/SROI). 2011; http://www.dir.ca.gov/dwc/EDI_Guide/ImpGuideFinal.pdf.
27. California Department of Industrial Relations. Workers' Compensation Information System (WCIS): California EDI implementation guide for first and subsequent reports of injury (FROI/SROI) Version 3.1. 2018; <https://www.dir.ca.gov/dwc/DWCPropRegs/WCIS-Regulations/Final-Regulations/Guides/FROISROIImplementationGuide-Final.pdf>.
28. National Institute for Occupational Safety and Health. NIOSH program portfolio: Musculoskeletal disorders. 2009; <http://www.cdc.gov/niosh/programs/msd/>.
29. Bureau of Labor Statistics. Employee tenure. 2018. https://stats.bls.gov/news.release/archives/tenure_09202018.pdf.

30. SAS Institute Inc. Poisson Regression: The GENMOD Procedure 2019; https://documentation.sas.com/doc/en/pgmsascdc/9.4_3.3/statug/statug_genmod_gettingstarted01.htm.
31. Lee SJ, Lee JH, Harrison R. Impact of California's safe patient handling legislation on musculoskeletal injury prevention among nurses. *American Journal of Industrial Medicine*. 2018;62(1):50–58. [PubMed: 30474130]
32. Lee SJ, Kang KJ, Lee JH. Safe patient handling legislation and changes in programs, practices, perceptions, and experience of musculoskeletal disorders by hospital characteristics: A repeated cross-sectional survey study. *International Journal of Nursing Studies*. 2021;113:103791. [PubMed: 33152606]
33. Silverstein B, Howard N, Adams D. Does safe patient handling legislation make a difference *Work*. 2012;41:6153–6155.
34. Rosebush CE, Zaidman B, Schofield KE, et al. Evaluation of the Minnesota safe patient handling act: trends in workers' compensation indemnity claims in nursing home workers before and after enactment of the law. *Occupational and Environmental Medicine*. 2020;78(1):22–28. [PubMed: 32895318]
35. Safety Occupational and Administration Health. Safe patient handling programs: Effectiveness and cost savings. 2013; <https://www.osha.gov/sites/default/files/publications/OSHA3279.pdf>
36. Lee SJ, Stock L, Michalchuk V, Adesoye K, Mullen K. Impact of California safe patient handling legislation: Health care workers' perspectives. *Workplace Health & Safety*. 2021;69(3):124–133. [PubMed: 33522462]
37. Azaroff LS, Levenstein C, Wegman DH. Occupational injury and illness surveillance: conceptual filters explain underreporting. *American Journal of Public Health*. 2002;92(9):1421–1429. [PubMed: 12197968]
38. Bernal JL, Cummins S, Gasparini A. Interrupted time series regression for the evaluation of public health interventions: a tutorial. *International Journal of Epidemiology*. 2017;46(1):348–355. [PubMed: 27283160]
39. Barnett AG, van der Pols JC, Dobson AJ. Regression to the mean: what it is and how to deal with it. *International Journal of Epidemiology*. 2005;34(1):215–220. [PubMed: 15333621]
40. Morton V, Torgerson DJ. Effect of regression to the mean on decision making in health care. *British Medical Journal*. 2003;326(7398):1083–1084. [PubMed: 12750214]

