Impacts of Manual Handling Training and Lifting Devices on Risks of Back Pain among Nurses: An Integrative Literature Review

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ABSTRACT

Background: Musculoskeletal injuries, notably lower back injuries, are major occupational health problems among nurses. These injuries occur mainly due to incorrect use of body mechanics upon handling, lifting, and transfer of patients. It is the leading cause of occupational disability and is associated with increased healthcare costs. Reducing these injuries can lead to a significant reduction in healthcare costs.
Purpose: This integrative literature review aims to examine the impacts of manual handling and lifting devices on the risk of back pain among hospital nurses.
Methods: This study uses an integrative literature review design. Proquest, Science Direct, MEDLINE, and CINAHL were searched comprehensively. A Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) flow diagram was used to check the number of publications that were identified and screened for eligibility, and the number of publications excluded and reasons for exclusion. The Critical Appraisal Skills Programme (CASP) and the Centre for Evidence-Based Management critical appraisal checklist for a cross-sectional study (CEBM) were used to appraise the quality of selected articles.
Results: Fifteen studies were found to highlight the importance of manual handling training programs and the consistent use of lifting devices in the prevention of low back pain. Ergonomics training, proper body mechanics and posture, use of body slings, workplace characteristics, availability of equipments and complexity of work, lost work days including nurses' knowledge, experience, attitude and compliance are essential factors that impacts back pain.
Conclusion: Manual handling training programs and the use of patient lifting equipment are effective in preventing lower back pain among nurses.

Keywords: Lower back pain; musculoskeletal injuries; musculoskeletal pain; nurses; patient lifting devices

BACKGROUND

Nurses comprise the largest group of healthcare service providers, accounting for about 70 percent of all healthcare staff (Movahedi, Ghafari, Nazari, & Valiani, 2017). They spend more time with and provide more direct care to patients than any other type of healthcare worker (Tosunoz & Oztunc, 2017). At the same time, the hospital environment predisposes nurses to various physical problems and stress, making nursing a high-risk occupation (Movahedi et al., 2017). Indeed, nursing is a physically demanding profession that has been ranked second only to industrial occupations in terms of physical activity and is associated with high rates of musculoskeletal disorders (Sharafkhani, Khorsandi, Shamshi, & Ranjbaran, 2014). In the United States, nursing is identified as amongst the riskiest professions for back pain with the highest incidence of all forms of work-related, nonfatal injuries (Sanjoy, Ahsan, Nabi, Joy, & Hossain, 2017).

Nurses spend around 20 percent of their work time executing patient mobility and handling tasks. Safe patient handling and mobility tasks encompass any physical maneuver or activity that requires the nurse to move, transfer, or lift patients (Vendittelli Penprase, & Pittiglio, 2016). Musculoskeletal injuries emanating from manual handling injuries comprise a significant organizational, employee, and societal burden (Lee & Lee, 2017). Hence, healthcare organizations are increasingly focusing on environmental and organizational strategies to create a safety culture that entails the safe execution of patient mobility and handling tasks. Nonetheless, nurses continue to experience musculoskeletal injuries despite the heightened emphasis on training, education, injury prevention guidelines on SPHM, and 'no lift policies' (Vendittelli et al., 2016).

Manual handling includes any task that necessitates the use of force to restrain, hold, move, carry, pull, push, lower, or lift an object, animal, or person. Unsafe execution of such activities can increase the risk of injury. Research has demonstrated a significant association between manual handling and musculoskeletal injuries (McDermott, Haslam, Clemes, Williams, & Haslam, 2012). Evidence suggests that patient handling increases the risk of back injuries by up to 89 percent (Garg & Kapellusch, 2012). Heavy manual handling has been cited as a risk factor for work disability. However, it has been shown that education and training on manual handling can help reduce these risks (Garg & Kapellusch, 2012; McDermott et al., 2012).

Research on healthcare personnel training for patient handling and moving skills has demonstrated that, while training may result in enhanced work technique, evidence of this leading to reduced rates of musculoskeletal injuries is lacking (McDermott et al., 2012). Studies employing the economic effectiveness approach have demonstrated that training is more cost-effective than engineering controls, but that the overall effectiveness of training remains low (Garg & Kapellusch, 2012). In addition, evidence from reviews of randomized controlled trials demonstrates mixed results about the effectiveness of manual handling training in minimizing the risk of back pain amongst workers: some studies found no evidence and others demonstrated little evidence supporting the effectiveness of training on manual handling (McDermott et al., 2012).

Researchers have also identified potential reasons for the lack of effectiveness of training on manual handling. First, it is believed that a lack of refreshing or reinforcing safe practices may cause individuals to revert to previous customs and habits. Second, the emergency situations, reduced physical well-being, increased body weight, or a sudden quick movement may cause considerable body strain if such conditions were absent during training (McDermott et al., 2012). Third, the inherent risk may not be eliminated by behavior modification in the context of stressful job requirements (McDermott et al., 2012). These activities are believed to increase the risk of disorders of the lower back in nursing personnel (Garg & Kapellusch, 2012).

Psychological studies have reported that nurses experience high stress on the shoulder and lower back during manual patient lifting and transfer (Garg & Kapellusch, 2012). These factors highlight the need for performance and motivation as concepts in the training process. In the manual handling training context, performance refers to the efficient execution of manual handling tasks to reduce injuries in the long-term (Karahan & Bayraktar, 2013). Conversely, motivation entails the determination of employees to gain and use new skills (McDermott et al., 2012).

Notwithstanding the limited supporting evidence and doubts surrounding manual handling training effectiveness, healthcare organizations are obligated to train workers on manual handling (Lim, Black, Shah, Sarker, & Metcalfe, 2011). Moreover, the efficacy of assistive lifting devices in reducing the risk of musculoskeletal injuries has been examined; the available research suggests that these devices can reduce the risk of injury, but the evidence appears to be mixed (McDermott et al., 2012). Thus, evidence of the effects of manual handling training and lifting devices on the risk of back pain remains limited and inconclusive (McDermott et al., 2012).

PURPOSE
The aim of this integrative literature review is to examine the impacts of manual handling training and lifting devices on the risk of back pain among hospital nurses.

METHODS
Research design
An integrative literature review method was employed to explore the impact of manual handling training and lifting devices on the risk of back pain amongst hospital nurses. It creates an objective summary, critique, and conclusions about a phenomenon through systematic search, thematic analyses, and categorization of past quantitative and qualitative research studies on the subject matter (Whittemore & Knafl, 2005). The design was chosen because of its comprehensive methodological approach that permits the inclusion of both experimental and non-experimental studies for an in-depth understanding of the phenomenon under review (Whittemore & Knafl, 2005). It combines data from both empirical and theoretical literature and permits the analysis of methodological problems on a given topic (De Souza, Da Silva, & De Carvalho, 2010).

Integrative literature review allows the research to accomplish various goals, including identification of gaps in current research, evaluation of scientific evidence strength, identification of significant issues in an area, bridging of knowledge gaps, generation of

a research question, exploration of successful research methods, and identification of a conceptual or theoretical framework, amongst other benefits (Russell, 2005). Therefore, this research design offers the most suitable approach to examine the impact of manual handling training and lifting devices on the risk of back pain amongst hospital nurses.

