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Research article

Patient handling training interventions and musculoskeletal injuries in healthcare workers: Systematic review and meta-analysis

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A R T I C L E I N F O

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A B S T R A C T

Introduction: Workplace injuries are a serious issue for the health and social care industry, with the sector accounting for 20 % of all serious claims reported. The aim of this systematic review was to determine whether patient handling training interventions that included instruction on patient transfer techniques are effective in preventing musculoskeletal injuries in healthcare workers. *Methods*: Electronic databases MEDLINE (Ovid), EMBASE (Ovid), CINAHL (EBSCO) and Health and Safety Science Abstracts (ProQuest) were searched for controlled trials from January 1996–August 2022. Risk of bias was evaluated using the PEDro scale and overall certainty of evidence assessed using the Grading of Recommendations, Assessment, Development and Evaluation for each meta-analysis. *Results:* A total of nine studies (3903 participants) were included. There is moderate certainty evidence that could not conclude whether patient handling training affects the 12-month incidence of lower back pain (OR = 0.83, 95 % CI [0.59, 1.16]). There is low certainty evidence that patient handing training does not prevent lower back pain in health professionals without pre-existing pain (MD = −0.06, 95 % CI [-0.63, 0.52]) but may reduce lower back pain in those with pre-existing pain (MD = −2.92, 95 % CI [-5.44, −0.41]). The results also suggest that there may be a positive effect of training incorporating risk assessment on musculoskeletal injury rates; however the evidence is of very low certainty. There is low certainty evidence from a single study that training may have a short-term effect on sickness absences.) *Conclusions:* There is a lack of evidence to support patient handling training when delivered to all healthcare staff. Training in its current form may be an ineffective strategy for reducing musculoskeletal injuries and pain. High quality disinvestment studies or trials incorporating risk assessment strategies are warranted. *Practical Applications:* This review suggests health service managers question the effectiveness of current patient handling training practices and consider evaluating current practices before allocating resources to meet employee risk reduction obligations.

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1. Introduction

Workplace injuries are a serious issue for the health and social care industry. The sector accounts for 20 % of all serious claims resulting in a total absence from work for one working week or more in Australia; this equates to 26,239 claims annually [1]. In 2021, the USA recorded 6.1 non-fatal work-related injuries for every 100 full-time hospital employees and 7.3 for nursing and residential aged care workers, with 2.3 and 4.0 of these resulting in days away from work respectively [2]. Musculoskeletal injuries make up approximately 68 % of those serious claims and health professionals, specifically those working in hospitals and residential aged care, are most at risk [3]. Over a third of injuries resulting in days away from work are associated with patient interactions [4] and can occur during the bending, twisting, lifting or generating of excessive physical effort that is associated with moving or transferring patients [5].

Patient handling describes the movement of patients with or without the use of equipment. Following the introduction of key manual handling legislation in the UK in 1992 [6], patient handling programs have been put in place to mitigate the risks faced by health professionals. The 'no-lift' movement was pioneered by the UK Royal College of Nursing [7] and controversial manual lifts such as the orthodox lift and shoulder lift have since ceased to be recommended in practice [8]. The replacement of manual lifts with the provision of lifting equipment, mechanised patient beds and training in the use of equipment has reduced injuries [8–12] but overall injury rates remain high.

Patient handling training interventions are one strategy by which organisations aim to build upon the beneficial impact of patient handling equipment to minimise the ongoing risk to their staff. Training can include education in self-protective behaviours, use of lifting equipment and modification strategies for high-risk tasks [13]. Conventional patient handling training is delivered on employment commencement, then annually, and includes a combination of face-to-face and online learning [14,15]. Although robust economic data are not readily available in this field, costs associated with staff training have been estimated from approximately $3217 USD [16] to $9500 USD [17] per hospital ward and are therefore substantial when incurred year on year across a health service. Previous reviews have suggested that there is either no evidence [18–20] or conflicting evidence [13,21,22] for the effectiveness of training interventions at reducing work-related musculoskeletal injuries when delivered as a single intervention or when associated with co-interventions.

Previous reviews have not focused on controlled trials investigating patient handling training, inclusive of instruction on patient transfer techniques, with or without the assistance of equipment as a way of reducing risk, across the health, aged and disability sectors. While one recent review concluded that there was a lack of research investigating the relationship between the effect of staff training on incidence of work-related injuries in the health setting [23], another recent review of 6 studies (including 2 randomised controlled trials) found training in the use of equipment was effective in reducing workplace injuries in the health setting, whereas a review of 12 studies (4 randomised controlled trials) found education and training comprising various interventions was not effective [12]. There are also several earlier reviews that were not able to conclude that patient handling training was able to effectively reduce workplace musculoskeletal injuries. These included an early review of interventions to reduce musculoskeletal injuries that found training of patient handling techniques to have no effect on injuries. However, 33 of the 63 included studies were published prior to 1996 during a time when it was common to teach now-banned manual patient lifts [24]. Richardson, McNoe [22] reviewed controlled trials and trials using a pre-post design to investigate a variety of interventions to reduce musculoskeletal injuries and pain in nurses. Of the 20 included studies, three studies reported on patient handling training. One study received a strong quality rating and found no effect of training on pain, while two studies received a moderate rating and found training to reduce injuries. The authors concluded that training may be beneficial but high-quality further research is needed. Clemes, Haslam [13] investigated patient handling training across a number of industrial sectors. Of the 53 included studies, 15 reported on patient handling training in the healthcare sector and a high proportion of those studies were of low quality. The authors concluded there is very little evidence of the effectiveness of training. It is unclear whether the patient handling training interventions investigated in previous reviews taught patient handling techniques beyond standard operating procedures of equipment use. It is important to conduct a review of training inclusive of and beyond safe use of patient handling equipment as this type of instruction may have the potential to improve outcomes beyond those seen initially following the introduction of patient handling equipment. Given the low quality of evidence previously reviewed, our review will focus on controlled studies.

The aim of the current study was to systematically review the literature for controlled trials to determine whether patient handling training interventions, that included instruction on patient transfer techniques inclusive of and beyond correct manual handling equipment use are effective at preventing musculoskeletal injuries in healthcare workers.

