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Safe patient handling and mobility (SPHM) for increasingly bariatric patient populations: Factors related to caregivers' self-reported pain and injury

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ABSTRACT

This study was conducted at 5 Veterans Administration Medical Centers (VAMCs). A cross sectional survey was administered to 134 workers who routinely lift and mobilize patients within their workplaces' safe patient handling and mobility (SPHM) programs, which are mandated in all VAMCs. The survey was used to examine a comprehensive list of SPHM and non-SPHM variables, and their associations with self-reported musculoskeletal injury and pain. Previously unstudied variables distinguished between "bariatric" (≥300 lb or 136 kg) and "non-bariatric" (<300 lb or 136 kg) patient handling. Significant findings from stepwise and logistic regression provide targets for workplace improvements, predicting: lower injury odds with more frequently having sufficient time to use equipment, higher back pain odds with more frequent bariatric handling, lower back pain odds with greater ease in following SPHM policies, and lower odds of upper extremity pain with more bariatric equipment, and with higher safety climate ratings.

1. Introduction

For many years, overexertion injury rates in hospitals have been twice the average rate for all U.S. occupations (Bureau of Labor Statistics, 2008–2018). Studies using workplace surveillance data, worker compensation records, and biomechanical analyses indicate these injuries are largely attributable to manually lifting and moving patients (Gomaa et al., 2015; Kim et al., 2012; Marras et al., 1999). "Safe Patient Handling and Mobility" (SPHM) interventions, in which workers use powered equipment to lift and move patients, have demonstrated significant reductions in biomechanical loads, overexertion injuries, and lost work time (Black et al., 2011; Collins et al., 2004; Evanoff et al., 2003; Garg and Kapellusch, 2012; Hwang et al., 2020; Wiggermann et al., 2020). SPHM programs involve multiple ongoing components, including staffing, training, and continuing education of program coordinators; equipment selection, procurement and maintenance; and worker training.

Optimizing SPHM programs requires research to identify factors most strongly associated with pain and injuries experienced by patient-handling staff. Koppelaar, Knibbe, Miedema and Burdorf (2009) conducted a systematic review of "facilitators and barriers" to SPHM. Factors such as "time to use lifting devices," "availability of equipment," and "supportive management climate," were consistently noted as SPHM facilitators by authors of the reviewed studies, but only anecdotally in qualitative terms. None of the reviewed studies quantified associations between those factors and worker symptoms or injuries.

Since Koppelaar et al.'s review, two studies have documented significant associations between SPHM factors and musculoskeletal outcome measures. Lee, Lee and Gershon (2015) found lower shoulder pain risk in nurses working in units equipped with ceiling lifts, compared to those with no access to lifts. Lee and Lee (2017) assessed frequency of SPHM behaviors using mean scores from workers' self ratings of their

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frequency of "assessment actions," "corrective actions," "use of a lift or transfer aid," "ask for assistance from coworkers," and "use of good body mechanics." Higher mean ratings were associated with fewer self-reports of musculoskeletal symptoms (pain, aching, stiffness, burning, numbness, or tingling in the lower back, neck, shoulders, or hands/wrists in the past 12 months). Further research is needed to examine a larger number of patient handling variables and their potential associations with workers' musculoskeletal outcomes.

One critical yet understudied factor that is likely to have a major influence on workers' overexertion injury risk is patient weight. Over time, SPHM has become progressively more challenging due to increases in the numbers of, and the weights of, obese patients. Obesity and severe obesity are defined as a body mass index (BMI) $\geq$ 30 kg/m^2 and $\geq$40 kg/m^2, respectively. Between 1960 and 2014, obesity prevalence increased 183% from 13.4% to 37.9%, and severe obesity prevalence rose 755% from 0.9% to 7.7% of U.S. adults (Flegal et al., 1998; Flegal et al., 2016). Increases in the weights of the heaviest adults have been especially marked, with progressively steeper increases at BMIs of 30, 40 and 50 (Sturm and Hattori, 2013).

Whereas powered patient lifts had maximum capacities of 113–136 kg (250–300 lb) in previous decades, the obesity epidemic has necessitated larger/stronger equipment for severely obese, i.e., "bariatric" patients. Currently, the maximum weight capacity for bariatric lifts is 499 kg (1100 lb), and some bariatric beds and air-assisted transfer mats can accommodate 544 kg (1200 lb).