Search strategy
A comprehensive literature search was conducted using the following academic electronic databases: ProQuest (Nursing & Health Alliance), Science Direct, MEDLINE, and the Cumulative Index of Nursing and Allied Health Literature (CINAHL). The search strategy involved the use of various keywords and Medical Subject Headings (MeSH) terms to guide the search. The first step involved the use of the following keywords: back pain, lower back pain, musculoskeletal injuries, musculoskeletal pain, nurses, nursing, nurse, lifting devices, manual handling, manual lifting, manual transfer, manual handling training, patient lifting, education, hospital, and hospitals (see Table 1). In addition, as the CINAHL and Medline databases use different terminology, the following Medical Subject Heading terms (MeSH) were used to retrieve the most relevant articles: 'Patient handling', 'Lifting', 'Back pain', 'Back injuries', 'Lifting and transfer equipment', 'Hospitals', and 'Nurses'. The initial search using these terms yielded numerous publications. The second step involved the use of the Boolean operators AND and OR to combine the MeSH/keywords and ensure a focused search.

Table 1. Search keywords

Manual handling (OR)	Back pain (OR)	Nurse (OR)	Hospital (OR)
Manual lifting (OR)	Lower back pain (OR)	Nurses (OR)	Hospitals
Manual handling AND training (OR)	Musculoskeletal AND injuries	Nursing AND	
Lifting devices (OR)	Musculoskeletal pain		
Manual transfer (OR)			
Patient lifting (OR)			
Education (OR)			

Exclusion criteria
Studies conducted in non-hospital settings, studies focused on causes of back pain rather than prevention, and studies concern with patients rather than nurses were not included in this study. A manual search of the reference lists of retrieved journal articles was performed to identify any additional relevant publications that the online search strategy did not capture for inclusion. The initial database search yielded a total of 347 publications; 15 articles were assessed based on quality appraisal and were found to be suitable for inclusion for critical analysis.

A flow diagram has been provided to show the number of publications that were identified and evaluated for eligibility (see Figure 1).
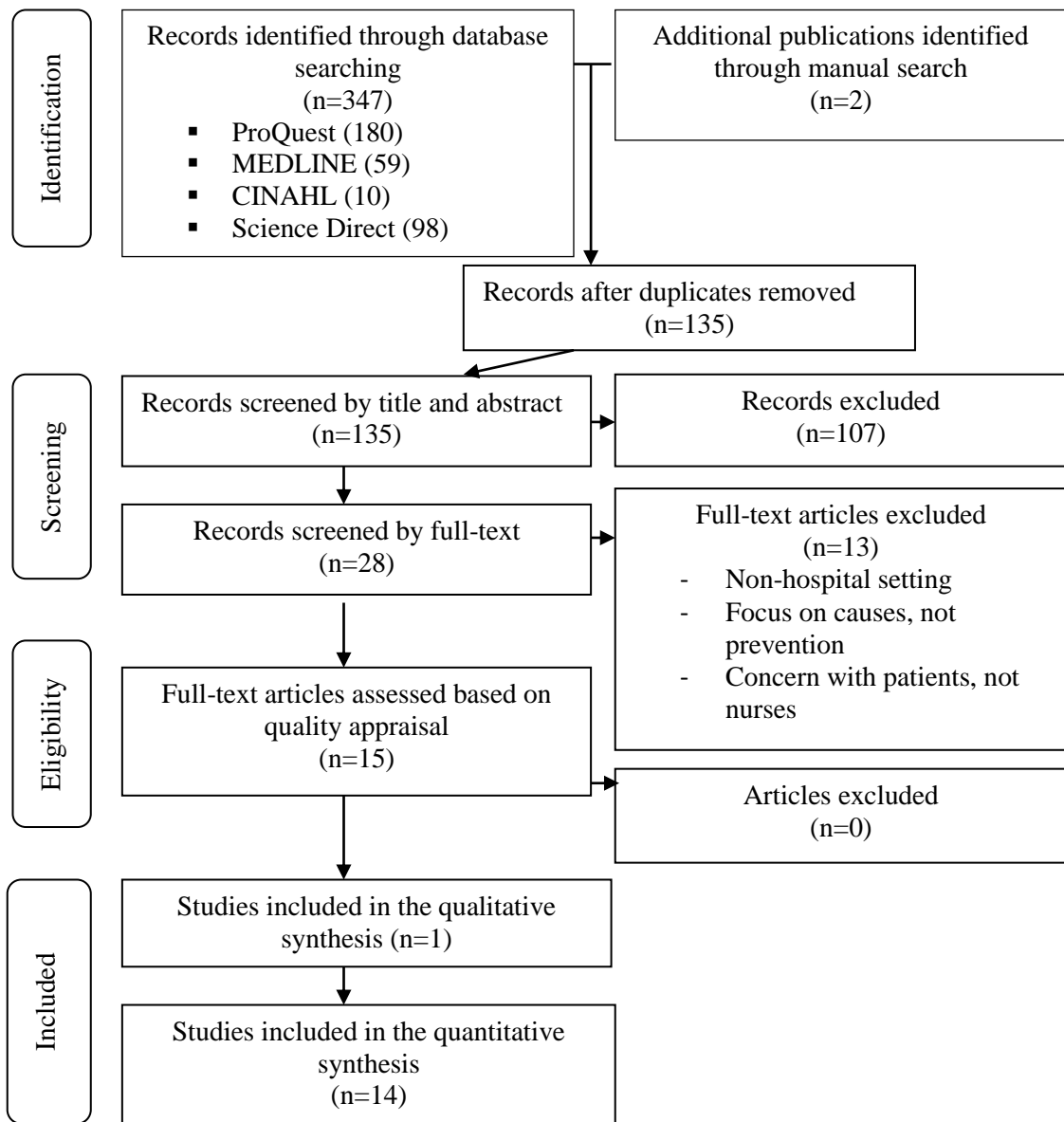
Figure 1. Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) flow diagram.

Critical appraisal of the selected studies

Critical appraisal of the quality of research publications is a vital step in the integrative literature review process. For this integrative literature review, the Critical Appraisal Skills Programme (CASP) and the Center for Evidence-Based Management critical appraisal checklist for a cross-sectional study (CEBM) were chosen to appraise the quality of the selected research articles.

The CASP is a research appraisal tool consisting of 10 to 12 questions to help researchers conduct an in-depth exploration and make sense of a research study in a systematic manner. It outlines three broad issues that should be taken into consideration when appraising a research report. These issues focus on whether the trial is valid, on the results themselves, and on whether the results would help in local settings. CASP checklists have been developed for critical appraisal of the cohort, case-control, and qualitative studies as well as systematic reviews and randomized controlled trials (Nadelson & Nadelson, 2014). While various critical appraisal tools are available, the CASP tools were chosen for this review because they effectively and succinctly cover the areas required for critical appraisal of research reports (Nadelson & Nadelson, 2014). The CASP process offers a systematic process of identifying the weaknesses and strengths of a research study, thus improves the usefulness of a study and its findings (Nadelson & Nadelson, 2014).