2. Methods

This review was reported as per the PRISMA guidelines [25] and was registered prospectively in the PROSPERO database (CRD42021275281).

2.1. Search strategy

The electronic databases MEDLINE (Ovid), EMBASE (Ovid), CINAHL (EBSCO) and Health and Safety Science Abstracts (ProQuest) were searched from January 1996–August 2022. The 1996 date restriction was selected due to the UK Royal College of Nursing [7] Code of Practice for Patient Handling being published at this time. The publication influenced global changes in clinical practice away from controversial manual patient lifts [8]. Only including studies published after this time ensures the examination of contemporary clinical practices.

The database search strategy had four components: healthcare professional or worker; injury or pain; patient manual handling or moving and lifting; and controlled trial. For each concept, key words and MeSH terms and synonyms were combined with the OR operator. The results of each concept were then combined with the AND operator. Database searching was supplemented by searching reference lists of included studies and forward citation tracking of included studies on Google Scholar. An example of the search strategy can be viewed in Appendix 1.

Database searches were downloaded to Endnote with duplicates removed and then managed in Covidence. Two reviewers independently screened titles and abstracts for inclusion. Full text of remaining articles not excluded based on title and abstract were obtained and two reviewers independently screened these for inclusion. Agreement between reviewers was assessed using Cohen's kappa [26] where greater than 0.80 is considered almost perfect agreement, 0.61–0.80 substantial agreement, 0.41–0.60 moderate agreement, 0.21–0.40 fair agreement and 0.00–0.20 slight agreement. Disagreements were resolved through discussion and reaching of consensus; where consensus could not be met, a third reviewer was consulted.

2.2. Eligibility criteria

Included studies were limited to controlled trials as this study design is associated with higher quality studies with a reduced risk of bias. Studies were eligible if: the study population consisted of health professionals working in hospital and aged care facilities, home care, community or disability support settings; participants received patient handling training that included patient handling techniques - interventions that taught correct equipment use could be included provided they also taught patient moving and handling techniques; and outcomes reported work-related musculoskeletal injuries (Table 1). There were no language restrictions.

2.3. Quality assessment

To evaluate the quality of the included papers, the PEDro scale was used [27]. PEDro is an 11-item scale scored from 0 to 10 for internal validity items. Rasch analysis has confirmed that PEDro measures a single concept and can be scaled [28]. Scores of 0–3 are considered 'poor', 4–5 'fair', 6–8 'good', and 9–10 'excellent' [29]. Two reviewers independently assessed the included studies. Disagreements were managed as described earlier.

2.4. Data extraction

Data extracted from the full text included details of study characteristics, participant characteristics, intervention and control group characteristics as per the Template for Intervention Description and Replication (TIDieR) checklist [30], and outcomes. A second reviewer checked the extracted data. Disagreements were resolved through discussion and reaching of a consensus; where consensus could not be met, a third reviewer was consulted.

2.5. Analysis

Meta-analysis was performed on clinically homogeneous randomised controlled trials with comparable outcome measures [31] using REVman software [32]. Consistent with recommendations, non-randomised studies of interventions were not included in meta-analyses [33]. For continuous data (pain intensity), post-intervention means and standard deviations were extracted from data tables and analysed using the inverse variance method and random effects model with estimate of effect expressed as mean difference. For dichotomous data (prevalence of pain), the number of participants experiencing pain was recorded and analysed using the Mantel-Haenszel method and random effects model to estimate odds ratios.

The certainty of evidence for each meta-analysis was determined with the Grading of Recommendations, Assessment, Development and Evaluations (GRADE) approach [34] and were applied by one researcher and checked by a second. Evidence was downgraded from

Table 1
Inclusion/exclusion criteria.

	Inclusion	exclusion
Population	Health professionals in hospital and aged care facility, home care, community, disability support settings	Other settings, non-health professionals not part of the care team such as orderlies, administration workers.
Intervention	Face-to-face, training of patient handling techniques/skills. Interventions that taught correct equipment use could be included provided they also taught patient moving and handling techniques. Interventions could be a single training intervention or multimodal	Online only, training on use of equipment only, training of now-banned patient lifts
Comparison	No training or usual care. Usual care may include online workplace induction, equipment use or back care education.	
Outcomes	Studies reporting on work-related musculoskeletal injuries which may include number of injuries, worker compensation claims or individual pain levels or the prevalence of pain.	Studies that do not include the primary outcome and only include psychological, emotional or mental injuries.
Study type	Controlled trials, including randomised controlled trials (RCT), cluster randomised controlled trials, non-randomised controlled trial.	Uncontrolled trials, including pre-post studies.
Date limit	1996–Aug 2022	Pre-1996

high to moderate to low and to very low quality in the following circumstances: If the PEDro score for at least 50 % of the included studies was less than 6 indicating a risk of bias; if there were greater than low levels of statistical heterogeneity between the trials ($I^2 \geq$ 25 %) [35] indicating inconsistency; or if confidence intervals were large such that the possible effect could range from a large effect to no effect indicating imprecision. Single, controlled trials were considered both inconsistent and imprecise and were therefore determined to provide low certainty evidence. This could be further downgraded to very low certainty evidence if there was also high risk of bias [36].

To evaluate the effect of co-interventions (e.g. psychological intervention, exercise intervention) and the use of equipment when added to patient handling training, we completed a descriptive synthesis. Study results, whether favouring or inconclusive regarding patient handling training, were tabulated against the presence of co-interventions and use of equipment and any patterns described.

3. Results

3.1. Study selection

A total of 4113 articles were identified by the database searches (Fig. 1); 842 duplicates were removed and the remaining 3271 were screened by title and abstract. Of these, 3226 were removed and the remaining 45 full-text studies were screened for eligibility. There was moderate agreement between the reviewers during the title and abstract screening ($\kappa = 0.49$, 95 % CI 0.38 to 0.60) and during full-text screening ($\kappa = 0.43$, 95 % CI 0.15 to 0.70). The most common reason for exclusion of full-text articles was ‘wrong intervention’ (n = 17). A number of studies with large sample sizes [9,37,38] were excluded as the methods did not indicate that patient handling techniques were taught beyond basic techniques of moving a patient with equipment. Searching the reference lists and forward citation tracking of the included studies did not result in the inclusion of any additional studies.