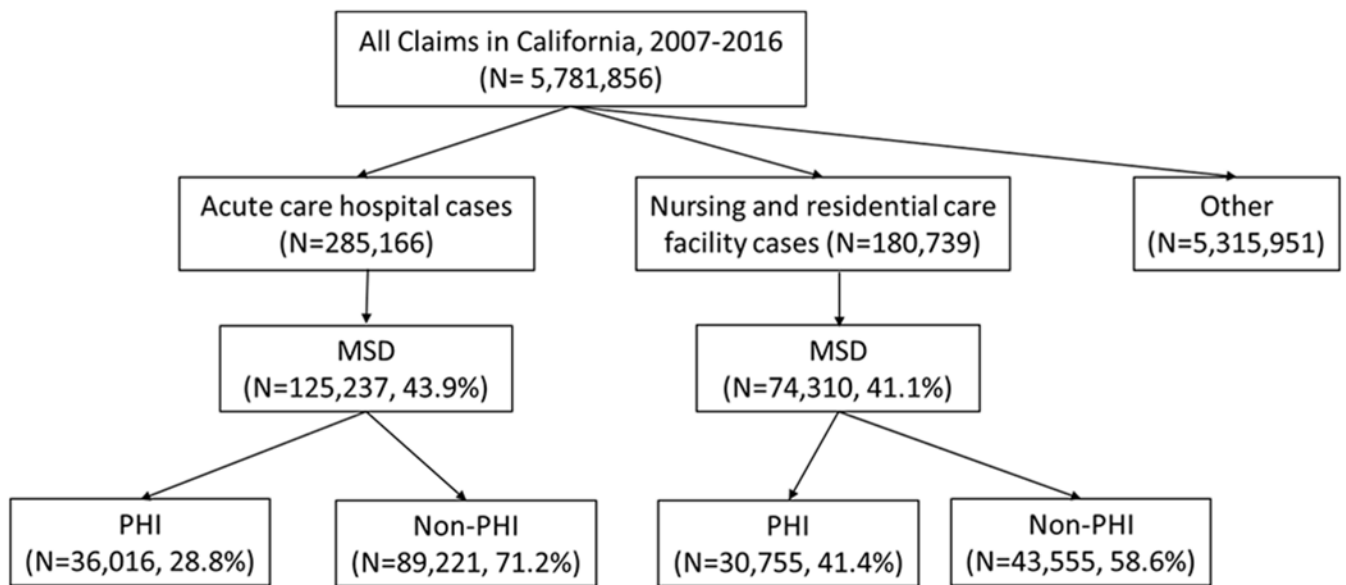


Figure 1. Musculoskeletal disorders (MSD) and patient handling injuries (PHI) in acute care hospitals and nursing and residential care facilities in California, 2007-2016
 Data Source: California Department of Industrial Relations, Workers' Compensation Information System