Many articles describing issues surrounding bariatric patient handling are available, yet prior quantitative SPHM research has not addressed bariatric – related variables (see review by Choi and Brings, 2016). Quantifying the frequency of bariatric patient handling, as well as the provision of bariatric equipment, should permit assessment of their potential associations with workers' perceived musculoskeletal pain and/or injury. Moreover, since bariatric-related variables do not operate in isolation, it is important to examine them along with non-bariatric SPHM and other factors such as time to use equipment, safety climate, worker demographics, etc., in seeking to predict workers' musculoskeletal outcomes. Toward these ends, the National Institute for Occupational Safety and Health (NIOSH) initiated an applied survey study conducted collaboratively with researchers at five Veterans Administration (VA) hospitals, or medical centers (VAMCs).

Unfortunately, SPHM programs and practices are the exception rather than the rule in non-VA U.S. hospitals. Survey results from a nationwide random sample of 361 critical care nurses indicated that over half of them had no lifting equipment on their unit, and that 74% of the nurses always lifted/transferred patients manually (Lee, Faucett, Gillen, Krause, & Landry, L. (2010). Surveys of health care workers in other studies also revealed that only about one third of them reported using lifts frequently (Koppelaar et al., 2013; LCWA Research Group, 2011; Lee and Lee, 2017). Other studies suggest that lift use is practically non-existent. A survey of patient care coordinators at 642 U.S. acute care hospitals indicated that a lift was used for only 3% of the 40,856 patients being treated, and for only 11% of the limited mobility patients (Kayser et al., 2020). Similarly, using continuous direct observation of 20 intensive care nurses during 12-hr shifts, Poole-Wilson et al. (2015) found that lifts were used during fewer than 3% of patient handling activities.

In contrast to non-VA hospitals, the VA has been the most proactive organization in adopting SPHM in the U.S. They completed rollout of mandatory SPHM programs in all VAMCs between 2008 and 2011, documenting a 40% reduction in manual patient handling injuries between 2006 and 2012 (Hodgson et al., 2013). Compared to the 38% prevalence of obesity in the general U.S. population (Flegal et al., 2016), obesity prevalence among veterans is 41% (Breland et al., 2017), and their mandatory SPHM programs include added emphasis on bariatric SPHM (VA, 2015, 2016). These characteristics increase the ability to detect the influence of program factors such as non-bariatric and bariatric equipment use, time and space to use equipment, and so forth. Thus, VAMCs provided optimal settings in which to pursue the goals of the current study.

Professional networking was used to garner the participation of five VAMCs in diverse U.S. regions (Pacific, Rocky Mountains, Midwest, South, and Southeast). To minimize potential response bias, it was agreed that data would be analyzed and reported in summary fashion across hospitals. The study was approved by the NIOSH Institutional Review Board (IRB) and each VAMC's IRB.

2. Methods

2.1. Participants

Research teams at each hospital used convenience sampling to recruit participants, identifying units in which workers handled patients on a regular basis and for which management approval for study participation could be obtained. Using emails and hallway postings, a total of 429 workers from those units were invited to participate in a one-time cross-sectional survey. They were assured that data would be reported in summary fashion across units and hospitals. Between January and June 2016, written and verbal survey descriptions and opportunities for questions were provided in sessions offered at multiple dates and times. Participants were given two weeks to fill out and deposit surveys in 1-way boxes. Documentation of informed consent was waived by the NIOSH and VA IRBs, and potential participants were instructed to omit names and any other personal identifiers if they decided to fill out surveys.

Of the 429 potential volunteers, 134 (31%) filled out the survey. Of those, 131 responded to the "unit type" item, including 42 (32%) Medical Surgical, 29 (22%) Intensive Care, 13 (10%) Progressive Care/Step Down, 13 (10%) Imaging, 13 (10%) "Other," 9 (7%) Emergency Room, 7 (5%) Rehabilitation, and 5 (4%) Long Term Care workers.

