The effect of manual handling training on transferring knowledge, employee’s behaviour change and subsequent reduction of work-related musculoskeletal disorders: a systematic review

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The effect of manual handling training on transferring knowledge, employees’ behaviour change and subsequent reduction of work-related musculoskeletal disorders: a systematic review

This systematic review investigated the effectiveness of manual handling training at transferring knowledge, leading to a positive change in employee’s manual handling behaviour and a reduction of WRMSDs following training. Six electronic databases were searched for randomised controlled trials, non-randomised controlled trials or cohort studies with a control and/or comparison group which investigated the effectiveness of manual handling training. Thirteen articles met the inclusion and exclusion criteria. Following quality assessment, nine of the included articles were found to be high quality. This systematic review suggests that there has been very little research focusing on the effectiveness of manual handling training on transferring knowledge to employee’s and behavioural change. This review indicates that whilst employees report understanding and awareness following training, this does not always lead to the expected behavioural change. This review also suggests it cannot be demonstrated that transferring knowledge to employees will lead to a reduction of WRMSDs.

Keywords: transferring knowledge to employees; behavioural change; occupational low back pain; manual handling training; systematic review.

Practitioner Summary: This systematic review investigated the effect of manual handling training on behavioural change and WRMSDs. Thirteen articles met the inclusion and exclusion criteria. Overall, the evidence suggests manual handling training is not effective at causing a change in employee’s manual handling behaviour following training or at reducing WRMSDs.
1. Introduction

Musculoskeletal disorders “include a wide range of inflammatory and degenerative conditions affecting the muscles, tendons, ligaments, joints, peripheral nerves and supporting blood vessels” (Punnett and Wegman 2004). Musculoskeletal disorders have a multi-causal aetiology including the individual’s characteristics, psychosocial and physical factors (Kumar 2001). In the work context, they can be caused or aggravated by many physical hazards, including manual handling and excessive static work load, and also by psychosocial hazards and are termed Work Related Musculoskeletal Disorders (WRMSDs). Within Europe, backache has been reported as the most prevalent work-related health problem by workers (Schneider et al. 2010). WRMSDs can result in direct and indirect financial costs for the employer (i.e. increases in insurance premiums, decreased productivity) and employee (i.e. loss of earnings). They can also result in a negative impact on the employee’s quality of life (Punnett and Wegman 2004). When manual handling tasks cannot be avoided in the workplace, the provision of manual handling training to employees is an essential element of the control of manual handling risks, i.e. possible injury. Therefore, the requirement for appropriate training in relation to manual handling has been outlined in Council Directive 90/269/EEC - manual handling of loads and has been included in the national legislation of European Union member states. A systematic review by Burdorf and Sorock (1997), showed that 16 out of 19 studies reported a positive association between back disorders and manual handling in the workplace. The risk estimates ranged from 1.12 to 3.07 with attributable fractions between 11 percent and 54 percent. Punnett et al. (2005) discussed that globally, 37 percent of low back pain is attributed to occupational risk factors i.e. heavy lifting and whole body vibration.
Goldstein (1991) defined training as “the systematic acquisition of attitudes, concepts, knowledge, rules of skills that result in improved performance at work”. From this definition, it can be inferred that there is an expectation that training should result in the acquisition of knowledge which results in changes to how the task is completed. The following theory, by Fitts (1962), details that the method by which individuals acquire new and complex skills can be broken down into three stages. The first stage is skill development “where the learner needs to understand what the task will involve and so needs appropriate details”. Following on from this is the associative stage, “where practice will help the learner to improve on association between knowledge and application”. Finally, the autonomous stage is “where the skill becomes automatic” and requires less attention whilst using the new skill (Matthewman et al. 2009, p.283). The Training Transfer Framework model proposed by Baldwin and Ford (1988) described the elements that allow for transferring knowledge to employees and, subsequently, for behaviour change to occur as dependent on the training design, trainee characteristics and work-environment characteristics. The theory indicates that if transfer of knowledge to employees occurs during the delivery of manual handling training, this should result in a decrease in “at-risk” behaviours which combined with proper work-environment characteristics should lead to a reduction in adverse bio-mechanical exposures. This in turn should result in decreased prevalence and severity of WRMSDs.