3.2. Risk of bias assessment

Of the nine studies, the majority (n = 5) scored less than 6 out of 10, indicating methodological limitations (Table 2). The most common methodological limitations were related to blinding. No studies blinded participants or the trainers and only the four higher-quality studies reported blinding of the assessors [39–42]. Six studies reported random allocation to groups and only one study [42] reported concealed allocation. Less than half of the studies (n = 4) achieved key outcome measures for more than 85 % of their participants.

3.3. Study designs

Three of the studies were individually randomised [42,44,45] and three were cluster randomised [39–41]. Two were pre-post studies with non-randomised controls [46,47] and one study was quasi-experimental with a non-randomised control [48].

3.4. Participants

The nine studies included 3903 individual participants. The mean age of participants ranged from 33 to 44 years old and the majority were from the nursing discipline, including nurses, nursing assistants and nursing students (Table 2). Black, Metcalfe [46] and Lim, Black [48] expanded their cohort to all healthcare workers providing direct patient care while Jaromi, Kukla [44] and Shojaei, Tavafian [42] restricted their participants to nurses with a history of lower back pain. Reflective of the typical nursing workforce, the vast majority of participants were female (range 84 %–100 %). Shojaei, Tavafian [42], a study conducted in Iran, was an exception with females accounting for approximately 21 % of participants.

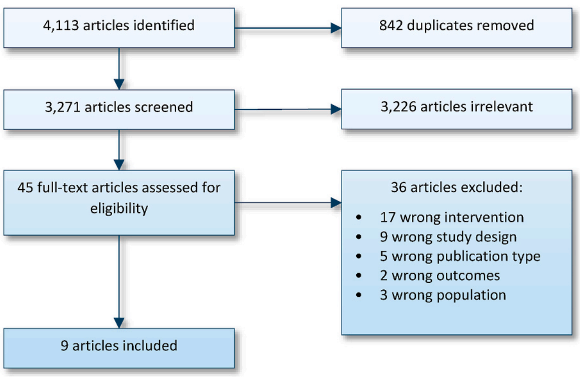

Fig. 1. PRISMA flowchart.

Table 2
Study characteristics.

Author	Participants	Intervention			Control			Design	Setting	Outcomes	Results	Quality Rating /10
		Number	Age, M (SD)	M/F (%F)	Number	Age, M (SD)	M/F (%F)					
Hartvigsen 2005	316 nurses & nursing assistants	171	44.6 (7.17[a])	100	145	44.4 (7.2[a])	100	Pre-post with nonrandomized control	Home care	No. days with LBP past 12 months; No. episodes of LBP past 12 months	No sig. differences at 24 months	3
Svensson 2009	688 Nursing assistant students	389	32 (10)	100	279	33 (11)	100	Cluster randomised prospective study	Higher education	Sickness absence (days) during the last 14 months; No. participants experienced LBP last 12 months	Sig. higher sickness absence in control group at 14 months; No sig. difference in LBP	6
Svensson 2011	306 Nursing assistant students	177	35 (12)	90	129	35 (11)	84	Cluster randomised prospective study	Higher education	No. participants experienced continuous LBP for >3 months; Sickness absence (days) in last 12 months	No sig. differences at 36 months	6
Black 2011	766 Direct care workers	151[a]	40.89 (10.2)[b]	94[b]	165[b]	39.1 (10.7)[b]	94 %[b]	Retrospective pre-post, with nonrandomized control	Hospital and residential aged care	Injury rate: No. injuries per 100 FTE hours	Sig. decrease in injury rates in intervention group	5
Lim 2011	1480 Direct care workers	782	41.2 (10.1)	93	689	39.3 (10.2)	91	quasi-experimental with non-randomised control	Hospital and residential aged care	No. repeated injuries	Sig. fewer repeated injuries in small and medium hospitals, no difference in large hospitals	5
Jaromi 2018	137 nurses with LBP	67	41.73 (3.54)	93	70	41.4 (3.7)	94	RCT	Hospital	LBP intensity (VAS) previous 1 week	Sig. reduction in VAS at conclusion of 12-week program	4
Jensen 2006	142 nurses, nursing assistants and home care workers	65	44.6 (9.8)	100	77	44 (8.5)	100	RCT	Home care, disability and residential aged care	LBP intensity (VAS) last 3 and 12 months	No sig. differences at 24 months	5
Shojaei 2017	125 nursing assistants with LBP	63	<30 = 14 30-45 = 36, >45 = 13	17.5	62	<30 = 15 30-45 = 40, >45 = 7	24.2	RCT	Hospital	LBP intensity (VAS), period undefined	Sig. reduction in VAS at 6 months	6
Warming 2008	181 nurses	105	33.65 (8.4)[c]	92[c]	76	35.7 (10.9)	90	Cluster randomised prospective study	Hospital	No. participants experienced LBP last 3 and 12 months; Average pain intensity (VAS) last 3 and 12 months; No. participants who have taken sick leave due to LBP last 3 and 12 months; LBP Disability score (Nordic Questionnaire) 12 months	No sig. differences	6

Abbreviations: No. – number, LBP – lower back pain, sig. – significant(ly), FTE – full-time equivalent, VAS – visual analogue scale, RCT – randomised controlled trial.
[a] Range converted to SD as per method describes by Hozo, Djulbegovic [43].
[b] post cohort data only.
[c] pooled for both intervention arms.

3.5. Interventions

The nine papers reported on seven different interventions. As per the inclusion criteria, all interventions included patient transfer technique training; however, there was variability in the interventions. Only Jensen, Gonge [45] and one of the intervention arms in Warming, Wiese [41] contained patient handling training as a single intervention. The interventions in each of the other studies were multi-modal, whereby patient transfer training was delivered with one or two co-intervention conditions including psychological interventions [39,40,42,47] and physical exercise training [39–41,44]. Seven of the nine included studies reported the incorporation of patient handling equipment into training. Four studies incorporated low-tech aids such as slide sheets [39–41,47] and three incorporated the use of high-tech equipment such as lifting machines in addition to low tech aids [45,46,48]. For the final two studies, the use of equipment in training was not reported [42,44]. Only the Transfer, Lifting and Repositioning (TLR) program reported on by Black, Metcalfe [46] and Lim, Black [48] included patient handling risk assessment in the content of the training. In the TLR program the risk assessment was taught in the form of patient handling algorithms. Training interventions across the included studies varied considerably in dose and duration from as little as two stand-alone 4-h sessions to weekly 1-h sessions over two years (Table 3).

