Accepted: 4 November 2018
DOI: 10.1002/ajim.22923

RESEARCH ARTICLE

WILEY AMERICAN JOURNAL OF INDUSTRIAL MEDICINE

Impact of California's safe patient handling legislation on musculoskeletal injury prevention among nurses

Soo-Jeong Lee RN, PhD[1] | Joung Hee Lee RN, PhD[1] | Robert Harrison MD, MPH[2]

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

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

Correspondence
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.
Email: soo-jeong.lee@ucsf.edu

Funding information
Southern California NIOSH ERC Pilot Research, Grant number: 2T42OH008412-08; University of California San Francisco, School of Nursing (Intramural grant)

Background: This study evaluated the impact of California's safe patient handling (SPH) legislation on musculoskeletal injury prevention among hospital nurses.

Methods: Two serial cross-sectional surveys were conducted using postal and online questionnaires in statewide random samples of California registered nurses in 2013 and 2016. Analysis included hospital nurses who performed patient handling (n = 254 and n = 281, respectively).

Results: In 2016, there were significant improvements in nurses' knowledge of a SPH policy in their hospital (87%), receipt of annual SPH training (73%), and availability of lift equipment (80%); 33% perceived their hospital's SPH programs as excellent or very good. Significant prevalence reduction was observed for work-related musculoskeletal symptoms (61% vs 52%; Adjusted Prevalence Ratio = 0.78, 95% CI 0.66-0.91).

Conclusions: Our findings indicate the significant role of SPH legislation with positive impacts on SPH policies and programs at the hospital level and on musculoskeletal health outcomes at the worker level.

KEYWORDS
legislation, musculoskeletal disorders, nurse, policy, safe patient handling

1 | INTRODUCTION

Musculoskeletal injuries and disorders from patient handling activities are well-identified occupational health problems in healthcare settings. Prior studies have documented the high incidence of musculoskeletal disorders and patient handing injuries among healthcare workers.[1,2] Recognizing the significant problem of patient handling injuries, there have been multi-level efforts to ensure safe patient handling (SPH) and prevent injuries, and legislative actions have been made in the United States (U.S.).[3] In 2005, Texas passed the first regulation pertaining to safe patient handing and then 10 other states – California, Illinois, Maryland, Minnesota, Missouri, New Jersey, New York, Ohio, Rhode Island, and Washington – have promulgated similar regulations.[4]

Among the states, California – where about 10% of U.S. healthcare workers are employed[5] – enacted the Hospital Patient and Health Care Worker Injury Protection Act (AB1136) in January 2012.[6] Pursuant to this law, the California Division of Occupational Safety and Health (Cal/OSHA) developed an enforceable workplace standard effective October 2014.[6] Under the SPH law and regulation, general acute care hospitals in California are mandated to establish an SPH policy and plan to protect workers from musculoskeletal injuries, including employee training, use of powered patient handling equipment to replace manual handling, and provision of lift teams or trained staff to assist. Hospital plans must also include procedures for identification and evaluation of patient handling hazards, investigation of patient handling injuries, correction of patient handling hazards, communication with employees, and evaluation of the effectiveness of the plan.[7]

Following the implementation of these standards, evaluation research is needed to assess the impact and effectiveness of the SPH law on hospital programs and practices and musculoskeletal injury prevention. While there are reports of positive outcomes of SPH programs at a single hospital or health systems level,[8–13] limited data

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

exist on the statewide impact of SPH legislation. Only Washington State evaluated the impact of SPH legislation and reported reduction of workers' compensation claim rates from musculoskeletal disorders.[14,15]

The purpose of this study was to evaluate the impact of the California SPH legislation. This study was a follow-up evaluation study, which was built on the 2013 baseline survey of California registered nurses (RNs).[16] The baseline study showed high prevalence of musculoskeletal symptoms among nurses and sub-optimal levels of safe patient handling programs in hospitals. This follow-up study evaluated changes in SPH programs and work environment of hospitals, perceptions and safe work practices of hospital nurses, and prevalence of work-related musculoskeletal symptoms and patient handling injuries.