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

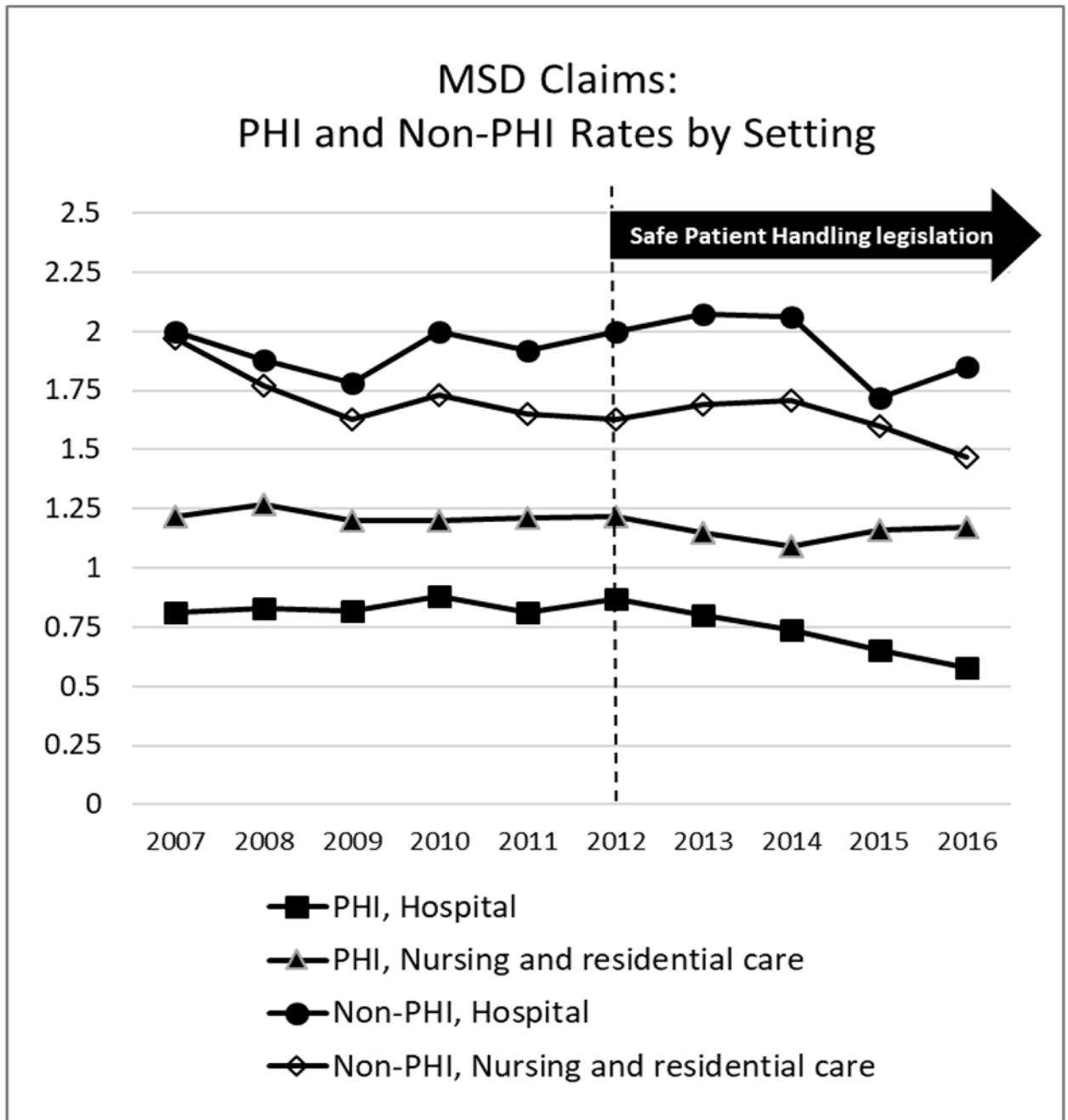


Figure 2. Musculoskeletal disorder (MSD) claim rates (per 100 employees) among healthcare workers by setting and type of injury (patient handling injury, PHI or other) in 2007-2016, California

Data Source: California Department of Industrial Relations, Workers' Compensation Information System

Table 1.

Musculoskeletal disorder claims among California healthcare workers in 2007-2016

Variable	Musculoskeletal disorder claims					
	Hospital ^a (n=125,237)		Nursing and residential care (n=74,310)		Total (n=199,547)	
	N	%	N	%	N	%
Patient handling injury						
Yes	36,016	28.8	30,755	41.4	66,771	33.5
No	89,221	71.2	43,555	58.6	132,776	66.5
Occupation						
Nursing	51,189	40.9	29,038	39.1	80,227	40.2
Other	74,048	59.1	45,272	60.9	119,320	59.8
Gender						
Female	98,311	78.5	60,727	81.7	159,038	79.7
Male	26,549	21.2	13,020	17.5	39,569	19.8
Unknown/Invalid	377	0.3	563	0.8	940	0.5
Age at the time of injury						
16-24 years	4,198	3.4	10,309	13.9	14,507	7.3
25-34	25,929	20.7	17,499	23.5	43,428	21.8
35-44	32,035	25.6	16,170	21.8	48,205	24.2
45-54	35,618	28.4	17,860	24.0	53,478	26.8
55-64	23,791	19.0	10,370	14.0	34,161	17.1
65+	3,519	2.8	1,782	2.4	5,301	2.7
Unknown/Invalid	147	0.1	320	0.4	467	0.2
Mean, SD (years)	44.3	11.6	40.4	13.0	42.8	12.3
Time from hire to injury						
12 months or less	15,284	12.2	25,157	33.9	40,441	20.3
13 months to 2 years	22,122	17.7	17,796	23.9	39,918	20.0
3-4 years	17,325	13.8	8,477	11.4	25,802	12.9
5-9 years	31,293	25.0	10,282	13.8	41,575	20.8
10+ years	36,492	29.1	6,418	8.6	42,910	21.5
Unknown/Invalid	2,721	2.2	6,180	8.3	8,901	4.5
Median, IQR ^b (years)	5.8	2.3-11.3	1.8	0.6-4.8	4.0	1.3-9.2
Nature of injury						
Strain	78,967	63.1	50,007	67.3	128,974	64.6
Sprain	20,148	16.1	12,542	16.9	32,690	16.4
Inflammation	2,490	2.0	1,452	2.0	3,942	2.0
Carpal tunnel syndrome	1,762	1.4	429	0.6	2,191	1.1
Multiple physical injuries	1,974	1.6	1,047	1.4	3,021	1.5
Dislocation	315	0.3	300	0.4	615	0.3
Hernia	368	0.3	246	0.3	614	0.3
Other	19,213	15.3	8,287	11.2	27,500	13.8