The details of each intervention were not well described (Table 3). Intervention rationale, content, modifications and fidelity/attendance were the areas most lacking. In particular, training procedures and the dose of 'coaching on the ward' were unclear in Black, Metcalfe [46], Lim, Black [48], Jensen, Gonge [45] and Warming, Wiese [41]. Control conditions were very poorly described (Supplementary Table 1).

3.6. Outcomes

The summary of findings and certainty of evidence from meta-analyses can be viewed in Table 4.

3.6.1. Lower back pain

Lower back pain was the most common variable measured with seven of the studies reporting measures related to this outcome. There was variability in the measures used to assess lower back pain, including differences in follow-up periods. Three studies [39,41,47] measured the incidence of lower back pain in the last 12-month period using the Nordic Questionnaire, while one study [40] defined incidence of lower back pain as continuous pain for a period of greater than 3 months. Three studies [41,44,45] measured the intensity of lower back pain using the Visual Analogue Scale (VAS). Follow-up periods for average VAS scores varied from 1 week [44] to 3 and 12 months [41,45].

Meta-analysis of two studies [39,41] with 749 participants provided moderate certainty evidence (Table 4) that could not conclude whether patient handling training affects the 12-month incidence of lower back pain (Fig. 2). Two studies not included in the metanalysis provided low [40] and very low [47] certainty evidence to support the inconclusive findings of the meta-analysis.

Metanalysis of two studies with 262 participants targeting health professionals with pre-existing lower back pain [42,44] provided low certainty evidence that training reduces lower back pain intensity in people with pre-existing lower back pain (Fig. 3). In the studies reporting on general populations, 65 % [41] and 76 % [45] of participants did not report a history of lower back pain. Metanalysis of these two studies with 225 participants targeting general healthcare staff populations [41,45] provided low certainty evidence that could not conclude whether training affects pain intensity in people without pre-existing lower back pain (Fig. 4).

3.6.2. Musculoskeletal injuries

Two papers reporting on the one training program measured musculoskeletal injuries by investigating injury claim data [46,48]. These single papers each provided very low certainty evidence that patient handling training incorporating risk assessment reduced overall injury rates (number of injuries per 100 full-time-equivalent hours) in a general population of direct care workers [46] and reduced the number of repeated musculoskeletal injuries in workers with a history of previous injury [48].

3.6.3. Sickness absences

Svensson, Stroyer [39] monitored sickness absences taken for any reason by nursing students during their 14-month course and placements. This study provided low certainty evidence that training significantly reduced absences in the intervention group. Positive effects were not maintained at 3 years [40]. Warming et al. (2008) monitored sick leave due to lower back pain over a 3-month period and reported no significant differences in either of the intervention groups [41].

3.6.4. Co-interventions and use of equipment

The presence of co-interventions and the category of equipment use did not appear to be associated with the outcome of the training intervention (Table 5). Of the four studies that included a physical exercise intervention, two reported positive outcomes [39,44] and two reported no effect [40,41]. Of the four studies that included a psychological intervention, two reported positive outcomes [39,42] and two reported no effect [40,47]. Of the four studies that reported the use of low-tech equipment, one reported positive outcomes [39] and three reported no effect [40,41,47]. Of the three studies that reported the use of low- and high-tech equipment, two reported positive outcomes [46,48] and one reported no effect [45].

4. Discussion

This review suggests that when patient handling training is applied to whole populations of health professionals, inclusive of and

Table 3
Intervention description.

Author	Name	Rationale	Materials	Procedures	Who provided	How	Where	When and how much	Tailoring	Modifications	Fidelity-planned	Fidelity - delivered
Hartvigsen, Lauritzen [47]	Intervention group	Bobath principle: reduce load on the body by maximising patient participation, reducing friction and maintaining natural body positions	Low-tech equipment	Practical training on lifting techniques and body mechanics according to the Bobath principle.	Train the trainer model. Nurse or nurse aid instructor trained by a physiotherapist skilled in body mechanics and lifting techniques	Face-to-face, group	NR	1 × 1hr per week session for 2 yrs +4 × 2hr psychology sessions	Encouraged to provide feedback on transfers during sessions.	NR	NR	NR
Svensson, Stroyer [39]	LBP Prevention program	Improve fitness to cope with sudden spinal loading, improve transfer techniques to reduce spinal loading, improve psychological coping strategies to LBP	Low-tech equipment	Physical training: unexpected trunk loading and balance. Patient transfers: theoretical education and practical exercises. Stress management: theoretical exercises and group discussions to increase coping capacity	School teaching teams	Face-to-face, group	NR	Physical training (48 × 1 hr). Patient transfer technique education (20 h) and Stress management (22 h).	NR	NR	All students in intervention group	NR
Svensson, Marott [40]	LBP Prevention program	Improve fitness to cope with sudden spinal loading, improve transfer techniques to reduce spinal loading, improve psychological coping strategies to LBP	Low-tech equipment	Physical training: unexpected trunk loading and balance. Patient transfers: theoretical education and practical exercises. Stress management: theoretical exercises and group discussions to increase coping capacity	School teaching teams	Face-to-face, group	NR	Physical training (48 × 1 hr). Patient transfer technique education (20 h) and Stress management (22 h).	NR	NR	All participants in intervention group	NR
Black, Metcalfe [46]	Transfer, Lifting and Repositioning (TLR) Program	To prevent patient handling-related musculoskeletal injuries	A course booklet and training materials, low- and high-tech equipment	Education on anatomy, injuries, body mechanics, personal health, lifting and patient handling procedures,	NR	Face-to-face, group	NR	Initial 1 × 8hr session + on-ward coaching + 1 h/year follow-up	NR	NR	Mandatory for all direct care working	NR

(continued on next page)

Table 3 (*continued*)