2 | METHODS

2.1 | Design and sample

We conducted two serial cross-sectional surveys in statewide random samples of California RNs in 2013 and 2016. The study was approved by the Committee on Human Research at the University of California San Francisco. We obtained up-to-date lists of RNs with an active license from the California Board of Registered Nursing (BRN) and randomly selected 2000 nurses in 2013 and 3000 nurses in 2016. We determined the sample sizes based on the following. To estimate parameters with a 95% confidence level and a 5% margin of error for the population of 250 000 California RNs, at least 384 subjects were needed. Considering the fact that the BRN list includes non-hospital RNs and retirees and possibly a low response rate as well, the 2013 survey comprised 2000 nurses. Using data from the baseline study sample of hospital nurses performing patient handling, 395–508 subjects were needed to detect a 10% difference in musculoskeletal symptom prevalence rates or an effect size (d) of 0.3 in mean differences with a two-sided alpha of 0.5 and power of 80%; therefore the follow-up survey comprised 3000 nurses. Using stratified random sampling, the California RN population was divided into nine regions of California (Northern counties, Sacramento region, Central 5-county San Francisco Bay Area, remainder of San Francisco Bay Area, Central Valley and Sierra, Central Cost, Los Angeles, Inland Empire, and Border counties)[17] and the selected sample size of each stratum was proportional to the RN population size by region. To make the sample independent between the two surveys, we excluded the 2000 nurses selected for the 2013 survey in the follow-up sampling. A total of 592 nurses responded to the 2016 survey (20% response rate) and 526 nurses in the 2013 survey (26% response rate). Of these, subjects were included if they were employed in hospitals for at least 3 months and performed direct patient care and/or patient handling. After excluding respondents with incomplete answers for the main study variables (eg, workplace setting, patient handling), a total of 254 nurses in 2013 and 281 nurses in 2016 were included in the data analysis.

2.2 | Data collection

The 2013 survey method has been described in detail elsewhere.[16] In 2016, we mailed out the survey packet containing a study information letter, mini-poster of 2013 survey findings, questionnaire, and a return envelope. The study letter provided the information of the alternative option of completing the survey in the on-line format version. The online survey was generated and distributed via Qualtrics software (Qualtrics, LLC, Provo, UT). Reminder postcards were sent at a 2-week interval three times and a final reminder 1 month later. The second reminder enclosed the study questionnaire again. As an incentive for participation, respondents entered into a raffle ($50 gift card for 20 winners in 2013; $100 gift card for 3 winners and $20 gift card for 50 winners).

2.3 | Measures

The 2016 study questionnaire included questions about demographics, job and workplace characteristics, SPH programs and practices, perceptions about the SPH law and programs, physical and psychosocial work factors, risk perception, and work-related musculoskeletal symptoms and injury. Variables used in this study are described briefly below. More details on specific measures can be found elsewhere.[16] The study questionnaire is available by contacting the corresponding author.

Demographic items included age, gender, race/ethnicity, and place of initial nursing education. Job and workplace items included employment status, job tenure in nursing, work setting, workplace area, type, and size, work unit, job title, work status, work shift, and direct care and patient handling duties. Respondents were asked about awareness of the SPH law (yes/no), perceptions about the law's effectiveness (1 = not at all effective, 5 = very effective), changes in the SPH program (yes/no), and perceptions about SPH programs in their workplace (1 = excellent, 5 = poor). SPH programs items included presence of an SPH policy, SPH committee, training, protocols and tools on patient handling or patient mobility assessment, and availability of lift team and mechanical lifts.

For work practices, the frequency of lift use and change in lift use over the past 4 years were asked. Physical workload was measured by the 19-item physical workload index questionnaire,[18,19] which produces an index of physical load from body postures and work activities such as lifting. For psychosocial work factors, job demand (5 items) and job control (9 items) were measured using the Job Content Questionnaire[20]; job strain was derived as the ratio of job demand to job control. For risk perceptions, respondents were asked about changes in perceived risk of injury from nursing work in general and patient handling tasks over the past 4 years (decreased/no change/increased). Musculoskeletal symptom questions inquired about pain, aching, stiffness, burning, numbness, or tingling for the lower back, neck, shoulders, and hands/wrists in the past 12 months with subsequent questions on intensity, duration, frequency, work-relatedness, health care seeking, interference with work performance, and missing work.[16] *Work-related symptoms* were defined as symptoms

caused or worsened by work. Symptoms with at least moderate intensity that lasted at least one week or occurred at least monthly were defined as *major symptoms*. For work-related injury, respondents were asked if they had any injury or illness at work in the past 12 months. In the 2016 survey, we asked specifically about patient handling injuries.