Previous systematic and narrative reviews have been completed to investigate the effectiveness of manual handling training relating to the reduction of back pain and back injury (Haslam et al. 2007, Clemes et al. 2010, Verbeek et al. 2011). The findings of these reviews have been negative overall in relation to the effectiveness of manual handling training at reducing back pain and back injury. Clemes et al. (2010) reported “there is little evidence for the effectiveness of educational- and technique-based manual handling training in all industries.” The authors discussed that interventions including physical activity show
promise, however, they feel further research is needed in this area. They also discussed a pressing need for “high-quality randomized control trials, involving sufficiently large samples and incorporating long term follow-up periods” (Clemes et al. 2010). Verbeek et al. (2011) reported “the studies included in this review do not provide evidence that training and advice prevent back pain when compared to no intervention or another intervention”. Both these reviews emphasise that the quality of the current literature is an issue and that further research in the area needs to be more robust. The primary focus of these reviews was on the effectiveness of manual handling training on the reduction of back pain and back injury with no or little emphasis on transferring knowledge to employees and their behavioural change following manual handling training.

The aim of this review was to investigate, from the published scientific literature, if manual handling training is effective at transferring knowledge to employees and, subsequently, causing a positive change in employee’s manual handling behaviour following training, leading to a reduction of WRMSDs. This information is essential to understand if the theoretical expectations of training around transferring knowledge to employees and subsequent behavioural change are transferred into practice. Therefore, from the authors’ perspective, to determine the effectiveness of manual handling training, a holistic approach must be taken which allows evaluation beyond just the physical risk factors. This would allow the investigation of employee knowledge and behavioural change as potential causal links between manual handling training and reduction of WRMSDs.
2. Methods

2.1. Inclusion and exclusion criteria

The study design of all eligible articles had to be experimental (randomised controlled trials), quasi-experimental (non-randomised controlled trials, controlled before and after studies) or cohort studies with a control and/or comparison group as these study designs were considered to produce the strongest scientific evidence in this context. The focus of the intervention had to be on education/training around manual handling or patient handling. Interventions can also use an integrated approach by assessing the effectiveness of manual handling training and other preventative methods i.e. lumbar support, physical exercise etc on the reduction and/or prevention of WRMSDs. To be included in this systematic review interventions with an integrated approach needed to investigate the education/training aspect individually in comparison with a control group without education/training, so the effect of education/training could be clearly determined.

All quantitative study types without a comparison and/or control group, laboratory based assessments of the effectiveness of manual handling training and qualitative studies were excluded from the review. Participants were working age adults, (aged 16 to 70 years), both male and female, who through their work or training, engaged in manual handling or patient handling tasks.

The outcome of this review was the effectiveness of manual handling training at transferring knowledge to employees and, subsequently, potentially causing a positive change in employee’s manual handling behaviour following training, potentially leading to a reduction of WRMSDs.
2.2. Literature Search

The following six electronic databases were searched up until 21 March 2013: Pubmed, Embase, CENTRAL (Cochrane Central Register of Controlled Trials), CINAHL, EBSCO and Web of Science. Within the EBSCO database, the following databases were searched: SocINDEX with Full Text, PsychINFO and Psychology & Behavioral Sciences Collection. The literature search also involved manually hand searching the references of all potentially eligible articles found to check for further eligible articles. Only articles published in peer-reviewed journals in the English language were accepted. Therefore, book chapters, conference papers, government documents and other grey literature were excluded.

Prior to completion of the literature search, the following keywords were decided upon as the search words for this review: ‘low back pain’, ‘back pain’, ‘back ache’, ‘musculoskeletal disorder’, ‘lifting’, ‘pulling’, ‘pushing’, ‘manual handling’, ‘manual materials handling’, ‘ergonomics’, ‘education’ and ‘training’. Different formats of these keywords were used to search each database with the separation of the Boolean Logic terms (AND, OR, AND NOT) when applicable.

The following search string developed and validated by Verbeek et al. (2005) was used in each search on each database, as it was determined to be the most sensitive search strategy for retrieving studies of occupational health interventions: “(effect* [tw] OR control* [tw] OR evaluation* [tw] OR program* [tw]) AND (work* [tw] OR occupation* [tw] OR prevention* [tw] OR protect*[tw])” (Verbeek et al. 2005).