Author	Name	Rationale	Materials	Procedures	Who provided	How	Where	When and how much	Tailoring	Modifications	Fidelity-planned	Fidelity - delivered
				standardized patient handling needs assessment, and patient handling algorithms. Practical patient handling skill component								
Lim, Black [48]	Transfer, Lifting and Repositioning (TLR) Program	To prevent patient handling-related musculoskeletal injuries	A course booklet and training materials. low- and high-tech equipment	Education on anatomy, injuries, body mechanics, personal health, lifting and patient handling procedures, standardized patient handling needs assessment, and patient handling algorithms. Practical patient handling skill component	NR	Face-to-face, group	NR	Initial 1 × 8hr session + on-ward coaching + 1 h/year follow-up	NR	NR	Mandatory for all direct care working	NR
Jaromi, Kukla [44]	Spine care for nurses	Increase knowledge of spinal biomechanics and patient handling techniques and strengthen muscles in order to avert microtrauma	Written materials detailing exercise program and patient handling skills, equipment use not reported	Theoretical sessions to educate on the spinal anatomy, biomechanics, injury prevention and lifting techniques. Practical sessions to practise spinal strengthening exercises and patient transfers according to the Dotte and Bobath methods	NR	Face-to-face, group	NR	2 × 60min sessions per week for 12 weeks	NR	NR	All participants in intervention group	NR
Jensen, Gonge [45]	Transfer Technique Intervention	Education based on Stockholm training concept to reduce biomechanical load on the back, minimise	Low- and high-tech equipment	Practical classroom education with 30 transfer situations taught, followed by implementation	Classroom sessions: project supervisors trained in Stockholm training concept. On-site	Face-to-face, group	On-site training in usual work setting	2 × 4hrs classroom education, 2–6 months of on-site training	On-site training adapted to individual work situations	NR	All staff	NR

(*continued on next page*)

Table 3 (*continued*)

Author	Name	Rationale	Materials	Procedures	Who provided	How	Where	When and how much	Tailoring	Modifications	Fidelity-planned	Fidelity - delivered
		asymmetric posture and avoid sudden loads		period of on-site training	group participants with additional 30hrs training							
Shojaei, Tavafian [42]	Educational Program	Education based on social cognitive theory increase likelihood of healthy behaviours of safe patient handling	Equipment use not reported	Education on self-efficacy, self-regulation, highlighting outcome expectation and emotional coping related to safe postures while moving patients. Education methods included, skills training, negotiation, role-playing, goal setting and self-assessment.	Health education specialist	Face-to-face, group	NR	4 × 2hr sessions	Individualised goal setting and addressing of barriers to safe handling	NR	All participants	NR
Warming, Wiese [41]	Transfer Training	Train the trainer model used to adapt knowledge from an expert to their local setting. Transfer techniques taught based on gravity, friction and lever arm principles	Low-tech equipment	Trainers trained colleagues on the ward. No further information about specific activities	Nurses with 4 days of training	Face-to-face	Hospital	Trainer available on ward for 2 × 6week blocks to train staff. No indication of dose per participant	Training individualised to wards and on the job situations	NR	All ward nurses	No. who complete training reported
	Transfer Training + Physical Training	As per TT with addition of physical training to increase physical capacity	Low-tech equipment, gym equipment and heart rate monitor watch	As per Transfer Training with addition of circuit training for aerobic fitness of 5 × 6mins, Strength of 4 × 5mins, 5min cool-down	NR	face-to-face, group	Hospital	Physical training: 2 × 1 h/week for 8 weeks	Programs individualised to work at 70–90 % of VO2 max	NR	All participants in the TT + PT group	No. who complete part of intervention reported (Physical Training reported, not Transfer Training)

Abbreviations: NR – not reported, LBP – lower back pain, VO2 max – maximum volume of oxygen consumption.
Equipment category descriptions: 1. Use of equipment not reported 2. Use of low-tech aids such as slide sheets and slings 3. Use of high-tech equipment such as hoists and lifting machines.

Table 4
Summary of findings and certainty of evidence.

No. of Studies	Quality Assessment			Outcome	No. of Participants		Effect (95 %CI)	Certainty (GRADE)
	Risk of Bias	Inconsistency	Imprecision		Training	No Training		
Effect of training on 12-month *LBP incidence*								
2	Not serious	Not serious	Serious	Nordic Questionnaire	432	317	OR = 0.83 (0.59,1.16)	Moderate
Effect of training on LBP intensity – Pre-existing LBP								
2	Serious	Serious	Not Serious	VAS	130	132	MD = −2.92 (−5.44 -0.41)	Low
Effect of training on LBP intensity – No pre-existing LBP								
2	Serious	Not Serious	Serious	VAS	113	112	MD = −0.06 (−0.63, 0.52)	Low

Abbreviations: GRADE – Grading of Recommendations, Assessment, Development and Evaluations, LBP – lower back pain, VAS – visual analogue scale, MD – mean difference (units out of 10), OR – odds ratio.

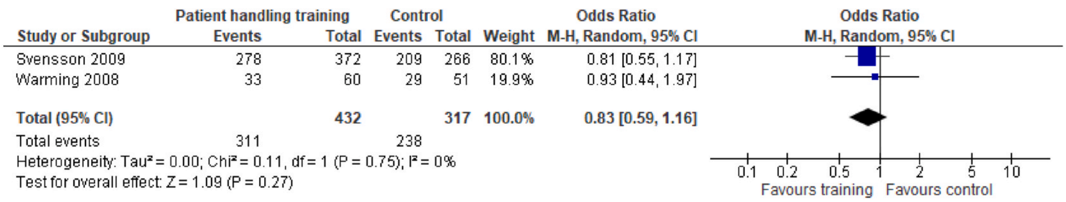

Fig. 2. No effect of intervention on incidence of lower back pain over 12 months.

beyond correct manual handling equipment use, it does not reduce musculoskeletal injuries or pain. The results of this study provide low to moderate quality evidence that patient handing training likely does not prevent lower back pain in health professionals without pre-existing pain but may reduce lower back pain in those with pre-existing pain. The results also suggest that there may be a positive effect of training incorporating risk assessment on musculoskeletal injury rates; however, the evidence is of very low certainty. There is low certainty evidence from a single study that training may have a short-term effect on sickness absences. These results are consistent with a number of previous reviews that have suggested that there is little evidence to demonstrate the effectiveness of patient handling training [8,13,20–22].