Variable	Musculoskeletal disorder claims					
	<u>Hospital^a (n=125,237)</u>		<u>Nursing and residential care (n=74,310)</u>		<u>Total (n=199,547)</u>	
	N	%	N	%	N	%
Body part						
Neck	4,235	3.4	2,088	2.8	6,323	3.2
Lower back	26,403	21.1	24,399	32.8	50,802	25.5
Trunk	15,963	12.8	7,709	10.4	23,672	11.9
Shoulder	14,784	11.8	8,826	11.9	23,610	11.8
Upper extremities	36,991	29.5	15,849	21.3	52,840	26.5
Lower extremities	11,622	9.3	7,493	10.1	19,115	9.6
Multiple	15,239	12.2	7,946	10.7	23,185	11.6

Data Source: California Department of Industrial Relations, Workers' Compensation Information System.

Note: Federal employees are not reported to the system. Percentage numbers may not add up to 100 due to rounding.

^a Cases in general acute care hospitals within the Department of Corrections and Rehabilitation or the State Department of Developmental Services were excluded.

^b Interquartile range

Table 2.

Workers' compensation claims due to musculoskeletal disorders (MSD) and patient handling injuries (PHI) among California healthcare workers, 2007-2016: Pre- vs. post- safe patient handling (SPH) legislation and California OSHA^a regulation

Setting and Claim type	Total	Year of Injury											Change between Pre and post legislation periods											
		Pre-SPH Legislation						Post-SPH Legislation					N	% ^c										
		2007	2008	2009	2010	2011	2012	2013	2014	2015	2016													
Hospital^b																								
MSD cases (N)	285,166	29,492	29,382	29,061	28,899	28,310	29,378	29,010	28,460	25,791	27,383										-5,122	-3.53		
MSD cases (%)	125,237	13,103	12,828	12,656	13,024	12,277	13,019	13,033	12,843	10,932	11,522												-3.97	
PHI cases (N)	36,016	3,785	3,930	3,975	3,994	3,642	3,930	3,639	3,402	2,983	2,736												-13.64	
PHI cases (%)	28.8	28.9	30.6	31.4	30.7	29.7	30.2	27.9	26.5	27.3	23.7												0.22	
Non-PHI cases (N)	89,221	9,318	8,898	8,681	9,030	8,635	9,089	9,394	9,441	7,949	8,786													
Non-PHI cases (%)	71.2	71.1	69.4	68.6	69.3	70.3	69.8	72.1	73.5	72.7	76.3													
Nursing or residential care	180,739	18,193	18,433	17,960	18,692	17,574	17,628	17,836	18,015	18,490	17,918													-1.06
MSD cases (N)	74,310	7,351	7,247	6,913	7,252	7,253	7,361	7,548	7,729	7,929	7,727													6.32
MSD cases (%)	41.1	40.4	39.3	38.5	38.8	41.3	41.8	42.3	42.9	42.9	43.1													
PHI cases (N)	30,755	2,801	3,032	2,926	2,971	3,064	3,141	3,059	3,010	3,335	3,416													7.89
PHI cases (%)	41.4	38.1	41.8	42.3	41.0	42.2	42.7	40.5	38.9	42.1	44.2													
Non-PHI cases (N)	43,555	4,550	4,215	3,987	4,281	4,189	4,220	4,489	4,719	4,594	4,311													5.24
Non-PHI cases (%)	58.6	61.9	58.2	57.7	59.0	57.8	57.3	59.5	61.1	57.9	55.8													

Data Source: California Department of Industrial Relations, Workers' Compensation Information System.

Note: Federal employees are not reported to the system. Percentage numbers may not add up to 100 due to rounding.

^aOccupational Health and Safety Administration

^bCases in general acute care hospitals within the Department of Corrections and Rehabilitation or the State Department of Developmental Services were excluded.

^cDifference in the numbers between the two periods divided by the number for the pre-legislation period.

Table 3.