Also, the Center for Evidence-Based Management critical appraisal checklist for a cross-sectional study (CEBM) was used (Center for Evidence-Based Management, 2014). Its 12 questions cover a study's aim, method, sample selections, presence of bias, and participants' response rate. Moreover, it assesses the measurement validity, statistical significance, and reporting confidence intervals, as well as whether the results can be applied in local practice settings.

RESULTS
Characteristics of the selected studies
Study designs
Various research designs were used in different studies included in this paper. Overall, the majority of these studies were experimental and employed pre- and post-intervention research designs. Out of the fifteen reviewed studies, eight used pre- and post-intervention study designs (Black, Shah, Busch, Metcalfe, & Lim, 2011; Garg & Kapellusch, 2012; Hodder, MacKinnon, Rahlan, & Keir, 2010; Karahan & Bayraktar, 2013; Li, Wolf, & Evanoff, 2004; Resnick & Sanchez, 2009; Risor, Casper, Andersen, & Sorensen, 2017; Theis & Finkelstein, 2014). One study used an explorative study design (Karahan & Bayraktar, 2004), and another study employed a quasi-experimental study (Lim et al., 2011). Two of the reviewed studies used cross-sectional study designs (Lee, Faucett, Gillen, & Krause, 2013; Lee & Lee, 2017), and one study employed a descriptive survey design (Vendittelli et al., 2016). Also, there was one study with a qualitative study design (De Ruiter & Liaschencko, 2011), and one with a single-blinded randomized controlled trial research design (Jaromi, Nemeth, Kranicz, Laczko, & Betlehem, 2012).

Countries
Of the fifteen articles selected for review, eight were carried out in various locations in the United States of America (USA). Specifically, one study was conducted in Southeast Michigan (Vendittelli et al., 2016), two in the State of Minnesota (De Ruiter & Liaschenko, 2011; Theis & Finkelstein, 2014), and one in the State of Florida (Resick & Sanchez, 2009). Also, one study was carried out in Missouri, USA (Li et al., 2004), two in the State of California (Lee & Lee, 2017; Lee et al., 2013), and one in Wisconsin, USA (Garg & Kapellusch, 2012). Two studies were carried out in Turkey in Bolu

(Karahan & Bayraktar, 2004) and the West Black sea (Karahan & Bayraktar, 2013). One study was conducted in Hungary (Jaromi et al., 2012), and another in the central region of Denmark (Risor et al., 2017). The remaining three studies were carried out in Saskatchewan, Canada (Black et al., 2011; Lim et al., 2011), and Newfoundland, Canada (Hodder et al., 2010).

Sample size and sample characteristics
The selected studies are different in the sample size. Three studies (Black et al., 2011; Garg & Kapellusch, 2012; Lim et al, 2011) used a quite large number of nurse participants. Their sample size was 766, 833, and 1480 participants, respectively. The remaining studies employed a lower number of participants, which range from 16 nurses (Resnick & Sanchez, 2009) to 443 nurses (Risor, et al., 2017). Moreover, one study recruited only female participants (Hodder et al., 2010) and 14 studies recruited both male and female nurses; however, the majority of them were females up to 90% (Black et al., 2011; Jaromi et al., 2012; Lee et al., 2013; Lim et al., 2011). All fifteen studies were carried out in many departments in different hospitals. Two studies were conducted in community hospitals (Black et al., 2011; Li et al., 2004), one in long-term care nursing facilities and chronic care hospital (Garg & Kapellusch, 2012), one study in rehabilitation hospital (Black et al., 2011) and the remaining studies took place in general hospitals (Hodder et al., 2010; Jaromi et al., 2012; Karahan & Bayraktar 2004; Karahan & Bayraktar, 2013; Lee et al., 2013; Lee & Lee, 2017; Lim et al., 2011; Resnick & Sanchez, 2009; Risor et al., 2017; Theis & Finkelstein, 2014; Vendittelli et al., 2016). Also, one study was carried exclusively in the intensive care unit (Lee et al., 2013) and another one in the emergency department (Resnick & Sanchez, 2009). Other studies were conducted in general departments. Moreover, seven studies highlight the importance of nurses' experience and knowledge (De Ruiter & Liaschenko, 2011; Hodder et al., 2010; Karahan & Bayraktar, 2004; Lee & Lee, 2017; Lim et al., 2011; Risor et al., 2017; Vendittelli et al., 2016) and five studies discusses nurses' compliance and attitude towards safe use of lifting devices (De Ruiter & Liaschenko, 2011; Lee & Lee 2017; Li et al., 2004; Resnick & Sanchez, 2009; Risor et al., 2017). Furthermore, the site of injuries was discussed in five studies (Black et al., 2011; Lee & Lee, 2017; Theis & Finkelstein, 2014; Vendittelli et al., 2016).

Manual handling training programs and patient lifting equipment
Ergonomics training
Training is a process that facilitates the acquisition of skills in a given area. Training and education in body mechanics, transferring, and lifting techniques have been employed to reduce musculoskeletal disorders among nursing personnel, but their effectiveness is questionable (Vendittelli et al., 2016). Appropriate assistive devices for transferring patients, such as mechanical patient-lifting hoists, provide engineering solutions to biomechanical stressor reduction among nurses. Garg and Kapellusch (2012) conducted an intervention study to investigate the long-term efficacy of a comprehensive ergonomic intervention program that encompassed patient handling devices in various nursing facilities on patient-handling injuries to nurses. It revealed a reduction in patient-handling injuries after the implementation of the program. Perceived shoulder and low back stresses among nurses were also reasonably low. Also, most patients felt that the devices were safe and comfortable. The findings of this study

suggest that patient-handling devices implementation with a comprehensive program is likely to be effective in reducing back injuries among nurses (Garg & Kapellusch, 2012).

Similarly, Jaromi et al. (2012) investigated the effectiveness of an ergonomics training program called "Back School" on low back pain and body posture of nurses. They found out that the ergonomic training program resulted in a significant decrease in the intensity of lower back pain and improved body posture among nurses. It revealed that these effects were maintained during a six-month and one-year follow-up. These findings suggest that this intervention can be used in the management of nurses with chronic lower back pain (Jaromi et al., 2012). In another study, Kaharan and Bayraktar (2013) evaluated the effectiveness of an education program in low back pain prevention among nurses. They found out that the program improved the mean procedure scores and knowledge of nurses about the prevention of low back pain.

Similarly, Theis et al. (2014) found out that the safe patient handling program (STEPS) program resulted in a significant reduction in the number of injuries due to patient transfers. However, this effect was found to be short-term and was not sustained in the long-term. This suggests that retraining on the same program is essential to help achieve the desired effect of the reduction of work-related injuries in the long-term. The transfer, lifting, and repositioning (TLR) program were investigated by two studies (Black et al., 2011; Lim et al., 2011). The program focuses on musculoskeletal injury reduction by assessing, defining, and standardizing procedures and requirements of patient handling for each patient with the aim of ensuring both worker and patient safety. The TLR training program stresses and reinforces minimal use of physical effort by maximizing the use of equipment. Black and colleagues (2011) examined the effectiveness of the TLR program in reducing musculoskeletal disorders among direct health care providers. It is said that the implementation of the TLR program was associated with a reduction in all injury rates in the intervention group from 14.7 before the intervention to 8.1 after the intervention. The intervention group also experienced a decrease in time-loss injury from 5.3 to 2.5. After controlling for hospital and group size, the study revealed that the relative all-injury rate and time-loss injuries before and after intervention decreased by 30 percent and 18.6 percent, respectively. Their findings show that the TLR program is effective in reducing the risk of back pain in direct health care workers. This suggests that the TLR program can be implemented to reduce injury rates in health care practice (Black et al., 2011). Also, Lim et al. (2011) evaluated repeated patient handling injuries after the implementation of a multi-factor TLR program in health care workers. They found out that its implementation resulted in a reduction of work-related injury (Lim et al., 2011).