2.4 | Statistical analysis

Data analysis was conducted using SAS 9.4 software program. The study variables were described using descriptive statistics of frequency, percentage, mean and standard deviation. Statistical analyses were conducted using two-tailed tests and 95% significance levels. Differences in proportions between 2013 and 2016 data were examined by chi-square test; mean differences were examined by Student's *t*-test. For musculoskeletal symptoms, prevalence was calculated only for work-related symptom cases. For work-related musculoskeletal symptoms and injuries, prevalence and incidence rates with 95% Confidence Intervals (CIs) were obtained. SAS PROC GENMOD with Poisson regression with robust variance was used to compare the rates between 2013 and 2016. Rate ratios (RR) with 95% CIs were obtained after controlling for a priori variables (age, gender, and race/ethnicity) and job variables significantly different between 2013 and 2016 samples ($P < 0.05$).

3 | RESULTS

Table 1 presents demographic and job characteristics for both the 2013 baseline ($n = 254$) and 2016 follow-up ($n = 281$) samples. There were no significant differences in demographic characteristics between the two samples. In both samples, the majority of respondents were female (88%); the mean age was 45–46 years; the mean job tenure in nursing was 17 years. About half of the respondents in 2013 and 2016 were non-Hispanic Whites (57 % and 47%, respectively) and Asians composed the next largest racial group (26% and 31%, respectively). About 20% received their initial nursing education in foreign countries. Nurses working in teaching and non-teaching hospitals showed similar distributions in the two samples; about 60% of the 2016 sample were employed in non-profit hospitals. About 40% were employed in medium-sized hospitals with 200–399 beds. There were significantly more nurses in small-size hospitals with <200 beds in the 2016 sample than in the 2013 sample (36% vs 23%, $P = 0.038$). The sample included nurses working in various units; the majority were full-time staff nurses working on day shifts. The 2016 sample reported significantly higher physical workload ($P = 0.0007$) and psychological job demand ($P = 0.039$) than the 2013 sample.

Knowledge of the California SPH law significantly increased from 56% in 2013 to 74% in 2016 ($P < 0.0001$) and the proportion of nurses with positive expectations of the legislative effect increased from 35% to 43%, with marginal significance ($P = 0.055$) (Table 2). Nurses reporting changes in workplace policies or programs doubled from 32% to 64% ($P < 0.0001$) and 33% perceived these policy and programs as excellent or very good. In 2016, 87% reported that their hospital had an SPH policy, which increased almost four times from 2013; over 60% reported that their hospital had a SPH committee (66%) and provided patient handling protocols or patient assessment tools (60%). In 2016, more nurses received SPH training in the previous year (73% vs 67%, $P = 0.038$) and had mechanical lifts on their unit (80% vs 61%, $P < 0.0001$). For intensive care, step-down, medical-surgical, and rehabilitation units, the provision of mechanical lifts ranged from 92% to 100% (data not shown). Nurses with ceiling lifts doubled from 12% to 24%. However, actual availability of lifts only slightly increased with marginal significance ($P = 0.051$) and the frequency of lift use showed no significant change between 2013 and 2016 ($P = 0.586$), with 39% reporting more frequent uses. The proportion of nurses with lift teams increased from 37% to 42%, but the overall change was not statistically significant. In further analysis of lift team availability, nurses in small hospitals (<200 beds) reported the biggest increase from 19% to 38% ($P = 0.014$). The availability of lift teams increased from 51% to 62.5% among nurses in large hospitals (≥400 beds) and hardly changed for medium-sized hospitals (39-38%). As regards risk perception of patient handling injury, 36% of nurses perceived the risk as increased over the past 4 years while only 30% perceived the risk as decreased.

Table 3 provides prevalence rates of work-related musculoskeletal symptoms by body parts and types; 2013 and 2016 rates were compared after controlling for age, gender, race/ethnicity, hospital size, physical workload index, and job demand. Significant prevalence reduction was observed for major musculoskeletal symptoms (61% vs 52%; Prevalence Ratio [PR] = 0.78, 95% CI 0.66-0.91), specifically in the low back (PR = 0.71, 95% CI 0.55-0.92), neck (PR = 0.60, 95% CI 0.44-0.82), and hands/wrists (PR = 0.59, 95% CI 0.39-0.91). For musculoskeletal injury incidence, there was no significant difference (21% vs 19%; RR = 0.86, 95% CI 0.55-1.33) and 16% reported having patient handling injuries in 2016.