2.3. Data extraction & management

All the search results were reviewed for duplicates both by reference management software and manually by the assessor (DH). For all the articles found during the search, both the titles and abstracts were scanned to allow the selection of potentially eligible articles. The full text
of each of these potentially eligible articles was reviewed to determine the appropriateness of the article for inclusion in the current review.

2.4. Quality Assessment

The quality of each included article was assessed using the Downs and Black (1998) checklist for measuring the methodological quality of the study. This checklist was developed and validated to determine the quality of both randomised and non-randomised interventions, specifically, in health care. This checklist assessed reporting, external validity, internal validity (bias & confounding) and power of the study. Each of the 27 questions within this checklist had a clear “Yes/No” answering scale, with “Yes” assigned a score of one and “No” assigned a score of zero. A number of questions also contained the option of “Unable to Determine” which was also assigned a score of zero. One question relating to detail of principal confounders was scored differently with an answer of “Yes” assigned a score of two, an answer of “Partially” scored as one and “No” assigned a score of zero.

This review used a modified version of this scale, which as of 5th October 2013, was available on the Spinal Cord Injury Rehabilitation Evidence (SCIRE) project website. This modified scale adapted the final question relating to the power of the study, which had originally been scaled 0 – 5 and changes it to a scale of 0 – 1, “where 1 was scored if a power calculation or sample size calculation was present while 0 was scored if there was no power calculation, sample size calculation or explanation whether the number of subjects was appropriate”. This revised checklist had a scoring scale which ranged from 0 – 28. This quality assessment was completed to allow for critical appraisal of the findings of each article i.e. weigh the evidence by the strength of the study quality score.
2.5. Data Synthesis

For this review, narrative synthesis was used as the methodology to synthesis the findings of all the included articles, which related to the outcomes of interest in this review i.e. the effectiveness of manual handling training at transferring knowledge to employees and, subsequently, causing a positive change in employee’s manual handling behaviour following training, leading to a reduction of WRMSDs. The findings of each included article were extracted and the narrative synthesis was then completed with the aim of describing the findings in each article which related to the outcomes of interest in this review.

3. Results

3.1. Results of the literature search

The six databases searched yielded 209 articles in total. Following the removal of 40 duplicates across databases, 169 articles remained. These articles were screened for eligibility to be included in this review based on title and abstract. Of the 169 articles screened, 40 articles emerged as potentially eligible. The full text for each of these potentially eligible articles was obtained and reviewed. Of these 40 articles, five articles were accepted as eligible for this review based on the predetermined inclusion and exclusion criteria (Best 1997, Yassi et al. 2001, Fanello et al. 2002, Hartvigsen et al. 2005, Warming et al. 2008).

The reference lists of each of the 40 eligible articles were manually hand searched to determine further eligible articles. Following screening of the title alone, another 39 articles emerged as potentially eligible. After subsequent review of the abstracts, seven of the 39 articles were deemed to be potentially eligible (Videman et al. 1989, Reddell et al. 1992, Feldstein et al. 1993, Daltroy et al. 1997, van Poppel et al. 1998, Johnsson et al. 2002, Jensen
et al. 2006). The full text of these articles was obtained, reviewed and all were accepted as eligible for this review based on the same criteria as previous.

The reference lists of these seven articles were manually hand searched to determine further eligible articles. Following screening of the title alone, another 12 articles emerged as potentially eligible. Following subsequent review of the abstracts, only one of these articles was deemed to be potentially eligible. The full text of this article was obtained, reviewed and accepted as eligible for this review based on the same criteria as previous. No further articles were deemed to be potentially eligible. In conclusion, 13 eligible articles were included in this review (Videman et al. 1989, Reddell et al. 1992, Daltroy et al. 1993, Feldstein et al. 1993, Best 1997, Daltroy et al. 1997, van Poppel et al. 1998, Yassi et al. 2001, Fanello et al. 2002, Johnsson et al. 2002, Hartvigsen et al. 2005, Jensen et al. 2006, Warming et al. 2008) (Figure 1).
209 records identified through database searching

169 of records after duplicates

169 of records screened

130 of records screened

39 of records excluded based on title

90 of records excluded based on abstract

35 of full text articles excluded
- 1 article – Population
- 6 articles – Outcome of interest
- 22 articles – Intervention / Study Design
- 6 articles – Systematic / Narrative Reviews