Body mechanism and posture
Poor body mechanics and poor posture are major risk factors for lower back pain. Proper body posturing and mechanics can reduce back pain. Various therapeutic approaches have been implemented in this regard (Jaromi et al., 2012). Evidence has shown a close association between correct body mechanics and lower back pain among nurses. The increase in the number of lower back pain cases among nurses has been attributed to incorrect use of body mechanics during work (Karahan & Bayraktar,

2004). Kaharan and Bayraktar (2004) investigated body mechanics use and lower back pain occurrence among nurses. They found that incorrect use of body mechanics was significantly associated with lower back pain. Factors such as heavy lifting and wearing high heels were associated with back pain among nurses. Nurses employed incorrect body mechanics when extending and lifting patients, and that this contributed to back pain. The findings of this study highlight the importance of correct body mechanics in nursing practice and the need to educate nurses on the same (Karahan & Bayraktar, 2004). Evidence has demonstrated that theoretical and practical training in transfer techniques can improve posture and other injury-associated risk factors (Hodder et al. 2010). The Back Injury Prevention Program (BIPP) is one of the intervention strategies that have been implemented to reduce back injuries. This program offers instruction on techniques of patient handling, identifies mechanisms of injury, and emphasizes back safety.

Furthermore, Hodder et al. (2010) have assessed the components BIPP in patient handling techniques and have found a reduction in muscle activity, lower spine angle variability, and smaller thoracolumbar spine angles. Overall, the BIPP patient transfer instruction has been associated with enhanced thoracolumbar biomechanics for experienced as well as new nursing staff (Hodder et al., 2010). Similarly, the Back School program focuses on minimizing the risk of back injury by increasing patients' knowledge and promoting behavior change through the adoption of good body posturing and proper lifting techniques during work (Jaromi et al., 2012). The BS program entails educating individuals about back anatomy and function, posture, and mechanical strain as well as providing isometric programs. It also includes information on patient transfer techniques, body mechanics, alternate body positioning during activities of daily living, standing posture, and sitting posture, among others. Implementation of the Back School program has been associated with significant improvement in healthcare workers' posture (Jaromi et al., 2012). Resnick and Sanchez (2009) contend that body mechanics training is one of the approaches that can be used to address the problem of lower back pain among nurses. They highlight the lack of a standardized training method for emergency nurses in manual handling of patients despite the high injury rates.

Consequently, Resnick and Sanchez (2009) evaluated the impact of various training protocols, including the use of realistic context in care delivery and the use of simulated emergency situations, on the postures of nurses and their compliances with the training. It revealed that all forms of training were associated with significant improvement in the torso flexion and rotation of nurses as well as nurses' compliance with safe patient handling practices. Additionally, they found out that contextual training resulted in the most significant improvement in all measures. The findings of this study suggest that contextual training approaches on safe patient handling can be used to reduce the risk of back injury among emergency nurses in their hectic and unpredictable healthcare environment (Resnick & Sanchez, 2009).

Use of body sling
Although body sling, including full-body sling, is useful in reducing the incidence of back pain among nurses, Theis and Finkelstein (2014) found out that staff did not use

positioning slings because they found it to cause disruption to patients' skin integrity and sleep as well as time-consuming. They also cited that the possibility of a lack of sufficient staff integration into the selection process of these devices, making it difficult for staff to fully appreciate their benefits in preventing injuries. This study highlights the need to incorporate and train staff in the selection and use of such devices to promote a culture that is safe and more accepting of equipment handling (Theis & Finkelstein, 2014). In another study, Hodder et al. (2010) cited patient condition as one of the factors that influence the use of body sling. Also, Risor et al. (2017) found out that their intervention was associated with increased sliding sheet use.

Workplace characteristics
Research suggests that the safety practices of workers are influenced by psychosocial and organizational job factors. Precisely, workplace safety climate, which includes the shared perceptions of workers about the safety of the organizational and workplace safety practices, has been linked to higher safe work practices among various health care workers. Safety climate has been demonstrated to be the most influential factor linked to safe patient handling behaviors among nurses (Lee & Lee, 2017).

Availability of equipment
Unsafe handling of patients has been cited as a significant musculoskeletal injury risk factor among nurses (Lee & Lee, 2017). Musculoskeletal injuries remain common among nurses despite a heightened emphasis on "no lift" policies (Vendittelli et al., 2016). Lifting equipment is a significant component of programs that focus on safe patient handling. Available literature suggests that mechanical patient lifting equipment use is likely to reduce musculoskeletal injury risk from patient handling (Lee & Lee, 2017). Reductions in worker's compensation rates, injury rates, musculoskeletal discomfort, and biomechanical stress have been demonstrated in research following lifting equipment use (Vendittelli et al., 2016).

Consequently, promoting adequate lifting equipment use and eliminating risky manual lifting have become significant aspects of patient handling policies globally. However, despite advances in safe patient handling and mobility equipment, the equipment is often not readily available, may not be used, or may have inconsistent policies regarding their use (Vendittelli et al., 2016). Despite being available, concerns have been raised regarding the frequent use of these devices by nurses and other healthcare professionals (Lee et al., 2013). In addition to appropriate lift equipment use, various work behavior including patient cooperation, getting the required help from co-workers, physical environment assessment and correction, and patient and risk assessment are vital in the safe performance of patient handling tasks (Lee & Lee, 2017). It is believed that there is an association between the availability of lifting equipment and musculoskeletal pain. Lee and colleagues (2013) carried out a study to investigate the effectiveness of lifts on musculoskeletal pain based on lift availability and use. Their study revealed that greater lift availability and use was linked to fewer incidents of musculoskeletal pain among critical care nurses. Their findings suggest that ready availability of lifts is vital for the effectiveness of lift interventions. Also, the study highlights the need to eliminate barriers against lift use in health care practice (Lee et al., 2013).

Similarly, Lee and Lee (2017) conducted a study to investigate safe patient handling behavior and the use of lift among hospital nurses and the associated factors. Their study demonstrated a strong association between high patient handling behaviors and positive organizational safety climate. There was also a significant association between high lift use and high lift availability, as well as positive perceptions regarding lift use. They concluded that ensuring ready availability of lift equipment and promoting positive experiences and perceptions about lifts can be vital in ensuring lift equipment use (Lee & Lee, 2017). Similarly, Vendittelli et al. (2016) found out that adequate safe patient handling and mobility equipment were reported to be available by only 39.4 percent of the nurses investigated. This suggests the need for increased acquisition of safe patient handling and mobility equipment to prevent musculoskeletal injuries (Vendittelli et al., 2016).