4 | DISCUSSION

To our knowledge, this is the first study to evaluate the impact of California SPH legislation on musculoskeletal injury prevention among California hospital workers. By conducting two statewide surveys of California RNs in 2013 and 2016, this study investigated changes in hospital policies and programs as well as practices and perceptions about patient handling and health outcomes. We found that there have been overall positive changes in policies and programs to ensure the safety of hospital nurses and improvements in their perceptions about the SPH law and hospital SPH programs over the past 3 years. In addition, these policy changes resulted in the significant reduction of self-reported work-related musculoskeletal symptoms among nurses.

The 2013 survey was conducted 1 year after California's SPH law became effective, and it was considered timely enough to assess hospitals' SPH programs and practices in an early implementation phase of the SPH law. The 2013 baseline survey data suggested that

TABLE 1 Sample characteristics: California hospital nurses in 2013 and 2016

	2013 Sample (*n* = 254)		2016 Sample (*n* = 281)		
Variable	***n***	**%**	***n***	**%**	***P*-value**
Gender					0.809
Female	221	87.4	243	88.0	
Male	32	12.6	33	12.0	
Race/ethnicity					0.140
Hispanic	22	8.7	33	11.7	
White, Non-Hispanic	144	56.7	131	46.6	
Asian, Non-Hispanic	65	25.6	87	31.0	
Black, Non-Hispanic	5	2.0	11	3.9	
Other, Non-Hispanic	18	7.1	19	6.8	
Country of initial nursing education					0.403
US	203	80.2	214	77.3	
Foreign	50	19.8	63	22.7	
Workplace area					0.415
Urban	133	53.9	163	59.4	
Suburban	85	34.4	81	29.6	
Rural	29	11.7	30	11.0	
Type of hospital					0.659
Teaching	120	47.2	123	46.1	
Non-teaching	118	46.5	131	49.0	
Unknown	16	6.3	13	4.9	
Type of hospital – ownership					NA
For profit	NA	NA	73	26.0	
Non-profit	NA	NA	166	59.1	
Government	NA	NA	28	9.9	
Unknown	NA	NA	14	5.0	
Size of hospital					**0.038**
<200 beds	58	22.8	101	35.9	
200-399 beds	96	37.8	112	39.9	
≥400 beds	59	23.2	56	19.9	
Unknown	41	16.1	12	4.3	
Work unit					0.732
Med-surg//step-down/orthopedic/rehab	82	32.4	94	33.9	
Adult ICU/CCU	34	13.4	39	14.1	
Operating room/PACU	31	12.3	22	7.9	
Pediatrics/neonatal ICU	29	11.5	29	10.5	
Emergency department	27	10.7	28	10.1	
Maternal/labor	25	9.9	33	11.9	
Other	25	9.9	32	11.6	
Job title					0.262
Staff nurse	229	90.2	260	92.9	
Other	25	9.8	20	7.1	
Work status					0.545
Full-time	186	73.5	213	75.8	
Part-time or per-diem	67	26.5	68	24.2	

(Continues)

TABLE 1 (Continued)

	2013 Sample (n = 254)		2016 Sample (n = 281)		
Variable	***n***	**%**	***n***	**%**	***P*-value**
Work shift					0.827
Days	147	57.9	160	56.9	
Other	107	42.1	121	43.1	
	Mean	**SD**	**Mean**	**SD**	
Age (years)	45.1	12.2	45.7	11.9	0.604
Job tenure in nursing (years)	16.8	12.3	17.2	11.8	0.694
Physical workload index	25.7	12.6	29.4	11.4	**0.0007**
Job demand	35.4	5.9	36.5	5.5	**0.039**
Job control	69.6	9.5	70.3	9.1	0.392
Job strain	0.52	0.12	0.53	0.12	0.345

Sample sizes for each variable vary due to missing data. Percentages may not add up to 100 due to rounding.