40 of full-text articles assessed for eligibility

5 articles included in synthesis

Reference searching of all full text screened articles identified a further 8 articles for inclusion

13 articles included in synthesis

Figure 1: Flow chart of article selection process
3.2. Characteristics of the included articles

Of the 13 included articles, nine were randomised controlled trials, (Reddell et al. 1992, Daltroy et al. 1993, Best 1997, Daltroy et al. 1997, van Poppel et al. 1998, Yassi et al. 2001, Fanello et al. 2002, Jensen et al. 2006, Warming et al. 2008). The other four were controlled trials (non-randomised) (Videman et al. 1989, Feldstein et al. 1993, Johnsson et al. 2002, Hartvigsen et al. 2005). Two of the included articles were based on the same randomised controlled trial with one reporting the effect on transferring knowledge to employees and employee behavioural change (Daltroy et al. 1993) and the other reporting the effect of the trial on low back injuries (Daltroy et al. 1997).

Nine of the included articles were completed in the healthcare sector (Videman et al. 1989, Feldstein et al. 1993, Best 1997, Yassi et al. 2001, Fanello et al. 2002, Johnsson et al. 2002, Hartvigsen et al. 2005, Jensen et al. 2006, Warming et al. 2008), with the other four completed in the postal service (Daltroy et al. 1993, Daltroy et al. 1997) and aviation industry (Reddell et al. 1992, van Poppel et al. 1998). Within the 13 articles, the participants in 12 of the articles were employees of the organisation, with one article using nursing students as the study population (Videman et al. 1989).


Daltroy et al. (1993) had “knowledge about safe lifting and posture” and behaviour change measures within its outcomes of interest, with Warming et al. (2008) investigating knowledge of transfer technique. Both Best (1997) and Videman et al. (1989) had ‘observed handling behaviour’ within their outcomes of interest. Twelve of the included articles had
either ‘low back pain’ or ‘back pain’ within their outcomes of interest. The final included article focused on injury rates (Reddell et al. 1992).

Seven of the included articles compared the intervention(s) under investigation to a “placebo” i.e. a less intense form of training or usual routine (Videman et al. 1989, Daltroy et al. 1993, Best 1997, Daltroy et al. 1997, Yassi et al. 2001, Hartvigsen et al. 2005, Warming et al. 2008). Four of the included articles compared the intervention(s) under investigation to a control undergoing no planned training (Reddell et al. 1992, Feldstein et al. 1993, van Poppel et al. 1998, Fanello et al. 2002). Jensen et al. (2006) compared the interventions under investigation to a control group undergoing unrelated training of their own choice i.e. chemical safety. The final article compared two models of learning relating to the training of patient moving and handling skills (Johnsson et al. 2002).

Eight of the included articles compared one intervention group to one control group. However, five of the included articles had more than one intervention group i.e. comparing lumbar support, training or combination of lumbar support & training (Reddell et al. 1992, van Poppel et al. 1998), training or training combined with physical fitness training (Warming et al. 2008), different levels of access to and training in the use of low tech ergonomic equipment (Yassi et al. 2001) and psychosocial intervention or transfer training intervention (Jensen et al. 2006) (Table 1).
Table 1: Characteristics of included articles

<table>
<thead>
<tr>
<th>Study ID</th>
<th>Study Design</th>
<th>Setting</th>
<th>Duration</th>
<th>Participants and Inc/Exc criteria</th>
<th>Intervention</th>
<th>Comparison</th>
<th>Outcomes</th>
</tr>
</thead>
</table>
| Best 1997     | Cluster RCT  | Three nursing homes in Melbourne            | 12 months         | Nurses and allied staff (n=55)    | None stated                          | Hospital orientation & a 32 hour training course | In-house orientation training | • Self-reported Back Pain  
• MH Behaviour (observations) |
| Daltory et al. 1993 | RCT         | Postal service                              | 2.5 years into a 5.5 year study | Random sample of 209 workers from 4,000 postal workers at two mail processing facilities | Inc. Mail handlers, maintenance workers and clerks | “Back Schools” with follow up training | No training | • Knowledge about safe lifting and posture / Perceived controllability of back safety  
• Worker and supervisor helping and reinforcement of safe lifting behaviours  
• Lifting on the job, posture on the job and exercise/stress reduction off the job / Having a tried back at the end of the day (all self-reported measures) |
| Daltroy et al. 1997 | RCT         | Postal service                              | 5.5 years         | 4,000 postal workers at two mail processing facilities. | Inc. Mail handlers, maintenance workers and clerks | “Back Schools” with follow up training | No training | • Rates of Primary Low Back Injury / Other musculoskeletal injuries (company accident-report data) / Primary prevention of low back injury |
| Fanello et al. 2002 | RCT         | Regional Hospital of Le Mans (France)        | 2 years           | 136 ‘non-trained’ employees & 136 ‘trained’ employees. | Inc. Cleaning staff, nursing assistants and nurses | Theoretical lifting instruction (advice during work tasks) | No training | • Self-reported back pain in the presence of occupational health physician |