The complexity of daily care and culture of safety
Research has demonstrated that patient handing in actual practice is complex and dynamic. Often, nurses are required to make rapid and ongoing assessments about patients and their environment. Various factors seem to influence the judgment of nurses regarding patient handling, including patients' overall mental and physical condition, patient size, patient preferences, and patient comfort. The realities of clinical practice highlight the importance of professional judgment and the autonomy of nurses on how some should be best handled. While excellent nursing care necessitates both judgment and knowledge, safe patient handling requires the application of guidelines and algorithms (De Ruiter & Liaschenko, 2011).

Workplace safety culture encompasses shared perceptions of workers regarding workplace safety and organization safety practices such as support and safety communication and management commitment. Safety culture has been cited as the most influential factors linked to safe patient handling behaviors among nurses (Lee & Lee, 2017). Consequently, hospitals have increased their focus on environmental and organizations aspects to create a safety culture that entails the safe execution of patient handling and mobility tasks (Vendittelli et al., 2016). Research has found that organizational safety culture is significantly associated with reduced experiences of musculoskeletal pain among healthcare providers (Lee & Lee, 2017). Vendittelli and colleagues (2016) carried out a descriptive study to explore hospital safety culture and the incidence of musculoskeletal injuries among new nurses. They found that environmental safety culture factors such as adequate staffing, the ability to refuse to engage in unsafe patient handling and mobility practice, a hospital interdisciplinary team, and the presence of a non-punitive environment were significantly associated with nurse injury incidence. Also, they noted that while there was evidence of commitment to safety culture, how this translates into actual practice needs further investigation (Vendittelli et al., 2016). Furthermore, research has shown that healthcare organizations with high safety culture and steadfast adherence to safe handling report the lowest incidence of musculoskeletal injuries among their employees (Theis & Finkelstein, 2014).

Lost work days

Musculoskeletal injuries arising from patient handling and mobility are the most frequent contributors to lost workdays among nurses and other direct patient care providers (Garg & Kapellusch, 2012; Jaromi et al., 2012). The number of lost workdays is a measure of the duration of disability arising from patient handling injuries and is representative of any preventive effects of an intervention (Black et al., 2011). A high number of lost workdays has facilitated the institution of safe patient handling programs in healthcare (Theis & Finkelstein, 2014). Black and colleagues (2014) explored the effectiveness of the engineering and administrative intervention for patient handling and found out that the intervention was associated with a significant decrease in time-loss days (from 35.99 days to 16.2 days) in the intervention groups (Black et al., 2011).

Similarly, Garg and Kapellusch (2012) found that implementation of a comprehensive ergonomics program was highly successful in reducing the number of lost workdays among nursing personnel. Their findings were also found a greater reduction in lost workdays relative to injuries, indicating less severity of post-intervention injuries, which enabled nursing personnel to resume employment much faster (Garg & Kapellusch, 2012). Jaromi and colleagues (2012) found out that the implementation of a spine training program had positive results, including fewer recurrent lower back pain episodes, improved spine functions, and decreased pain and disability intensity, factors that translate to deceased number of days off from low back pain (Jaromi et al., 2012). Also, it is believed that these programs can maintain reductions in staff injuries, thereby reducing the number of lost workdays (Theis & Finkelstein, 2014).

Individual characteristics
Experience and knowledge

Nurses' knowledge and experience seem to influence their judgment on safe patient handling and mobility. Lack of knowledge about safe patient handling is believed to be a significant contributor to lower back pain. Karahan and Bayraktar (2004) found out that nurses who lack knowledge of proper body mechanics have a higher likelihood of experiencing lower back pain. Lee and Lee (2017) cite a lack of knowledge as one of the significant barriers against lifting equipment use (Lee & Lee, 2017). Similar findings were reported by Vendittelli et al. (2016). Research has shown that nurses derive their knowledge on the safe handling of patients from various sources, including formal education, patient records, and prior experience with patient care (De Ruiter & Liaschenko, 2011). In particular, knowledge of a specific patient has been found to be critical to patient handling. The knowledge does not seem to be limited to aspects of the condition of the patient; rather, it encompasses any unique way that a patient can respond to being handled or moved (De Ruiter & Liaschenko, 2011). Knowledge of the patient is generally attained through subtle but intricate attention to sensory information. Subsequently, knowledge will inform how healthcare providers handle or help patients move. Research suggests that these sensory cues are a significant means through which nurses can know how to handle patients. If nurses lack this knowledge, they can employ previous experience with similar patients or consult colleagues with similar past experiences (De Duiter & Liaschencko, 2011). Karahan and Bayraktar (2013) found that training nurses can significantly improve their knowledge and behavior on low back pain prevention. Their study revealed that the mean knowledge scores of nurses after

training were significantly higher than the pre-training scores. Another study by Hodder and colleagues (2010) demonstrated that experience affects patient transfer biomechanics. They found that experienced nurses are more likely to employ a smaller range of motion and a neutral spine posture than novice nurses, yet that had higher muscle activity compared to novices.

Compliance and attitude toward the safe use of lifting device
Nurses' attitudes are likely to influence their compliance with the safe use of lifting devices. Nurses are less likely to use lifting devices if they perceive those devices as posing a risk of harm to patients or that the equipment might malfunction (De Ruiter & Liaschenko, 2011). Similarly, Lee and Lee found out that the perceptions or attitudes of nurses towards lift use significantly influenced the use of such devices. They recommend the need to improve psychosocial working conditions to promote safe work practice and prevent musculoskeletal injuries (Lee & Lee, 2017). Research has shown that nurses are generally poorly compliant with the use of lifting devices. Li and colleagues (2004) found that the nurses used stand-up lifts occasionally and were most reluctant to use these devices for patient handling tasks. Nurses used stand-up lift equipment an average of 1.1 times each day instead of the required 3-4 times a day. Nurses in this study identified various reasons for failing to use stand-up lifts, including the lack of perceived need for using the devices for several transfers, lack of maneuvering space, and the increased time needed to use the equipment (Li et al., 2004). Risor et al. (2017) revealed that a multi-component patient-handling intervention was effective in improving nurses' attitudes towards patient-handling devices and their use. Resnick and Sanchez (2009) found that contextual training was more effective in promoting compliance with safe patient handling practices than classroom training.

Site of injury
Research has shown that back, shoulder, and neck are the most common parts of the body to sustain an injury during manual patient handling practices (Black et al., 2011). Lee et al. (2013) found a significant association between the availability of lifts and work-related shoulder and back pain, and the level of availability of patient handling devices influenced the place of injury. The study demonstrated that nurses who reported medium-level of availability of lifts had a 3.6 times less likelihood of sustaining work-related shoulder pain and nurses who reported high-level of availability of lifts had half the likelihood of sustaining low-back pain in their work compared to nurses without lifts. Concerning lift use, the study found out that nurses reporting medium-level lift use were three times less likely to experience work-related shoulder pain, whereas nurses with low-level use were three times more likely to develop neck pain (Lee et al., 2013). Lim et al. (2011) found out that any attempt to minimize ergonomic risk in one part of the body is likely to heighten the risk of injury in another body part. Lifting equipment reduced back strain; however, it increases stress on the shoulder.