the vast majority of hospitals did not have an SPH policy in place and that – while about two thirds of the nurse sample received training in the previous year and had mechanical lifting equipment on their units – most nurses did not use it often.[16] The 2016 follow-up survey data indicated that hospitals have taken steps to respond to the regulatory requirements, such as establishing SPH policies and committees, purchasing and providing more lifting equipment (particularly ceiling lifts), providing and requiring annual SPH training, and providing protocols and patient assessment tools. We found significant improvements in nurses' knowledge of the SPH law (74%), SPH policy in their hospital (87%), receipt of annual training (73%), and availability of lift equipment (80%), with some gaps falling short. As the data were collected from nurses, not from hospitals, there could be some underreporting due in part to a lack of awareness, but such lack of knowledge among workers would reflect, in turn, some gaps in the organizations' strategies to reach all employees to ensure the success of their actions and programs. Similarly, the Washington evaluation study reported increased awareness of their hospital's SPH policy among workers, with knowledge gaps in specific SPH programs between staff and SPH committee representatives.[14,15]

Among SPH program components, lift teams have been highly appreciated by nurses as a helpful and effective intervention.[21] We noticed only a small increase (5%) in the availability of lift teams between 2013 and 2016 among the total sample, but a significant increase (19%) in the availability of lift teams was found among nurses working in small hospitals (<200 beds), while nurses working in large hospitals (≥400 beds) had more lift teams (63%). The California SPH regulation requires to "have a sufficient number of designated health care workers available to perform patient handling tasks" but does not mandate hospitals to have a dedicated lift team.[7] According to a recent focus group study by the authors (to be published), some hospitals removed existing lifting teams while enhancing lift equipment and instituting new systems such as lift coach or buddy system. Sufficient staffing would be a critical issue to ensure appropriate staff assistance available timely as well as successful outcomes of lite teams.

As regards health outcomes at the worker level, we found empirical evidence suggesting positive impacts of the SPH law. Significant risk reduction was suggested for major symptoms with greater severity, duration, and/or frequency in the low back, neck, and hands/wrists. Musculoskeletal injury risk also showed a decreasing pattern although the finding was not significant. Many institutional-level intervention studies have reported positive effects of SPH programs on musculoskeletal injury reduction.[8–13] In our study, risk reduction was not observed for minor symptom parameters. In interpreting these findings, it should be considered that patient handling is only part of the multifactorial etiology of musculoskeletal disorders. Other ergonomic risk factors that are not addressed by the SPH law and programs – for example, risk from pushing and pulling of a heavy computer-mounted cart – can contribute to the continuing high prevalence of musculoskeletal symptoms. Additionally, our study sample reported significantly higher physical workload and psychological job demands in 2016, which may indicate increases in overall workload in nursing care environments.

As regards safe patient handling practices measured by regular use of lifting equipment, we did not find significant improvement among nurses. In 2016, almost 60% of nurses answered that lift equipment was readily available over 75% of the time when needed, but only 23% used it over 75% of the time; these numbers minimally changed from 2013. The use of lift equipment has been emphasized as a key component of safety practices to reduce the risk of injury from manual patient handling.[22,23] Our findings suggest that SPH programs might have not sufficiently addressed the barriers to lift use such as time burden and staffing. Moreover, some patient care tasks require manual maneuvers to move or hold the patient's body part (eg, changing clothes/diapers, holding a leg for wound care). Therefore, further intervention efforts are needed to remove barriers and support safe patient handling practices.

TABLE 2 Impacts of safe patient handling (SPH) legislation:Changes in policies, programs, practices, and perceptions among California hospital nurses between 2013 and 2016

	2013 Sample (*n* = 254)		2016 Sample (*n* = 281)		
Variable	***N***	**%**	***N***	**%**	***P*-value**
Knew the SPH law (yes)	141	56.4	205	74.3	**<0.0001**
Expected effectiveness of the SPH law for worker protection					0.055
Not at all effective	14	6.0	11	4.0	
Not too effective	45	19.3	62	22.8	
Neutral	93	39.9	81	29.8	
Somewhat effective	67	28.8	89	32.7	
Very effective	14	6.0	29	10.7	
Change in patient handling policy or programs in the workplace (yes)	79	32.1	174	64.0	**<0.0001**
Perception about SPH policy and programs in the workplace					NA
Excellent	NA	NA	28	10.7	
Very good	NA	NA	59	22.4	
Good	NA	NA	87	33.1	
Fair	NA	NA	59	22.4	
Poor	NA	NA	30	11.4	
SPH policy (yes)	57	22.5	239	86.9	**<0.0001**
Received training on safe patient handling					**0.038**
Within 1 year	167	66.5	200	73.3	
1-3 years ago	42	16.7	46	16.9	
>3years	24	9.6	21	7.7	
Never	18	7.2	6	2.2	
SPH committee (yes)	NA	NA	180	65.5	NA
Patient handling protocol or assessment tool (yes)	NA	NA	162	60.0	NA
Lift team (yes)	93	36.8	116	42.2	0.203
Lift team availability (lift team = yes)					0.147
≤25% of the time	20	23.3	32	34.0	
26-50%	21	24.4	15	16.0	
51-75%	22	25.6	17	18.1	
76-100%	23	26.7	30	31.9	
Lift equipment on their unit					**<0.0001**
Yes – ceiling lift	31	12.2	65	23.6	
Yes – other types only	125	49.2	156	56.7	
No	98	38.6	54	19.6	
Readily availability of lift (lift = yes)					0.051
≤25% of the time	29	18.7	28	14.7	
26-50%	28	18.1	21	11.0	
51-75%	13	8.4	30	15.7	
76-100%	85	54.8	112	58.6	
Change in lift availability					NA
Improved	NA	NA	127	61.3	
No change	NA	NA	79	38.2	
Got worse	NA	NA	1	0.5	