Note: RCT – randomised controlled trial; NRCT – non-randomised controlled trial; Inc/Exc criteria – inclusion/exclusion criteria; MH – manual handling; PH – patient handling
## Table 1: Characteristics of included articles

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<th>Inc/Exc criteria</th>
<th>Intervention</th>
<th>Comparison</th>
<th>Outcomes</th>
</tr>
</thead>
</table>
| Feldstein et al. 1993 | NRCT         | Two medical centres                          | 1 month  | 55 nurses, aides and orderlies            | Inc. Nurses, aides and orderlies           | Training in lifting, body mechanics etc.                                    | No training                                                              | • Composite back pain  
• Composite fatigue (both self-reported)                                       |
| Hartvigsen et al. 2005 | NRCT         | 4 Danish municipalities                       | 2 years  | 345 home care nurses and nurses’ aids     | Inc. Home care nurses and nurses’ aids     | An educational and low-tech ergonomic intervention programme                | Once off three hour instruction in lifting technique                      | Number of days with self reported LBP during the past year  
Number of episodes of LBP  
• Care seeking for LBP during the past year                                             |
| Jensen et al. 2006      | RCT          | 3 Danish eldercare wards                     | 6 months | 210 home care workers, nurses & nurse’s aides | Inc. Permanent staff engaged in client care at the 3 wards | Transfer Technique or Stress Management Intervention | Training in an unrelated topic i.e. skin care, chemical safety | • Self-reported LBP  
• Self reported perceived physical and mental exertion                               |
| Johnsson et al. 2002      | NRCT         | One medical area of Stockholm County Council | 6 months | 51 nurses, occupational therapists and physio-therapists | None stated                                | Traditional training groups                                                | Quality circles                                                          | • Prevalence of MS problems, job strain and perceived exertion (self-reported) |
| Reddell et al. 1992       | RCT          | Four international airports                  | 8 months | 642 fleet service clerks                 | None stated                                | Weightlifting belt, training class & both together                        | No training or weightlifting belt                                       | • Injury incident rate (company statistics)                                   |

Note: RCT – randomised controlled trial; NRCT – non-randomised controlled trial; Inc/Exc criteria – inclusion/exclusion criteria; MH – manual handling; PH – patient handling
<table>
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<th>Intervention</th>
<th>Comparison</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Van Poppel et al. 1998</td>
<td>RCT with a factorial design</td>
<td>Cargo department of a Dutch airline in Schiphol Airport</td>
<td>6 months</td>
<td>312 workers whose job included MH.</td>
<td>Exc. workers with work disability</td>
<td>Education or lumbar support &amp; both together</td>
<td>No education or lumbar support</td>
<td>• Lower back pain incidence (self-reported).</td>
</tr>
<tr>
<td>Videman et al. 1989</td>
<td>NRCT</td>
<td>Nursing School</td>
<td>3 years follow up for both groups</td>
<td>Nursing students</td>
<td>None stated</td>
<td>40 hours of both practical and theoretical training spread over 2.5 years.</td>
<td>Traditional form of training</td>
<td>• Observed patient handling skill</td>
</tr>
<tr>
<td>Warming et al. 2008</td>
<td>Cluster RCT</td>
<td>Bispebjerg University Hospital, Copenhagen</td>
<td>12 months</td>
<td>337 nurses on wards with no previous patient transfer technique.</td>
<td>Exc. temp &amp; retired nurses, in a job-change situation, on long-term leave, with no patient contact &amp; pregnant nurses</td>
<td>Transfer technique education programme alone or in combination with physical fitness training.</td>
<td>Follow usual routine</td>
<td>• Perceived LBP</td>
</tr>
<tr>
<td>Yassi et al. 2001</td>
<td>RCT</td>
<td>An acute and tertiary care hospital in Canada</td>
<td>1 year</td>
<td>346 nurses and unit assistants</td>
<td>Exc. float pool staff</td>
<td>No strenuous lifting arm &amp; safe lifting arm</td>
<td>Control arm (usual practice)</td>
<td>• Frequency of PH tasks / Self-perceived frequency &amp; intensity of physical discomfort associated with various PH tasks</td>
</tr>
</tbody>
</table>