DISCUSSION
Training programs and lifting equipment
Overall, the review has shown that training programs and the use of lifting equipment are effective in preventing back injuries among nurses. Safe patient-handling behaviors could be improved through training. Training on low back pain prevention can result in

significant improvement in nurses' behaviors and knowledge of safe patient-handling. They observed significant improvement in nurses' knowledge scores after the intervention, but these changes were not maintained in the long-term (Kaharan & Bayraktar, 2013). Theis and Finkelstein (2014) found that training and retraining on safe patient handling practices resulted in a significant reduction in musculoskeletal injuries among therapy and nursing staff. Resnick and Sanchez (2009) showed that specific training, particularly contextual training, on patient handling reduced the risk of back injury among emergency nurses. Similarly, Hodder et al. (2010) concluded that the training program, the BIPP, was effective in improving back posture and muscle activity during repositioning activities. Training reduced backload and the risk of injury by reducing peak muscle activity and spine deviation. Likewise, Jaromi et al. (2012) found out that the Back School program enabled study participants to display good body posture and beneficial spine movements, which resulted in reduced load to the back during daily activities. The study also revealed a significant long-term reduction in pain following the intervention, which was believed to be due to the adoption of the right body posture, observance of spine protection rules, and application of these elements to daily practice. Similar findings have been reported by other researchers (McDermott et al., 2012; Rasmussen, Holtermann, Bay, Sogaard, & Jorgensen, 2015). This shows that nurses who have learned appropriate body posture use are more likely to work safer and easier, thereby avoiding overloading spine movements and reducing the risk and relapse of lower back pain (Jaromi et al., 2012).

Black et al. (2011) demonstrated evidence that a multifactor program for direct care health workers was effective in preventing patient handling and mobility injuries. They supported the implementation of this program, particularly in smaller hospitals. They also found that the most significant decrease was evident in the number of lifting injuries, then transferring injuries, and lastly, repositioning injuries. Evidence suggests that a TLR program is likely to help prevent injuries during the performance on a single form of maneuver and not another based on the focus of the intervention. Additionally, it is believed that certain patient handling maneuvers are more stressful, with higher injury risk, implying that they could have enormous improvement potential (Black et al., 2011). These findings were supported in a study by Shojaei and colleagues (2017), which showed that a multidisciplinary workplace intervention employing social cognitive theory and using ergonomic posture training and education was effective in reducing the risk of work-related low back pain among nursing staff (Shojaei, Tavafian, Jamshidi, & Wagner, 2017). Garg and Kapellusch (2012) found out that implementation of ergonomics programs that involved modern patient-handling devices in seven nursing facilities resulted in a reduced number of injuries, workers' compensation costs, modified-duty days, and lost workdays linked to patient-handling tasks, despite an increase in the level of patient acuity post-intervention.

Additionally, they observed significant reductions in workers' compensation costs and lost workdays relative to patient-handling injuries, indicating less severity of injuries post-intervention and the ability of personnel to resume employment earlier due to patient-handling equipment availability. The study identified various intangible benefits of patient-handling device use and ergonomic program implementation, including nurses being less tired and their backs being less sore, being able to continue

employment, ability to work even when pregnant, and decreased employee absenteeism and improved morale (Garg & Kapellusch, 2012). These findings were supported by the study carried out by Andersen and colleagues (2014), which showed that persistent assistive device use was linked to reduced back injury risk among healthcare workers who transfer patients daily (Andersen et al., 2014).

Li et al. (2004) found out that mechanical patient lifts were effective in reducing injury rates, musculoskeletal symptoms, workers' compensation costs, and lost workday injury rates (Li et al., 2004). The findings of this study were supported by Burdorf and colleagues (2012), who showed that proper lifting device implementation resulted in reduced lower back pain and injury claims among health care workers. They recommended the implementation of programs to help minimize manual patient lifting in healthcare settings (Burdorf, Koppelaar & Evanoff, 2012). Similarly, Risor et al. (2016) found out that patient-handling equipment use led to improvements in nurse behaviors and attitudes on safe patient handling and reduced episodes of aggression. Lim et al. (2011) found that a multi-factor ergonomic intervention program reduced work-related repeated injuries among health care workers. Also, Humrickhouse and Knibbe (2016) found out that safe patient handling (SPH) programs were more effective in facilitating the improvement in safe patient handling and mobility practices and reducing musculoskeletal disorders among healthcare workers than single interventions. These findings are supported by Schoenfisch, Lipscomb, Pompeii, Myers, and Dement (2013).

Workplace environment
Environmental factors seem to influence safe patient handling and mobility practices, including the use of lifting devices. Workplace safety culture encompasses shared perceptions of workers regarding workplace safety and organization safety practices such as support and safety communication and management commitment. Safety culture has been cited as the strongest factors linked to safe patient handling behaviors among nurses. Organizational safety culture is significantly associated with reduced experiences of musculoskeletal pain among healthcare providers (Lee & Lee, 2017). Environmental safety culture factors such as adequate staffing, the ability to refuse to engage in unsafe patient handling and mobility practice, a hospital interdisciplinary team, and the presence of a non-punitive environment are significantly associated with nurse injury incidence. However, evidence shows that while there was evidence of commitment to safety culture, how this translates into actual practice needs further investigation (Vendittelli et al., 2016). Furthermore, research has shown that healthcare organizations with high safety culture and firm adherence to safe handling report the lowest incidence of musculoskeletal injuries among their employees (Theis & Finkelstein, 2014).

Noble and Sweeney (2018) found out that environmental influences directly or indirectly affected the worker's commitment to or actual use of assistive devices. A study by Lee et al. (2013) revealed that great use and availability of lifts were linked to less musculoskeletal pain among nurses. They suggested the need to ensure the ready availability of lifts and the removal of barriers against their use in order to ensure the effectiveness of lift interventions. Similarly, in their study, Lee and Lee (2017) found

out that ergonomic practices, people-oriented culture, and favorable safety climate were significantly associated with safe patient handling behaviors. They also highlighted the need for promotion of safe patient-handling practices for injury prevention by organizational culture and safety practices. They also suggest the need to ensure ready equipment availability to improve experiences and positive perceptions regarding lifts and their use. Koppelaar and colleagues (2011) demonstrated that organizational factors such as easy accessibility and convenience, supportive management climate, and management support played an essential role in the successful lifting device implementation (Koppelaar, Knibbe, Miedema, & Burdorf, 2011).

Demographics
The reviewed evidence did not show any significant association between gender and safe patient handling and mobility. However, there is some evidence suggesting that age could play a role. Vendittelli and colleagues found out that musculoskeletal injuries were more common among participants aged between 25 and 34 years (Vendittelli et al., 2016). They correlated these findings to the higher likelihood of nurses in this age group working in direct care positions as well as nurse inexperience. They highlight the need to educate and train new nurses on safe patient-handling practices to improve their knowledge, skills, and competence. Black et al. (2011) found that most musculoskeletal injuries occurred among female direct care workers with a mean age of 40 years. A study by Sikiru & Hanifa (2010) showed that the likelihood of female nurses to have back pain is higher compare to male nurses. Although Sikiru and Hanifa (2010) did not state an apparent reason for it, they relate it to the anatomical, physiological, and structural differences between males and females.