(Continues)

TABLE 2 (Continued)

Variable	2013 Sample (*n* = 254)		2016 Sample (*n* = 281)		
	N	%	*N*	%	*P*-value
Lift use (lift = yes)					0.586
≤25% of the time	80	51.0	96	46.8	
26-50%	28	17.8	33	16.1	
51-75%	16	10.2	30	14.6	
76-100%	33	21.0	46	22.5	
Change in lift use					NA
Use more frequently	NA	NA	81	39.1	
No change	NA	NA	116	56.1	
Use less frequently	NA	NA	10	4.8	
Change in perceived risk of injury from nursing work in general					NA
Risk decreased	NA	NA	64	23.4	
No change	NA	NA	110	40.1	
Risk increased	NA	NA	100	36.5	
Change in perceived risk of injury from patient handling					NA
Risk decreased	NA	NA	83	30.3	
No change	NA	NA	93	33.9	
Risk increased	NA	NA	98	35.8	

4.1 | Limitations

Our study has several limitations. First, this study was an observational study using an ecological study design and did not have a comparison group due to a very small number of respondents employed in non-hospital settings. Therefore, the identified changes cannot be fully attributed to the SPH law. Second, both surveys had low response rates despite using multiple strategies such as a choice of postal or online completion of a survey, multiple reminders, and raffle incentives with different approach. This was more or less an expected outcome from using the BRN sampling frame, which includes retired and unemployed nurses and nurses working in various settings where patient handling is not applicable. Low response rates limited the representativeness of our study sample and the nonresponse bias might have distorted our study findings due, for instance, to possible overestimation of musculoskeletal symptom prevalence or injury incidence. Third, our study relied on self-reporting. Reporting bias might have resulted from social desirability, recall errors, lack of knowledge, or negative affectivity. For example, SPH policy or program data might have been underreported due to the lack of awareness, and lift use might have been overreported to give socially desirable answers. Also, if the respondent had overall negative perceptions about work environment, responses might have leaned towards negative directions as well. In comparing the data between the 2013 and 2016 surveys, the potential nonresponse and reporting biases are more likely to be nondifferential rather than differential, and this would lead towards the null hypothesis. Therefore, statistically significant changes found in this study may be better supported. Lastly, we were not able to examine a change for patient handling injury rates because that information was not obtained in the baseline survey in 2013.

5 | CONCLUSIONS

Nurses are the largest healthcare occupation and play a pivotal role on the front line of health care. Nurses' health and safety is essential for workers themselves and also to continue providing quality care. Keeping nurses healthy and safe is critical to meet the health care needs of the population. This study evaluated the impact of SPH legislation to protect the safety of healthcare workers and provides important data to understand the impact at the hospital and worker levels. Our findings document clear improvements in SPH policies and programs at the hospital level and significant reduction of major musculoskeletal symptom prevalence at the worker level. On the other hand, nurses' safe patient handling practices of lift use showed a minimal change and their perception of injury risk from patient handling continued to be substantial. In implementing SPH programs, employee involvement and input would be crucial to best address their concerns and barriers and ensure safe patient handling practices. More research is needed to further examine the impact of SPH legislation, including longer-term outcomes, using a larger sample and stronger study methodology.