One possible implication of these findings is that the content of the training that is currently being implemented is ineffective. It has been suggested that training interventions that include patient handling risk assessment may be effective at preventing injuries [8,24,49–51]. Risk assessment training aims to provide a framework by which clinicians use clinical reasoning to assess patient handling scenarios and decide how to proceed based on unique clinical information. This allows for an individualised approach to patient handling that empowers clinicians to deal with the complex and changing situations that they encounter during their workdays. In Australia, 92 % of hospitals and residential aged care services delivering conventional patient handling training identified that risk assessment was missing in part of in whole from their training programs [14]. Risk assessment training has been demonstrated to positively change clinical behaviour during the patient handling interactions [52], while there is very little evidence that conventional patient handling training programs result in behaviour change [20]. Only two reports, each with a high risk of bias, reported on a single trial where the patient handling program included risk assessment [46,48]. While providing very low certainly evidence, these studies had positive results. Higher quality research of programs containing risk assessment are required to further investigate the question of what constitutes effective training content.

In light of the mounting evidence, the possibility that patient handling training in its current form is ineffective at preventing injury and should not continue may be considered by the staff assisting patient movement, and their managers. Given the high cost of implementing large-scale mandatory patient handling training programs, the health industry may consider disinvesting in these programs in their current form. One concern for managers at health networks might be that they feel obliged to continue current training because of legislative requirements. In the Australian context, local legislation states that workplaces provide "… training or

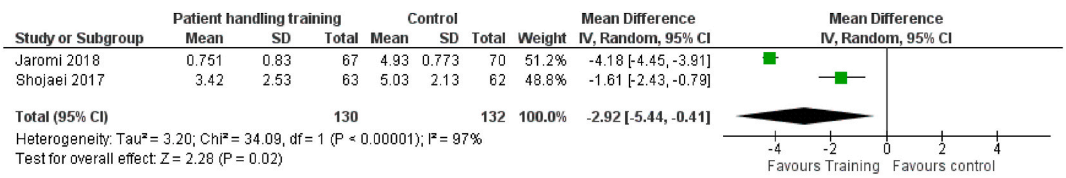

Fig. 3. Change in lower back pain VAS in nurses with pre-existing lower back pain.

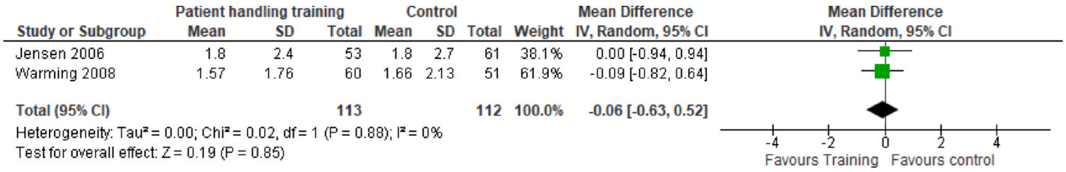

Fig. 4. No change in lower back pain VAS in nurses without pre-existing lower back pain.

supervision to employees … to enable those persons to perform their work in a way that is safe and without risks to health" (Occupational Health and Safe Act 2004 (Vic) div 2(21)). The results from this review suggests that employers may not be meeting these prescribed duty of care requirements with current training strategies. Disinvestment studies, such as those currently being completed for falls sensor alarms [53], patient falls risk screening tools [54] and weekend allied health therapy [55], have been successful in adding valuable contributions to the literature. Reinvestment in establishing programs that target patient handling training to health professional with a history of pre-existing musculoskeletal injuries or pain [42,44] may be an appropriate starting point for refining the scope of this type of intervention. In addition, investment in interventions with some supporting evidence such as risk assessment training or training in the use of equipment [12] with research designs with a low risk of bias may also be warranted. Common to these suggestions is the idea that training interventions should be rigorously evaluated before resources for scaled up, routine implementation are allocated.

This review is relevant to the health professional workforce as nurses, nursing assistants and students, who are at the highest risk of injury, were the majority of the participants included in the studies. A strength of this systematic review is that it built on previous investigations into injury prevention in the healthcare industry by refining the systematic review question to specifically investigate the effect of interventions involving patient handling training. The review followed the preferred reporting items for systematic reviews and meta-analyses (PRISMA) guidelines [25] and only included controlled trials. Where meta-analysis was able to be performed, applying the GRADE approach helped to determine level of certainty of the evidence.

4.1. Limitations

A limitation of the findings of this systematic review is that some of the included studies were not randomised controlled trials and were therefore not able to be included in meta-analyses. Of the meta-analyses that were performed, each included only two trials, the heterogeneity at times was high and the certainty of evidence did not exceed a rating of moderate. This review found that training interventions were poorly described, particularly the dose of intervention and the adherence to the programs. It is therefore difficult to evaluate whether specific content or modes of implementation may contribute to the effectiveness of training. This review focused on

Table 5
Co-interventions and use of equipment for positive and non-significant studies of patient manual handling.

		Patient handling training	Risk assessment included	Psychological intervention	Exercise intervention	Use of low-tech equipment	Use of high-tech equipment	Equipment use not reported
Reported positive results								
Jaromi et al. (2018)	Reduction in LBP (VAS)	✓	×	×	✓	×	×	✓
Shojaei et al. (2017)	Reduction in LBP (VAS)	✓	×	✓	×	×	×	✓
Svensson et al. (2009)	Reduction in sickness absences	✓	×	✓	✓	✓	×	×
Black et al. (2011)	Reduction in rate of injury	✓	✓	×	×	✓	✓	×
Lim et al. (2011)	Reduction in repeat injuries	✓	✓	×	×	✓	✓	×
Reported non-significant results								
Jensen et al. (2006)	No effect on LBP (VAS)	✓	×	×	×	✓	✓	×
Svensson et al. (2011)	No effect on sickness absences	✓	×	✓	✓	✓	×	×
Hartvigsen et al. (2005)	No effect on LBP (incidence)	✓	×	✓	×	✓	×	×
Warming et al. (2008)	No effect on LBP (VAS or incidence or sickness absences	✓ ✓	× ×	× ×	× ✓	✓ ✓	× ×	× ×

studies of patient handling training, described as the movement of patients with or without the use of equipment. We cannot conclude on the effectiveness of other interventions that have been the focus of other reviews. For example, one review that included a focus of training in the use of equipment concluded this type of training was effective in benefiting healthcare worker health compared to no intervention [12]. Therefore, our findings are limited to interventions that train healthcare staff to assist movement of patients and should not be interpreted to provide guidance on other interventions.