2.2. The survey

The 43-item survey was drafted by NIOSH to measure workers' perceived/recalled musculoskeletal outcomes (overexertion injuries; back pain; upper extremity pain), and predictors (SPHM- and non-SPHM-related variables) potentially associated with outcomes. Some pre-existing items from the NIOSH Quality of Worklife (QWL) Survey (General Social Survey, 2002–2014) were used; most were new items developed for this study. Information from SPHM research literature and consultations with practitioners was used to determine a small list of items representing outcome variables, as well as items representing a comprehensive list of predictor variables with feasible potential for influencing outcomes. It was piloted by the researchers and six workers, and edited with minor revisions to confirm clarity and face validity. Dual entry of responses from paper surveys was used to identify and correct errors, and SAS® (Release 9.4, SAS Institute, Inc., Cary, North Carolina) was used for statistical analyses.

2.2.1. Definitions of "patient handling" and "bariatric patients"

Survey instructions defined patient handling as "lifting or moving the patient or a part of the patient's body during tasks like transferring, bathing, dressing, wound care, therapy, etc." Participants were also instructed to consider body weight – not body fat – as the sole characteristic defining "bariatric" and "non-bariatric" patients, with the former weighing 300 or more lb (136 or more kg), and the latter weighing less than that. Surveyed nurses have identified 300 lb as the weight at which difficulties in providing care become evident (Drake et al., 2008), and it is sometimes used as a benchmark for defining bariatric in terms of weight (VA, 2015, 2016). Instructions reminded participants that even a patient without excessive fat might weigh 300 or more lb due to height and/or muscularity.

2.2.2. Survey items representing outcome variables

Responses to five dichotomous items were used as self-report measures of patient handling injuries and of pain in the back and upper extremity. One item was, "During the past 12 months have you been injured (sprain, fracture, etc.) while you were handling a patient? Answer yes only if you lost one or more work days because of the injury." Workers responding yes were asked to recall a weight category for the patient involved (less than 300 lb; 300 or more lb; Don't know/can't remember). They were also asked, "Please describe the injury and how it happened. If you were using patient handling equipment at the time, what kind of equipment was it?" Two items, from the NIOSH QWL were, "In the past 12 months, have you had back pain/pain in the hands, wrists, arms, or shoulders every day for a week or more?" Two others were, "In the past 4 weeks, have you had any back pain/pain in the hands, wrists, arms, or shoulders?"

2.2.3. Survey items representing predictor variables

Each predictor was designated as an SPHM variable or a non-SPHM covariate. SPHM variables represented workplace factors directly related to patient handling, including "intervenable" program factors, i.e., that can feasibly be altered by SPHM managers to improve program quality. One SPHM predictor variable was Safety Climate, measured using four survey items comprising the NIOSH QWL Safety Climate Scale. They include, "The safety of workers is a high priority with management where I work," "There are no significant compromises or shortcuts taken when worker safety is at stake," "Where I work, employees and management work together to ensure the safest possible working conditions," and "The safety and health conditions where I work are good." Each had four options ranging from "1 Strongly disagree" to "4 Strongly agree." Internal consistency among scale items was high (Cronbach's alpha = 0.87), and the mean of the four responses served as each participant's safety climate score.

Other SPHM predictor items inquired about Bariatric and non-Bariatric Patient Handling Frequency (Never or less than once per year; More than once per year but less than once per month; More than once per month but less than once per week; More than once per week but less than once per day; 1–3 times per day; More than 3 times per day), Equipment Sufficiency (None; Some but we need more; All that we need), and Training Helpfulness (No training; Not very helpful; Fairly helpful; Very helpful).

Three SPHM predictor items asked how often (Never; Sometimes; Usually; Always) there was Space to use equipment, Time to use equipment, and Equipment there when I need it. Other predictor items asked how Easy/Difficult it is to follow SPHM Policies and Procedures (No policy; Usually difficult; Sometimes easy, sometimes difficult; Usually easy), and how committed their management is to SPHM (Not; Somewhat; Very).