AUTHORS' CONTRIBUTIONS

SJL conceptualized and designed the study, collected data, conducted data analysis, and wrote the manuscript. JHL collected data, participated in the data analysis and interpretation, and contributed

TABLE 3 Prevalence or incidence rates (%) of work-related musculoskeletal symptoms and injuries among California hospital nurses: Comparison of 2013 and 2016 surveys using Poisson regression with robust variance analysis

	2013 Sample (n = 254)	2016 Sample (n = 281)	Ref = 2013
Variable	**% (95% CI)**	**% (95% CI)**	**Adj. PR (95% CI)[b]**
Work-related musculoskeletal symptom (Yes)			
Any low back symptom	52.4 (46.0-58.6)	55.4 (49.4-61.4)	0.99 (0.84-1.18)
Major low back symptom[a]	39.4 (33.3-45.7)	30.9 (25.5-36.7)	**0.71 (0.55-0.92)****
Any neck symptom	37.9 (31.9-44.2)	41.5 (35.6-47.5)	0.98 (0.77-1.24)
Major neck symptom[a]	31.6 (25.9-37.8)	21.9 (17.2-27.3)	**0.60 (0.44-0.82)***
Any shoulder symptom	32.5 (26.8-38.7)	39.6 (33.8-45.7)	1.13 (0.88-1.47)
Major shoulder symptom[a]	27.2 (21.8-33.2)	24.4 (19.4-30.0)	0.81 (0.59-1.12)
Any hand/wrist symptom	26.6 (21.2-32.5)	30.7 (25.3-36.6)	1.03 (0.76-1.40)
Major hand/wrist symptom[a]	19.8 (15.1-25.3)	14.1 (10.2-18.8)	**0.59 (0.39-0.91)***
Any musculoskeletal symptom	67.1 (60.9-72.8)	73.6 (68.0-78.8)	1.06 (0.93-1.19)
Major musculoskeletal symptom[a]	60.8 (54.5-66.9)	51.9 (45.7-58.0)	**0.78 (0.66-0.91)****
Affected work performance	50.8 (44.5-57.1)	55.2 (49.0-61.2)	1.04 (0.86-1.25)
Sought health care	35.3 (29.4-41.6)	41.7 (35.8-47.8)	1.11 (0.87-1.43)
Missed work	15.5 (11.2-20.5)	23.8 (18.8-29.3)	1.49 (0.99-2.26)
Work-related injury in the past 12 months (yes)	**% (95% CI)**	**% (95% CI)**	**Adj. RR (95% CI)[b]**
Any injury/illness at work	28.0 (22.5-33.9)	26.9 (21.8-32.6)	1.02 (0.97-1.07)
Musculoskeletal injury	20.5 (15.7-26.0)	19.2 (14.8-24.3)	0.86 (0.55-1.33)
Patent handling injury	NA	16.2 (12.1-21.2)	NA

Sample sizes for each variable vary due to missing data.
*P < 0.05, **P < 0.01.
[a]Major symptoms refer to symptoms with at least moderate intensity that lasted at least 1week or occurred at least monthly.
[b]Multivariable analysis was adjusted for age, gender, race/ethnicity (non-Hispanic White vs other), hospital size, physical workload index, and job demand.

to critical revision of the manuscript. RH contributed to 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.

ACKNOWLEDGMENT

We acknowledge study participants for providing valuable information.

FUNDING

This study was supported by the Southern California NIOSH ERC Pilot Research Grant (2T42OH008412-08) and an intramural grant from the University of California San Francisco School of Nursing.

INSTITUTION AND ETHICS APPROVAL AND INFORMED CONSENT

The study was approved by the Committee on Human Research at the University of California, San Francisco (UCSF) and was performed at UCSF. The study used postal surveys (and with an on-line response option) and the informed consent document was enclosed in the postal survey packet. We used an opt-in approach, where those who consent respond to the surveys; we did not ask to return their signed informed consent forms.

DISCLOSURE (AUTHORS)

The authors declare no conflicts of interest.

DISCLOSURE BY AJIM EDITOR OF RECORD

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

DISCLAIMER

None.

ORCID

Soo-Jeong Lee http://orcid.org/0000-0002-6686-355X

REFERENCES

1. Gomaa AE, Tapp LC, Luckhaupt SE, et al. Occupational traumatic injuries among workers in health care facilities – United States, 2012–2014. *MMWR Morb Mortal Wkly Rep*. 2015;64:405–410.