4.2. Conclusion and practical applications

The results of this review provide low to moderate quality evidence that patient handling training likely does not prevent lower back pain in health professionals without pre-existing pain but may reduce lower back pain in those with pre-existing pain. The results also suggest that there may be a positive effect of training incorporating risk assessment on musculoskeletal injury rates however the evidence is of very low certainty. There is low certainty evidence from a single study that training may have a short-term effect on sickness absences. Patient handling training, whether delivered with or without co-interventions such as exercise and the use of equipment, in its current form may be an ineffective strategy for reducing musculoskeletal injuries. Health service managers are encouraged to question the effectiveness of current patient handling training practices and consider rigorously evaluating current practice to better allocate resources to meet their employee risk reduction obligations. High quality disinvestment studies or trials incorporating innovative risk evaluation strategies are recommended as the next step to investigating this area.

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Date availability statement

Upon reasonable request, the template data collection forms, data extracted from included studies and data used for all analyses can be made available.

CRediT authorship contribution statement

Helen L. Kugler: Writing – review & editing, Writing – original draft, Visualization, Validation, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Nicholas F. Taylor:** Writing – review & editing, Visualization, Validation, Supervision, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Natasha K. Brusco:** Writing – review & editing, Visualization, Validation, Supervision, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization.

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.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.heliyon.2024.e24937.

References

[1] Safe Work Australia, Key Work Health and Safety Statistics, 2022, p. 2022. Australia.
[2] U.S Bureau of Labor Statistics, Injuries, Illnesses, and Fatalities, 2022, 25/07/2023]; Available from: https://www.bls.gov/iif/nonfatal-injuries-and-illnesses-tables/table-1-injury-and-illness-rates-by-industry-2021-national.htm#soii_n17_as_t1.f.1.
[3] Safe Work Australia, Number, Frequency Rate and Incidence Rate of Serious Claims by Occupation 2011-12 to 2015-16p, Statistics on workers in Australia, 2018 [cited 2021 March 4]; Available from: https://www.safeworkaustralia.gov.au/system/files/documents/1805/number-frequency-incidence-serious-claims-by-occupation-2011-12-to-2015-16p.pdf.
[4] Occupational Safety and Health Administration, Facts about Hospital Worker Safety, 2013. Available from: https://www.osha.gov/sites/default/files/1.2_Factbook_508.pdf.
[5] S.L. Sampath, et al., Reality of safe patient handling policies and programs in hospitals across the United States, International Journal of Safe Patient Handling & Mobility 9 (2) (2019) 69–76.
[6] Health, Safety Executive, Manual Handling Operations Regulations 1992 *(As Amended)*, 2016 [cited 2021 March 4]; Available from: https://www.hse.gov.uk/pubns/books/l23.htm.
[7] Royal College of Nursing, RCN Code of Practice for Patient Handling, Royal College of Nursing, London, 1996.
[8] S. Hignett, et al., Evidence-based patient handling: systematic review, Nurs. Stand. 17 (33) (2003) 33–36.
[9] I.L. Engkvist, Evaluation of an intervention comprising a no lifting policy in Australian hospitals, Appl. Ergon. 37 (2) (2006) 141–148.