Knowledge
Lack of knowledge about safe patient handling is believed to be a significant contributor to lower back pain (Sikiru & Hanifa 2010). The formal knowledge of handling patient safety that is taught in-services or classes focuses on moving patients in real space and time. Research has shown that knowledge of patients gained through the care experience is the most essential knowledge for safe patient handling. The foundation of this knowledge is mostly dependent on continuity of care. Nurses are only able to gain the knowledge required to make appropriate judgments needed for excellent care provision through continuity of care (De Ruiter & Liaschenko, 2011). However, it has been argued that the strategy used by experienced patient handlers to adjust postures to prevent low back pain can transfer loads to other joints, including the shoulder joint, thereby increasing injury risk to other tissues of the body. This suggests that they need to take into consideration other parts of the body, such as the shoulder joint in training programs focusing on patient handling and transfer (Hodder et al., 2010).

The complexity of daily care
De Duiter and Liaschenko (2011) examined the factors that influence the judgment of nurses on how to move patients. They found out that the complexity of everyday care, patient treatment goals, time, and knowledge all influenced how nurses moved patients. The study also showed that almost all lifting equipment use needed a certain degree of manual handling. These findings suggest the need to take into account the professional judgment and autonomy of nurses on how to best handle certain situations (De Ruiter &

Liaschenko, 2011). The research also showed the conflict between patient goals achievement and exposure of nurses to injury risk, suggesting that nurses' focus on minimizing injury risk would compromise patient care. This highlights the need to acknowledge that the safety and interests of patients are closely interconnected with caregivers' safety (De Ruiter & Liaschenko 2011). Also, the study found that conditions of patients change rapidly over time, generally rendering irrelevant the best plans for moving them. Nurses are forced to make quick judgments to adjust to acute situations. These factors should be taken into account when developing guidelines on safe patient handling (De Ruiter & Liaschenko, 2011).

Barriers in implementing effective patient handling devices
Lack of space for equipment use and non-availability of equipment have been identified as significant barriers to equipment use. Evidence also shows that nurses tend to be reluctant to use equipment that has failed in the past. Failure to take into account equipment failure is likely to expose patients and nurses to a higher risk of injury when the inevitable malfunction takes place. This risk can be minimized through ensuring equipment availability at the bedside and incorporating problem-solving into training (De Ruiter & Liaschenko, 2011). Noble and Sweeney (2018) found out that environmental, organizational, situational, and interpersonal influences directly or indirectly affect workers' commitment to or actual use of assistive devices. Time constraints were also found associated with less likelihood of the use of assistive devices. In another study, Koppelaar and colleagues (2011) found out that inclusion of guidelines and protocols of care, back pain presence in the last year, and nurse motivation were the strongest determinants of the use of lifting devices. They also found out that organizational factors, such as easy accessibility and convenience, supportive management climate, and management support, were linked to these determinants (Koppelaar et al., 2011). Similarly, Aslam and colleagues (2015) found that policy change, educational approaches, and technological interventions were all effective in reducing worker injuries and improving their safety. They also found out that these factors were associated with reduced worker compensation costs (Aslam, Davis, Felman, & Martin, 2015).

Karahan and Bayraktar (2004) identified the factors that contributed to the high rates of lower back pain among Turkish nurses, including heavy lifting, wearing high heels and incorrect use of body mechanics. In another study, Andersen et al. (2014) found out that daily patient transfers, history of a back injury, and pain, as perceived influence and seniority at work, were associated with increased back injury risk. Additionally, Al-Eisa and Al-Abbad (2013) identified the lack of workplace patient handling policy as significant risk factors for lower back pain development while regular exercise was a protective factor. Moreover, factors such as patients in isolation, inexperience in lift use, and high staff turnover are barriers to compliance. This suggests the need for incentive programs and additional training to promote compliance with these devices. Also, the adoption of no manual handling policies is likely to promote compliance with patient handling and mobility devices (Li et al., 2004).

Strengths and limitations
This integrative literature review has various strengths. The studies reviewed were from different countries worldwide, suggesting that the findings are representative of a global population and can be applied to improve safe patient handling and mobility practices anywhere in the world. The used of various study designs in the reviewed studies is also an advantage. Also, most of the reviewed publications were current, suggesting that this review provides up-to-date evidence. However, there are some limitations. Some of the studies raised data quality concerns due to use of administrative data; lack of information of detailed injury and demographic characteristics of the subjects; and the short duration of pre- and post-intervention that made it difficult to identify general injury rate trends (Black et al., 2011). Another limitation is that some participants knew they were being observed, suggesting that they may have demonstrated more mindfulness of their posture during the study than during their typical work shift. This shows that the findings reported in the study may not be a true reflection of what actually happens on the ground (Hodder et al., 2010). In addition, some studies used small sample sizes, which suggest the need for well-designed studies with larger sample sizes to yield more reliable results (De Ruiter & Liaschenko, 2011; Li et al., 2004). One study used a quasi-experimental design for their study, suggesting the need for randomized controlled trials to confirm their findings before they can be applied in clinical practice (Lim et al., 2011).

Implications
The findings of this review highlight the significance of manual handling training programs and the consistent use of lifting devices in low back pain prevention. Healthcare organizations should focus on training their direct healthcare providers to increase their knowledge of safe patient handling and mobility. This training must increase knowledge and lead to positive change in behavior (Karahan & Bayraktar, 2013). Research highlights the need for occupational health professionals to work together with hospital administrators and nurse educators to equip nurses with essential competence, knowledge, and skills to execute patient handling and mobility activities safely (Vendittelli et al., 2016). Additionally, there is a need to address the barriers to lifting device implementation and use to minimize the risk of lower back pain in this nurse population.

CONCLUSION
Manual handling training programs and the use of patient lifting equipment are effective in preventing lower back pain among nurses. This is supported by several studies conducted globally. These studies have consistently revealed a reduction in patient-handling injuries after the implementation of education and training programs. The training which incorporates some strategies such as body mechanics, transferring and lifting techniques, that have been employed to reduce musculoskeletal disorder among nursing personnel, are effective.

There are several strategies to reduce risks such as the provision of safety climate, promotion of adequate lifting equipment, and ensure its availability and accessibility to healthcare workers and improving nurse's compliance with the proper use of lifting devices and transfer of patients. Hospital organizations hospitals should increase their

focus on environmental and organization aspects to create a safety culture that entails the safe execution of patient handling and mobility tasks. Safe patient handling and mobility programs should address these factors to improve compliance and effectiveness of their interventions.

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CONFLICT OF INTEREST
The authors declare no conflict of interest.

REFERENCES
Al-Eisa, E., & Al-Abbad, H. (2013). Occupational back pain among rehabilitation nurses in Saudi Arabia. *Workplace Health Safety, 61*(9), 401-407.

Andersen, L. L., Burdorf, A., Fallentin, N., Persson, R., Jakobsen, M. D., Mortensen, …, & Holtermann, A. (2014). Patient transfers and assistive devices: prospective cohort study on the risk for occupational back injury among healthcare workers. *Scand J Work Environ Health*, *40*(1),74-81. doi:10.5271/sjweh.3382.