Note: RCT – randomised controlled trial; NRCT – non-randomised controlled trial; Inc/Exc criteria – inclusion/exclusion criteria; MH – manual handling; PH- patient handling
3.3. Findings of the Quality Assessment

The methodology of quality assessment used in this review was similar to the methodology used in the previous systematic review by Clemes *et al.* (2010). Within the quality assessment, 49 percent or below was taken to describe articles of poor quality, with 50 to 59 percent describing articles of fair quality and 60 to 69 percent describing articles of good quality. To be determined as excellent quality, articles needed to score 70 percent or greater.

The quality assessment was completed twice with a timeframe of six months between each assessment. This was completed to ensure the reliability of the quality score and resulted in very little difference to the quality score for each article.

Following quality assessment, three of the included articles obtained a percentage greater than 70, which showed them to be of excellent quality (*Daltroy et al.* 1993, van Poppel *et al.* 1998, Hartvigsen *et al.* 2005). Seven of the included articles obtained a percentage between 61 and 68 which showed them to be of good quality (*Reddell et al.* 1992, Feldstein *et al.* 1993, Daltroy *et al.* 1997, van Poppel *et al.* 1998, Yassi *et al.* 2001, Jensen *et al.* 2006, Warming *et al.* 2008). Three of the included articles obtained a percentage between 50 and 54 which showed them to be of fair quality (*Best* 1997, Fanello *et al.* 2002, Johnsson *et al.* 2002). The non – randomised controlled trial on nursing students, by Videman *et al.* (1989), obtained the lowest quality assessment percentage of 36, therefore, this article was described as poor quality (Table 2).
<table>
<thead>
<tr>
<th>Study ID</th>
<th>Study Design</th>
<th>Reporting (out of 10)</th>
<th>External Validity (out of 3)</th>
<th>Internal validity – bias (out of 7)</th>
<th>Internal validity – confounding (out of 6)</th>
<th>Power (out of 1)</th>
<th>Study Quality Score (out of 28)</th>
<th>Study Quality Percentage (out of 100%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Best 1997</td>
<td>Cluster RCT</td>
<td>6</td>
<td>1</td>
<td>5</td>
<td>2</td>
<td>0</td>
<td>14</td>
<td>50%</td>
</tr>
<tr>
<td>Daltroy et al. 1993</td>
<td>RCT</td>
<td>8</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>1</td>
<td>20</td>
<td>71%</td>
</tr>
<tr>
<td>Daltroy et al. 1997</td>
<td>RCT</td>
<td>7</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>1</td>
<td>19</td>
<td>68%</td>
</tr>
<tr>
<td>Fanello et al. 2002</td>
<td>RCT</td>
<td>6</td>
<td>1</td>
<td>4</td>
<td>3</td>
<td>0</td>
<td>14</td>
<td>50%</td>
</tr>
<tr>
<td>Feldstein et al. 1993</td>
<td>NRCT</td>
<td>8</td>
<td>1</td>
<td>6</td>
<td>4</td>
<td>0</td>
<td>19</td>
<td>68%</td>
</tr>
<tr>
<td>Hartvigsen et al. 2005</td>
<td>NRCT</td>
<td>9</td>
<td>2</td>
<td>5</td>
<td>4</td>
<td>0</td>
<td>20</td>
<td>71%</td>
</tr>
<tr>
<td>Jensen et al. 2006</td>
<td>RCT</td>
<td>9</td>
<td>1</td>
<td>5</td>
<td>3</td>
<td>0</td>
<td>18</td>
<td>64%</td>
</tr>
<tr>
<td>Johnsson et al. 2002</td>
<td>NRCT</td>
<td>6</td>
<td>1</td>
<td>5</td>
<td>3</td>
<td>0</td>
<td>15</td>
<td>54%</td>
</tr>
<tr>
<td>Reddell et al. 1992</td>
<td>RCT (randomised [complete] block design)</td>
<td>8</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>17</td>
<td>61%</td>
</tr>
<tr>
<td>Van Poppel et al. 1998</td>
<td>RCT with factorial design</td>
<td>9</td>
<td>1</td>
<td>4</td>
<td>5</td>
<td>1</td>
<td>20</td>
<td>71%</td>
</tr>
<tr>
<td>Videman et al. 1989</td>
<td>NRCT</td>
<td>5</td>
<td>1</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>10</td>
<td>36%</td>
</tr>
<tr>
<td>Warming et al. 2008</td>
<td>Cluster RCT</td>
<td>8</td>
<td>2</td>
<td>5</td>
<td>4</td>
<td>0</td>
<td>17</td>
<td>61%</td>
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<tr>
<td>Yassi et al. 2001</td>
<td>RCT</td>
<td>7</td>
<td>2</td>
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<td>64%</td>
</tr>
</tbody>
</table>
3.4. Findings of the Data Synthesis