Non-SPHM covariate items represented demographic and other variables that can affect worker outcomes but are not amenable to intervention. They included Age, Hours per Week, Months on Unit, Years in Occupation, BMI (from responses on height and weight), Job Title, Sex, Prior Back Pain or Injury, Frequency of non-Work Strenuous Tasks, Job Stress Frequency, Level of Job Satisfaction, Assaulted by Patient(s) in Past Year? ('hit, scratched, kicked, pinched, shoved, bitten, spit on, etc.'), Number of Patient Assaults in Past Year, Hospital, and Unit Type.

2.3. Statistical design and analyses

Stepwise multiple logistic and linear regression were used to derive predictive models identifying variables most strongly associated with each of the five outcomes/dependent variables, while adjusting for the full set of predictor variables. Individual predictors were considered equally likely to be associated with outcomes, and no variables were forced into the models. With the exception of the safety climate score (mean response to four scale items), no re-coding of participants' responses to quantitative predictor items was done. Beginning with the full set of predictors listed in section 2.2.3. above, each was entered and removed in the stepwise analysis for each dependent variable, using an entry/exit criterion of $p < 0.05$, until no further predictor variables were eligible for entry or removal. Then, a logistic regression analysis was conducted to estimate a final model for each dependent variable, using the set of predictors that remained significant in its stepwise analysis.

3. Results

Table 1 contains summary statistics for each outcome variable. With the exceptions of Hospital and Unit Type (described above in sections 1. and 2.1.), summary statistics for all predictor variables are shown in Table 2.

3.1. Patient handling injury descriptions

Numbers of workers reporting they were injured while patient handling in the past year, and their recalled weight categories of the patients involved, can be seen in Table 1. Injury and equipment descriptions are summarized here.

One worker who indicated being injured while handling a patient less than 300 lb noted back and thumb injuries from being "leaned on" by the patient. The remaining six injured while handling non-bariatric patients noted injuries from manual exertion with no powered assistive devices, i.e., emergency handling of a patient in cardiac arrest; catching falling or confused patients; lifting, pushing or pulling while transferring; and pushing the patient in a non-motorized bed. Three did not specify the body part injured. The other three specified the back.

One respondent who reported an injury while handling a patient weighing 300 or more lb noted using a bariatric ceiling lift, but the patient "jerked back," injuring the worker's shoulder. Another noted a back injury from manually rolling a bariatric patient using non-powered wedge devices. Another worker noted injuries to the back, shoulder, and thumb while manually rolling a bariatric patient.

3.2. Results of predictive analyses

Table 3 contains final predictive models from the logistic regression analyses, presenting odds ratios with 95% confidence intervals for significant predictors of each outcome variable. These results are summarized below.

The odds of recalling a patient handling injury in the past year were lower in workers who more often had enough time to use equipment

Table 1
Outcome Variables and their summary statistics. Items from the NIOSH Quality of Worklife Survey are marked (QWL).

Outcome Variable	n (%)
Patient handling injury resulting in 1 or more lost work days in past year?	
No	121 (91)
Yes	12 (9)
If yes, how much did the patient weigh?	
Less than 300 l b (136 kg): Non-bariatric	7
300 l b (136 kg) or more: Bariatric	3
Don't know/Can't remember	2
Back pain every day for 1 week or more in past year? (QWL)	
No	88 (66)
Yes	46 (34)
Hand, wrist, arm, or shoulder pain every day for 1 week or more in past year? (QWL)	
No	84 (63)
Yes	50 (37)
Any back pain in past 4 weeks?	
No	46 (34)
Yes	88 (66)
Any hand, wrist, arm, or shoulder pain in past 4 weeks?	
No	48 (36)
Yes	86 (64)

Table 2
Predictor Variables and their summary statistics. Items from the NIOSH Quality of Worklife Survey are marked (QWL).