Aslam, I., Davis, S. A., Felman, S. R., & Martin, W. E. (2015). A review of patient lifting interventions to reduced healthcare worker injuries. *Workplace Health and Safety, 63*(6), 267-275.

Black, T. R., Shah, S. M., Busch, A. J., Metcalfe, J., & Lim, H. J. (2011). Effect of transfer, lifting, and repositioning (TLR) injury prevention program on musculoskeletal injury among direct care workers. *Journal of occupational and environmental hygiene*, 8(4), 226-25.

Burdorf, A., Koppelaar, E., & Evanoff, B. (2012). Assessment of the impact of lifting device use on low back pain and musculoskeletal injury claims among nurses. *Occupational and Environmental Medicine, 70,* 491-497.

Center for Evidence Based Management. (2014). Critical appraisal checklist for cross-sectional study. Retrieved from https://www.cebma.org/resources-and-tools/ what-is-critical-appraisal/

De Souza, M. T., Da Silva, M. D., & De Carvalho, R. (2010). Integrative review: What is it? How to do it? *Einstein, 8*(1), 102-106.

De Ruiter, H-P., & Liaschenko, J. (2011). To lift or not to lift: Patient-handling practices. *AAOHN Journal, 59*(8), 337-344.

Garg, A., & Kapellusch, J. M. (2012). Long-term efficacy of an ergonomics program that includes patient-handling devices on reducing musculoskeletal injuries to nursing personnel. *Human Factors and Ergonomics Society, 54*(4), 608-625.

Hodder, J. N., MacKinnon, S. N., Ralhan, A., & Keir, P. J. (2010). Effects of training and experience on patient transfer biomechanics. *International Journal of Industrial Ergonomics, 40,* 282-288.

Humrickhouse, R, & Knibbe ,H,J (2016). The importance of Safe Patient Handling to Create a Culture of Safety: An Evidential Review. *The Ergonomics Open Journal, 9(1),* 27-42.

Jaromi, M., Nemeth, A., Kranicz, J., Laczko, T., & Betlehem, J. (2012). Treatment and ergonomics training of work-related lower back pain and body posture problems for nurses. *Journal of Nursing, 21,* 1776-1784.

Karahan, A., & Bayraktar, N. (2004). Determination of the usage of body mechanics in clinical settings and the occurrence of low back pain in nurses. *International Journal of Nursing Studies, 41,* 67-75l

Karahan, A., & Bayraktar, N. (2013). Effectiveness of an education program to prevent nurses' low back pain: An interventional study in Turkey. *Workplace Health & Safety, 61*(2), 73-79.

Koppelaar, E., Knibbe, J. J., Miedema, H. S., & Burdorf, A. (2011). Individual and organizational determinants of use of ergonomic devices in healthcare. *Occupational and Environmental Medicine, 68,* 659-665.

Lee, S., Faucett, J., Gillen, M., & Krause, N. (2013). Musculoskeletal pain among critical-care nurses y availability and use of patient lifting equipment: An analysis of cross-sectional survey data. International Journal of Nursing Studies, 50(12), 1648-1657.

Lee, S-J., & Lee, J. H. (2017). Safe patient handling behaviors and lift use among hospital nurses: A cross-sectional study. *International Journal of Nursing Studies, 74,* 53-60.

Li, J., Wolf, L., & Evanoff, B. (2004). Use of mechanical patient lifts decreased musculoskeletal symptoms and injuries among helath care workers. Injury Prevention, 10(44), 212-216.

Lim, H. J., Black, T. R., Shah, S. M., Sarker, S., & Metcalfe, J. (2011). Evaluating repeated patient handling injuries following the implementation of a multi-factor ergonomic intervention program among health care workers. *Journal of Safety Research, 42,* 185-191.

McDermott, H., Haslam, C., Clemes, S., Williams, C., & Haslam, R. (2012). Investigation of manual handling training practices in organization and beliefs regarding effectiveness. *International Journal of Industrial Ergonomics, 42,* 206-211.

Movahedi, M., Ghafari, S., Nazari, F., & Valiani, M. (2017). The effects of acupressure on pain severity in female nurses with chronic low back pain. *Iranian Journal of Nursing and Midwifery Research, 22*(5), 339-342.

Nadelson, S. S., & Nadelson, L. S. (2014). Evidence based practice article reviews using CASP tools: A method for teaching EBP. *Worldviews on Evidence-Based Nursing, 2014,* 1-3.

Noble, N. L., & Sweeney, N. L. (2018). Barriers to the use of assistive devices in patient. *Continuing Education, 66*(1), 41-48.

Rasmussen, C. D. N., Holtermann, A., Bay, H., Sogaard, K., & Jorgensen, M. B. (2015). A multifaceted workplace intervention for low back pain in nurses' aides: A pragmatic stepped wedge cluster randomized controlled trial. *Pain, 156,* 1786-1794.

Resnick, M. L., & Sanchez, R. (2009). Reducing patient handling injuries through contextual training. *Journal of Emergency Nursing, 35,* 504-508.

Risor, B. W., Casper, S. D., Andersen, L. L., & Sorensen, J. (2017). A multi-component patient-handling intervention improves attitudes and behaviors for safe patient handling and reduces aggression experienced by nursing staff: A controlled before-after study. *Applied Ergonomics, 60,* 74-82.

Russell, C. L. (2005). An overview of the integrative research review. *Progress in Transplantation, 15,* 1-7.

Sanjoy, S. S., Ahsan, G. U., Nabi, H., Joy, Z.F., & Hossain, A. (2017). Occupational factors and low back pain: A cross-sectional study of Bangladeshi female nurses. *BMC Research Notes, 10,* 173-178.

Schoenfisch, A. L., Lipscomb, H. J., Pompeii, L. A., Myers, D. J., & Dement, J. M. (2013). Musculoskeletal injuries among hospital patient care staff before and after implementation of patient lift and transfer equipment. *Scandinavian Journal of Work, Environment, and Health, 39*(1), 27-36.

Sharafkhani, N., Khorsandi, M., Shamsi, M., & Ranjbaran, M. (2014). Low back pain preventive behaviors among nurses based on the health belief model constructs. *SAGE Open, 2014,* 1-7.

Shojaei, S., Tavafian, S. S., Jamshidi, A, R., & Wagner, J. (2017). A multidisciplinary workplace intervention for chronic low back pain among nursing assistants in Iran. *Asian Spine Journal, 11*(3), 419-426.

Sikiru, L & Hanifa, S. (2010). Prevalence and risk factors of low back pain among nurses in a typical Nigerian hospital. *African Health Science. 10(1),* 26-30.

Theis, J. L., & Finkelstein, M. J. (2014). Long-term effects of safe patient handling program on staff injuries. *Rehabilitation Nursing, 39,* 26-35.

Tosunoz, I. K., & Oztunc, G. (2017). Lower back pain in nurses. *International Journal of Caring Sciences, 10*(3), 1728-1732.

Vendittelli, D., Penprase, B., & Pittiglio, L. (2016). Musculoskeletal injury prevention for new nurses. *Workplace Health and Safety, 64*(12), 573-585.

Whittemore, R., & Knafl, K. (2005). The integrative review: Updated methodology. *Journal of Advanced Nursing, 52*(5), 546-553.