Annual rates of musculoskeletal disorder (MSD) and patient handling injury (PHI) claims among California healthcare workers, 2007-2016: Pre- and post- safe patient handling (SPH) legislation and California OSHA^a regulation

Claim type by setting	Claim rate (per 100 employees) by year of injury										Average rate change, Pre vs. post legislation periods			Rate change per year, 2011-2016		
	Pre-SPH Legislation					Post-SPH Legislation					Pre	Post	Change	IRR	95% CI	
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016						
Hospital^b																
MSD rate	2.82	2.71	2.60	2.88	2.73	2.87	2.87	2.81	2.37	2.43	2.75	2.67	-2.9%	0.967	0.943	0.991
PHI rate	0.81	0.83	0.82	0.88	0.81	0.87	0.80	0.74	0.65	0.58	0.83	0.73	-12.0%	0.927	0.903	0.952
Non-PHI rate	2.00	1.88	1.78	2.00	1.92	2.00	2.07	2.06	1.72	1.85	1.92	1.94	+1.0%	0.982	0.956	1.009
Nursing and residential care																
MSD rate	3.19	3.04	2.83	2.93	2.86	2.85	2.84	2.80	2.76	2.64	2.97	2.78	-6.4%	0.986	0.980	0.991
PHI rate	1.22	1.27	1.20	1.20	1.21	1.22	1.15	1.09	1.16	1.17	1.22	1.16	-4.9%	0.990	0.976	1.005
Non-PHI rate	1.97	1.77	1.63	1.73	1.65	1.63	1.69	1.71	1.60	1.47	1.75	1.62	-7.4%	0.983	0.965	1.001

Data Source: California Department of Industrial Relations, Workers' Compensation Information System. Note: Federal employees are not reported to the system.

Data Source for denominators: U.S. Bureau of Labor Statistics, Quarterly Census of Employment and Wages. Denominators are employment in private sector and state and local governments.

^aOccupational Health and Safety Administration

^bCases in general acute care hospitals within the Department of Corrections and Rehabilitation or the State Department of Developmental Services were excluded.

Table 4. Musculoskeletal disorder (MSD) and patient handling injury (PHI) claims by injury characteristics among California hospital^a workers in 2007-2016: Changes between pre- and post- safe patient handling legislation

Variable	MSD Claims				MSD-PHI Claims							
	Pre-Legislation 2007-2011	N	%	Change: Post vs. Pre	Pre-Legislation 2007-2011	N	%	Change: Post vs. Pre				
Part of body injured												
Neck	1,951	3.1	2,284	3.7	333	17.1	619	3.2	604	3.6	-15	-2.4
Lower back	13,049	20.4	13,354	21.8	305	2.3	5,981	30.9	5,637	33.8	-344	-5.8 ^c
Trunk, excluding lower back	9,156	14.3	6,807	11.1	-2,349	-25.7	3,750	19.4	2,502	15.0	-1,248	-33.3
Shoulder, excluding UE	6,684	10.5	8,100	13.2	1,416	21.2	2,301	11.9	2,538	15.2	237	10.3
Upper extremities (UE)	18,974	29.7	18,017	29.4	-957	-5.0	3,406	17.6	2,777	16.6	-629	-18.5
Lower extremities	5,936	9.3	5,686	9.3	-250	-4.2	1,151	6.0	1,113	6.7	-38	-3.3
Multiple	8,138	12.7	7,101	11.6	-1,037	-12.7	2,118	11.0	1,519	9.1	-599	-28.3
Nature of injury												
Strain	41,011	64.2	37,956	61.9	-3,055	-7.4	13,260	68.6	11,389	68.2	-1,871	-14.1
Sprain	10,561	16.5	9,587	15.6	-974	-9.2	3,923	20.3	3,135	18.8	-788	-20.1
Inflammation	1,378	2.2	1,112	1.8	-266	-19.3	167	0.9	110	0.7	-57	-34.1
Carpal tunnel syndrome	930	1.5	832	1.4	-98	-10.5	18	0.1	21	0.1	3	16.7
Multiple physical injuries	747	1.2	1,227	2.0	480	64.3	110	0.6	181	1.1	71	64.5
Dislocation	167	0.3	148	0.2	-19	-11.4	45	0.2	43	0.3	-2	-4.4
Hernia	204	0.3	164	0.3	-40	-19.6	58	0.3	43	0.3	-15	-25.9
Other	8,890	13.9	10,323	16.8	1,433	16.1	1,745	9.0	1,768	10.6	23	1.3

Data Source: California Department of Industrial Relations, Workers' Compensation Information System. Note: Federal employees are not reported to the system.

^aCases in general acute care hospitals within the Department of Corrections and Rehabilitation or the State Department of Developmental Services were excluded.

^bDifference in the numbers between the two periods divided by the number for the pre-legislation period.

^cFrom 2012 (n=1,382) to 2016 (n=836), there was a 39.5% decrease.