SPHM Variable	n (%)	Mean ± SD, Min-Max
Mean response to Safety Climate items (QWL) (1 Strongly disagree, 2 Disagree, 3 Agree, 4 Strongly agree)	134	3.1 ± 0.63, 1-4
About how often do you do Non-Bariatric Patient Handling?		
1 Never or less than once a year	1 (.75)	
2 More than once a year but less than once a month	0 (0)	
3 More than once a month but less than once a week	1 (.75)	
4 More than once a week but less than once a day	9 (7)	
5 1–3 times a day	17 (13)	
6 More than 3 times a day	106 (79)	
About how often do you do Bariatric Patient Handling?		
1 Never or less than once a year	4 (3)	
2 More than once a year but less than once a month	13 (10)	
3 More than once a month but less than once a week	31 (24)	
4 More than once a week but less than once a day	41 (31)	
5 1–3 times a day	28 (21)	
6 More than 3 times a day	14 (11)	
How much Non-Bariatric (regular size) equipment is provided?		
1 None	5 (4)	
2 Some but we need more	52 (39)	
3 All that we need	76 (57)	
How much Bariatric (extra-large) equipment is provided?		
1 None	14 (11)	
2 Some but we need more	72 (54)	
3 All that we need	47 (35)	
How helpful is the training on Non-Bariatric patient handling?		
1 No training	7 (5)	
2 Not helpful	13 (10)	
3 Fairly helpful	69 (52)	
4 Very Helpful	44 (33)	
How helpful is the training on Bariatric patient handling?		
1 No training	17 (13)	
2 Not helpful	18 (13)	
3 Fairly helpful	59 (44)	
4 Very Helpful	40 (30)	
How often enough space to use patient handling equipment?		
1 Never	33 (25)	
2 Sometimes	46 (35)	
3 Usually	45 (34)	
4 Always	9 (7)	
How often enough time to use patient handling equipment?		
1 Never	16 (12)	
2 Sometimes	57 (43)	
3 Usually	43 (32)	
4 Always	17 (13)	
How often is equipment there when I need it?		
1 Never	5 (4)	
2 Sometimes	36 (27)	
3 Usually	63 (47)	
4 Always	30 (22)	
How often difficult/easy to follow SPHM policies/procedures?		
1 There is no policy	0 (0)	
2 Usually difficult	13 (10)	
3 Sometimes easy, sometimes difficult	60 (45)	
4 Usually easy	60 (45)	
How committed is management to SPHM?		
1 Not	7 (5)	
2 Somewhat	49 (37)	
3 Very	77 (58)	

Non-SPHM Covariates	**n (%)**	**Mean ± SD, Min-Max**
Age	129	42 ± 11, 21-67
Hours usually worked per week	118	41 ± 7.4, 8-72
Months Working on Unit	132	57 ± 65, 1-336
Years in Occupation	133	13 ± 10, 1-40
Body Mass Index $_{kg/m2}$	124	28 ± 6.3, 18-46
<25	47 (38)	
25–29.9 Overweight	38 (31)	
30–34.9 Obese (Class 1)	18 (14)	
35–39.9 (Class 2)	14 (11)	
≥40 (Class 3)	7 (6)	
Job Title		
Nurse	99 (75)	
Nurse Assistant	15 (11)	

(*continued on next page*)

Table 2 (*continued*)

SPHM Variable	n (%)	Mean ± SD, Min-Max
Other	18 (14)	
Sex	132	
Female	106 (80)	
Male	26 (20)	
Back pain or injury before this job?		
No	84 (63)	
Yes	49 (37)	
When not at work, how often do you do hard physical tasks e.g. move furniture, lift kids?		
1 Never or less than once a year	7 (5)	
2 More than once a year but less than once a month	15 (11)	
3 More than once a month but less than once a week	29 (22)	
4 More than once a week but less than once a day	31 (24)	
5 1–3 times a day	27 (21)	
6 More than 3 times a day	23 (17)	
How often do you find your job stressful? (QWL)		
1 Never	1 (1)	
2 Rarely	11 (8)	
3 Sometimes	52 (39)	
4 Often	55 (41)	
5 Always	14 (11)	
All in all, how satisfied are you with your job? (QWL)		
1 Not at all	0 (0)	
2 Not too	8 (6)	
3 Somewhat	61 (46)	
4 Very	64 (48)	
Assaulted* by patient while handling in past year?		
*hit, scratched, kicked, pinched, shoved, bitten, spit on, etc.		
No	65 (49)	
Yes	69 (51)	
If assaulted, about how many times in past year?	61	3.6 ± 3.9, 1-24

Table 3
Final predictive models for each outcome.