[10] E. Koppelaar, et al., Determinants of implementation of primary preventive interventions on patient handling in healthcare: a systematic review, Occup. Environ. Med. 66 (6) (2009) 353–360.
[11] J. Hegewald, et al., Do Technical aids for patient handling prevent musculoskeletal complaints in health care Workers?-A systematic review of intervention studies, Int. J. Environ. Res. Publ. Health 15 (3) (2018).
[12] C. Wahlin, K. Stigmar, E. Nilsing Strid, A systematic review of work interventions to promote safe patient handling and movement in the healthcare sector, Int. J. Occup. Saf. Ergon. 28 (4) (2022) 2520–2532.
[13] S.A. Clemes, C.O. Haslam, R.A. Haslam, What constitutes effective manual handling training? A systematic review, Occup. Med. (Lond.) 60 (2) (2010) 101–107.
[14] N. Brusco, et al., *In* Australian hospitals and residential aged care facilities, how do we train nursing and direct care staff to assist patients and residents to move? A national survey, Aust. Health Rev. 47 (3) (2023) 331–338.
[15] H. McDermott, et al., Investigation of manual handling training practices in organisations and beliefs regarding effectiveness, Int. J. Ind. Ergon. 42 (2) (2012) 206–211.
[16] A. Nelson, et al., Development and evaluation of a multifaceted ergonomics program to prevent injuries associated with patient handling tasks, Int. J. Nurs. Stud. 43 (6) (2006) 717–733.
[17] T. Dang, et al., A return-on-investment model using clinical and economic data related to safe patient handling and mobility programs in the ICU, Int. J. Ind. Ergon. 92 (2022).
[18] C. Caponecchia, et al., Musculoskeletal disorders in aged care workers: a systematic review of contributing factors and interventions, Int. J. Nurs. Stud. 110 (2020) 103715.
[19] K.P. Martimo, et al., Effect of training and lifting equipment for preventing back pain in lifting and handling: systematic review, BMJ 336 (7641) (2008) 429–431.
[20] D.A. Hogan, B.A. Greiner, L. O'Sullivan, The effect of manual handling training on achieving training transfer, employee's behaviour change and subsequent reduction of work-related musculoskeletal disorders: a systematic review, Ergonomics 57 (1) (2014) 93–107.
[21] A.P. Dawson, et al., Interventions to prevent back pain and back injury in nurses: a systematic review, Occup. Environ. Med. 64 (10) (2007) 642–650.
[22] A. Richardson, et al., Interventions to prevent and reduce the impact of musculoskeletal injuries among nurses: a systematic review, Int. J. Nurs. Stud. 82 (2018) 58–67.
[23] K. Johnson, et al., Manual patient handling in the healthcare setting: a scoping review, Physiotherapy 120 (2023) 60–77.
[24] S. Hignett, Intervention strategies to reduce musculoskeletal injuries associated with handling patients: a systematic review, Occup. Environ. Med. 60 (9) (2003).
[25] M.J. Page, et al., PRISMA 2020 Explanation and Elaboration: Updated Guidance and Exemplars for Reporting Systematic Reviews, Bmj, 2021.
[26] J.R. Landis, G.G. Koch, The measurement of observer agreement for categorical data, Biometrics 33 (1) (1977) 159–174.
[27] C.G. Maher, et al., Reliability of the PEDro scale for rating quality of randomized controlled trials, Phys. Ther. 83 (8) (2003) 713–721.
[28] N.A. de Morton, The PEDro scale is a valid measure of the methodological quality of clinical trials: a demographic study, Aust. J. Physiother. 55 (2) (2009) 129–133.
[29] A.G. Cashin, J.H. McAuley, Clinimetrics: physiotherapy evidence database (PEDro) scale, J. Physiother. 66 (1) (2020) 59.
[30] T.C. Hoffmann, et al., Better reporting of interventions: template for intervention description and replication (TIDieR) checklist and guide, BMJ Br. Med. J. (Clin. Res. Ed.) 348 (2014) g1687.
[31] M. Cumpston, et al., Updated guidance for trusted systematic reviews: a new edition of the Cochrane Handbook for Systematic Reviews of Interventions, Cochrane Database Syst. Rev. 10 (2019) ED000142.
[32] The Cochrane Collaboration, Review Manager (RevMan) [Computer Program] 5.3, The Nordic Cochrane Centre, Copenhagen, 2014.
[33] Reeves, B.C., et al. Chapter 24: Including non-randomized studies on intervention effects. Cochrane handbook for systematic reviews of interventions version 6.3 (updated February 2022) 2022 23/02/2023]; Available from: www.training.cochrane.org/handbook..
[34] G.H. Guyatt, et al., GRADE: an emerging consensus on rating quality of evidence and strength of recommendations, BMJ 336 (7650) (2008) 924–926.
[35] J.P. Higgins, et al., Measuring inconsistency in meta-analyses, BMJ 327 (7414) (2003) 557–560.
[36] S. Gluppe, M.E. Engh, K. Bo, What is the evidence for abdominal and pelvic floor muscle training to treat diastasis recti abdominis postpartum? A systematic review with meta-analysis, Braz. J. Phys. Ther. 25 (6) (2021) 664–675.
[37] E.L. Sabbath, et al., Paradoxical impact of a patient-handling intervention on injury rate disparity among hospital workers, Am. J. Publ. Health 109 (4) (2019) 618–625.
[38] J.T. Dennerlein, et al., Lifting and exertion injuries decrease after implementation of an integrated hospital-wide safe patient handling and mobilisation programme, Occup. Environ. Med. 74 (5) (2017) 336–343.
[39] A.L. Svensson, et al., Multidimensional intervention and sickness absence in assistant nursing students, Occup. Med. (Lond.) 59 (8) (2009) 563–569.
[40] A.L. Svensson, et al., Sickness absence in student nursing assistants following a preventive intervention programme, Occupational medicine (Oxford, England) 61 (1) (2011) 57–61.
[41] S. Warming, et al., Little effect of transfer technique instruction and physical fitness training in reducing low back pain among nurses: a cluster randomised intervention study, Ergonomics 51 (10) (2008) 1530–1548.
[42] S. Shojaei, et al., A multidisciplinary workplace intervention for chronic low back pain among nursing assistants in Iran, Asian Spine Journal 11 (3) (2017) 419–426.
[43] S.P. Hozo, B. Djulbegovic, I. Hozo, Estimating the mean and variance from the median, range, and the size of a sample, BMC Med. Res. Methodol. 5 (2005) 13.
[44] M. Jaromi, et al., Back School programme for nurses has reduced low back pain levels: a randomised controlled trial, J. Clin. Nurs. 27 (5–6) (2018) e895–e902.
[45] L.D. Jensen, et al., Prevention of low back pain in female eldercare workers: randomized controlled work site trial, Spine 31 (16) (2006) 1761–1769.
[46] T.R. Black, et al., Effect of transfer, lifting, and repositioning (TLR) injury prevention program on musculoskeletal injury among direct care workers, J. Occup. Environ. Hyg. 8 (4) (2011) 226–235.
[47] J. Hartvigsen, et al., Intensive education combined with low tech ergonomic intervention does not prevent low back pain in nurses, Occup. Environ. Med. 62 (1) (2005) 13.
[48] H.J. Lim, et al., Evaluating repeated patient handling injuries following the implementation of a multi-factor ergonomic intervention program among health care workers, J. Saf. Res. 42 (3) (2011) 185.
[49] A. Carta, et al., Training in safer and healthier patient handling techniques, Br. J. Nurs. 19 (9) (2010) 576–582.
[50] T. Ore, Evaluation of safety training for manual handling of people with disabilities in specialised group homes in Australia, Aust. N. Z. J. Publ. Health 27 (1) (2003) 64–69.
[51] C. Johnsson, R. Carlsson, M. Lagerstrom, Evaluation of training in patient handling and moving skills among hospital and home care personnel, Ergonomics 45 (12) (2002) 850–865.
[52] H.L. Kugler, et al., Nurses sustain manual handling risk assessment behaviours six-months after a training program to move patients safely: a pre-post study, Disabil. Rehabil. 45 (5) (2022) 927–935.
[53] N.K. Brusco, et al., Mobilisation alarm triggers, response times and utilisation before and after the introduction of policy for alarm reduction or elimination: a descriptive and comparative analysis, Int. J. Nurs. Stud. 117 (2021) 103769.
[54] M.E. Morris, et al., Divesting from a scored hospital fall risk assessment tool (FRAT): a cluster randomized non-Inferiority trial, J. Am. Geriatr. Soc. 69 (9) (2021) 2598–2604.
[55] T.P. Haines, et al., Impact of disinvestment from weekend allied health services across acute medical and surgical wards: 2 stepped-wedge cluster randomised controlled trials, PLoS Med. 14 (10) (2017) e1002412.