2. Bureau of Labor Statistics. Nonfatal occupational injuries and illnesses requiring days away from work, 2015. 2016; https://www.bls.gov/news.release/osh2.nr0.htm, Accessed August 15, 2017.
3. Edlich RF, Hudson MA, Buschbacher RM, et al. Devastating injuries in healthcare workers: description of the crisis and legislative solution to the epidemic of back injury from patient lifting. *J Long Term Eff Med Implants*. 2005;15:225–241.
4. 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, Accessed August 15, 2017.
5. Bureau of Labor Statistics. May 2016 State Occupational Employment and Wage Estimates. 2018; https://www.bls.gov/oes/current/oes_ca.htm, Accessed March 20, 2018.
6. California Department of Industrial Relations. Safe Patient Handling. 2017; http://www.dir.ca.gov/dosh/Safe_Patient_Handling.htm, Accessed August 15, 2017.
7. California Department of Industrial Relations. Safe patient handling in California: Fact sheet for hospital workers. 2016; http://www.dir.ca.gov/dosh/dosh_publications/Safe-Patient-Handling-for-Web-fs.pdf, Accessed August 15, 2017.
8. Olinski C, Norton CE. Implementation of a safe patient handling program in a multihospital health system from inception to sustainability: successes over 8 years and ongoing challenges. *Workplace Health Saf*. 2017;65:560.
9. Powell-Cope G, Toyinbo P, Patel N, et al. Effects of a national safe patient handling program on nursing injury incidence rates. *J Nurs Adm*. 2014;44:525–534.
10. Restrepo TE, Schmid FA, Gucer PW, Shuford HL, Shyong CJ, McDiarmid MA. Safe lifting programs at long-term care facilities and their impact on workers' compensation costs. *J Occup Environ Med*. 2013;55:27–35.
11. Teeple E, Collins JE, Shrestha S, Dennerlein JT, Losina E, Katz JN. Outcomes of safe patient handling and mobilization programs: a meta-analysis. *Work*. 2017;58:173–184.
12. Theis JL, Finkelstein MJ. Long-term effects of safe patient handling program on staff injuries. *Rehabil Nurs*. 2014;39:26–35.
13. Dennerlein JT, O'Day ET, Mulloy DF, et al. Lifting and exertion injuries decrease after implementation of an integrated hospital-wide safe patient handling and mobilisation programme. *Occup Environ Med*. 2017;74:336–343.
14. Washington State Department of Labor and Industries' SHARP Program. Implementaion of Safe Patient Handling in Washingtons State Hospitals. 2011; http://www.lni.wa.gov/Safety/Research/Files/SafePatientHandlingRpt2010.pdf, Accessed September 1, 2016.
15. Silverstein B, Howard N, Adams D. Does safe patient handling legislation make a difference. *Work*. 2012;41:6153–6155.
16. Lee SJ, Lee JH, Gershon RR. Musculoskeletal symptoms in nurses in the early implementation phase of california's safe patient handling legislation. *Res Nurs Health*. 2015;38:183–193.
17. Spetz J, Herrera C. Changes in nurse satisfaction in California, 2004 to 2008. *J Nurs Manag*. 2010;18:564–572.
18. Hollmann S, Klimmer F, Schmidt KH, Kylian H. Validation of a questionnaire for assessing physical work load. *Scand J Work Environ Health*. 1999;25:105–114.
19. Janowitz IL, Gillen M, Ryan G, et al. Measuring the physical demands of work in hospital settings: design and implementation of an ergonomics assessment. *Appl Ergon*. 2006;37:641–658.
20. Karasek R, Brisson C, Kawakami N, Houtman I, Bongers P, Amick B. The Job Content Questionnaire (JCQ): an instrument for internationally comparative assessments of psychosocial job characteristics. *J Occup Health Psychol*. 1998;3:322–355.
21. Kutash M, Short M, Shea J, Martinez M. The lift team's importance to a successful safe patient handling program. *J Nurs Adm*. 2009;39:170–175.
22. Waters TR. When is it safe to manually lift a patient? *Am J Nurs*. 2007;107:53–58. quiz 59.
23. Nelson A, Baptiste AS. Evidence-based practices for safe patient handling and movement. *Orthop Nurs* . 2006;25:366–379.

How to cite this article: Lee SJ, Lee JH, Harrison R. Impact of California's safe patient handling legislation on musculoskeletal injury prevention among nurses. *Am J Ind Med*. 2018;1–9. https://doi.org/10.1002/ajim.22923