Outcome	N	Predictor	OR	95% CI
Overexertion injury while patient handling in past year	133	How often enough time to use equipment	0.24	0.10–0.58
Back pain every day for ≥1 week	114	Bariatric patient handling frequency	2.01	1.32–3.06
		Hours worked per week	1.09	1.01–1.17
		Prior back pain or injury	4.18	1.69–10.32
Hand, wrist, arm, or shoulder pain every day for ≥1 week	130	How much bariatric equipment	0.40	0.20–0.78
		How often job is stressful	2.47	1.45–4.21
Any back pain in past 4 weeks	130	How often it's easy to follow SPHM policies	0.41	0.21–0.80
		Sex $_{\text{Female vs Male}}$	4.46	1.42–13.99
		Prior back pain	11.42	3.62–36.03
Any hand, wrist, arm, or shoulder pain in past 4 weeks	134	Safety Climate Score	0.33	0.16–0.67
		Assault by patient(s)	3.74	1.67–8.36

(OR = 0.24, 95% CI: 0.10–0.58).

Back pain lasting a week or more in the past year was associated with more frequent bariatric patient handling (OR = 2.01, 95% CI: 1.32–3.06). Non-SPHM covariates significantly associated with this outcome were hours worked per week (OR = 1.09, 95% CI: 1.01–1.17), and prior back pain or injury (OR = 4.18, 95% CI: 1.69–10.32).

Hand, wrist, arm, or shoulder pain lasting a week or more in the past year was associated with less bariatric equipment (OR = 0.40, 95% CI: 0.20–0.78). The covariate job stress frequency was also a significant predictor of this outcome (OR = 2.47, 95% CI: 1.45–4.21).

Reduced odds of any back pain in the past four weeks were associated with more often finding it easy to follow SPHM policies (OR = 0.41, 95% CI: 0.21–0.80). Significant Non-SPHM covariates were female sex (OR = 4.46, 95% CI: 1.42–13.99), and prior back pain or injury (OR = 11.42, 95% CI: 3.62–36.03).

Odds of any hand, wrist, arm, or shoulder pain in the past four weeks were lower in workers with higher safety climate scores (OR = 0.33, 95% CI: 0.16–0.67). The covariate patient assault was also significant (OR = 3.74, 95% CI: 1.67–8.36).

4. Discussion

As described in section 1., VAMCs were chosen as the most suitable settings in which to examine the variables of interest for this study. While perhaps not immediately generalizable to non-VA hospitals largely lacking in SPHM programs and practices, the current results should be useful to any organization seeking to implement or improve SPHM. Also whereas overall obesity prevalence among veterans exceeds that in the general population (Breland et al., 2017), the same trends in body weight data over time are evident. Consistent with U.S. national data (Flegal et al., 2016), patient weights from this study's VAMCs show similar increases over the past decade, with the most marked increases in the weights of the heaviest patients (unpublished data).

To our knowledge, no previous studies have quantified separately workers' perceptions regarding their frequency of bariatric and non-bariatric patient handling. Most participants (31%) reported handling bariatric patients more than once per week but less than once per day, with responses distributed fairly normally below and above that mode. It is worth noting that 63% reported bariatric handling more than once per week, including 11% of the sample who recalled handling such patients more than three times per day. By contrast, 92% of participants reported handling non-bariatric patients one or more times per day, including

79% of the sample who recalled handling such patients more than three times per day. Adding new response options representing higher frequencies would be prudent in future studies, to allow more thorough assessment of perceived bariatric and non-bariatric patient handling frequency. An extended scale would more accurately reflect the distribution of non-bariatric handling frequencies and improve the ability to detect any significant associations with musculoskeletal outcomes.

Logistic regression analyses identified SPHM factors that were most strongly predictive of worker outcomes, while statistically controlling for non-SPHM factors feasibly expected to covary with outcomes. Although the latter variables were not of primary interest, those identified as significant predictors are discussed below.

Consistent with previous studies (Hoy et al., 2012; Harber et al., 1994; Yang et al., 2016), back pain risk was higher for women than men, and was also associated with prior pain/injury and with longer weekly work hours.

Similar to findings reported by Miranda et al. (2011), being assaulted by a patient one or more times in the past year was associated with higher risk of recent (past 4 weeks) upper extremity pain. Yet in either or both studies, this outcome could have been spurious, given a lack of information on the relative timing of assaults and symptoms. Future SPHM studies of musculoskeletal outcomes would benefit from using more time-specific measures to examine the potential influence of patient assaults.

As in an earlier study of nurses (Ahlberg-Hultén et al., 1995) higher frequency of perceived job stress was associated with upper extremity pain. Of course, correlational research precludes examining the direction of any potential influence between variables. Self-reported job stress and musculoskeletal pain could influence one another in either or both directions.

Results in regard to SPHM predictors add new information and also extend earlier research. The risk of chronic (continuous one week or more in past year) back pain was associated with bariatric patient handling frequency wherein the odds of back pain doubled with each unit increase in the 6-point frequency scale. On the other hand, the odds of chronic upper-extremity pain were 60% lower with each increase in the 3-point scale for perceived bariatric equipment sufficiency. To our knowledge these are the first published results to quantitatively identify (1) bariatric patient handling frequency as a work hazard and (2) bariatric equipment sufficiency as a significant safety program factor. The latter result supports and extends two earlier studies in which access to ceiling lifts and SPHM practices including lift use were significantly associated with fewer reports of musculoskeletal symptoms (Lee et al., 2015; Lee and Lee, 2017).

Factors identified anecdotally as SPHM facilitators in studies reviewed by Koppelaar et al. (2009) were also associated with better musculoskeletal outcomes. The odds of reporting a patient handling injury in the past year were lower in workers who felt they more often had sufficient time to use patient handling equipment. The odds of acute (any in past four weeks) back pain were lower in workers who felt it was more often easy, rather than difficult, to follow their workplace's SPHM policies and procedures. Finally, the odds of acute upper extremity pain were lower for workers with higher safety climate ratings.

5. Study limitations

This research had limitations. Convenience sampling in a small number of VA medical centers was used, potentially limiting generalizability of results. The self-reported survey responses were subject to recall error and bias. Recall error could be particularly relevant to ratings of patient handling frequency. Poole-Wilson et al. (2015) found that workers' recalled frequencies of handling tasks were significant underestimates of directly observed/video-recorded frequencies. Also, the current study used "3 or more times per day" as the upper end of the frequency scale. As described in section 4., response options reflecting higher frequencies may have enhanced the ability to detect associations between non-bariatric handling frequency and musculoskeletal outcomes. Although statistical power was sufficient to detect several significant predictor-outcome associations, the small sample size may have limited the ability to detect other, more subtle associations. Finally, the correlational approach ruled out causal inferences and the direction of any potential influence between variables could not be verified.

6. Conclusions

This study provides new empirical evidence regarding factors that can be evaluated and modified to improve SPHM for workers who routinely handle bariatric as well as non-bariatric patients. Periodically requesting worker feedback on how often they feel they have time to use equipment, whether they have sufficient bariatric equipment, their perceived ease in following SPHM policies, and safety climate on their unit, can help identify needed changes.

The current findings reflect progress in applied SPHM research, and highlight the importance of equipment use for reducing the risk of pain and injury. With the exception of one worker who reported being injured by a patient who "jerked back" while in a bariatric lift, all injuries described by respondents occurred when powered equipment was not being used. More widespread adoption of SPHM programs and practices in non-VA hospitals would enable improved SPHM studies and safety outcomes in the wider U.S. healthcare worker population.

7. Addendum on obesity

Before closing, some ideas from a wider public health perspective are offered. Bariatric SPHM is essentially a "tertiary prevention measure" for coping with just one of the innumerable effects of obesity. More research is needed on primary and secondary measures aimed at preventing and treating this disease. It is widely assumed that adiposity is dictated mainly by diet and exercise; research on these behavioral factors has been ongoing and should continue. At the same time, substantial evidence is accumulating which points to other, non-behavioral factors in its etiology (Tara, 2017). These include genetic (Khera et al., 2019), hormonal (Friedman and Halaas, 1998), bacterial (Ley et al. (2006), and viral factors (Dhurandhar et al., 1997; Lin et al., 2013). Progress in these areas with respect to obesity prevention and treatment should lead to lower biomechanical demands on healthcare workers, along with improvements in the general health of workers and patients alike.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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