To interpret the findings of this review, the evidence was weighted by the strength of the study quality as determined in the quality assessment. Of the thirteen included articles, five reported findings related to transferring knowledge to employees and behavioural change which showed a comparison between the intervention(s) group and the control group. The randomised controlled trial by Warming et al. (2008), showed an improvement in knowledge of patient transfer technique in the intervention group when completing a per protocol analysis. However, this improvement did not exist when an intention to treat analysis was completed. Daltroy et al. (1993) and Daltroy et al. (1997), reported evidence of transferring knowledge to employees, however, not to the level expected within the intervention group which was still only at 50 percent. Following on from this, there was no evidence of employee behavioural change. Hartvigsen et al. (2005), reported that over 94 percent of individuals in the intervention group stated that they used relevant patient transfer techniques in their daily work. Interestingly, in the control group, this figure was quite similar at 93 percent. Whilst, Videman et al. (1989) did not directly investigate employee behavioural change, the handling skills of the trained participants compared to control participants were assessed. This showed the trained participants to have significantly better handling skills. Two of these articles were of excellent quality (Daltroy et al. 1993, Hartvigsen et al. 2005), with another two of good quality (Daltroy et al. 1997, Warming et al. 2008) and the final article was of poor quality (Videman et al. 1989).

Four of the remaining eight articles, (Best 1997, van Poppel et al. 1998, Fanello et al. 2002, Johnsson et al. 2002), only reported descriptive results from surveying the intervention group to determine their opinions of the training programme. These articles discussed that a large percentage of trained employees, ranging from 73-94 percent, reported using the techniques taught in the manual handling training sessions in their daily work. Of these four
articles, one was of excellent quality and the other three were of fair quality. The rest of the articles provided no results pertaining to transferring knowledge to employees or behavioural change (Reddell et al. 1992, Feldstein et al. 1993, Yassi et al. 2001, Jensen et al. 2006) (Table 3).


The two articles which showed a significant association were of fair quality. Of the three articles which showed a partial association, one of them was of good quality, one of fair quality and the final one was of poor quality. In contrast, of the seven articles which showed no association, two were of excellent quality, with the other five of good quality. Therefore, these findings indicated that the scarce research completed on transferring knowledge to employees and behavioural change leading to a reduction of WRMSDs following manual handling training, suggests that manual handling training appears to be ineffective at reducing WRMSDs.
### Table 3: Narrative synthesis of results for the included articles

<table>
<thead>
<tr>
<th>Study ID</th>
<th>Analysis method</th>
<th>Effect on transferring knowledge to employees &amp; behavioural change</th>
<th>Effect on WRMSDs reduction / prevention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Best 1997</td>
<td>Chi-square Mann-Whitney U test</td>
<td>94% (n=17) of intervention group, agreed that the training made their manual handling job easier.</td>
<td><strong>Significant association</strong>&lt;br&gt;Decrease incidence of back pain in the intervention group (55.6% - 43.8%)&lt;br&gt;Increases in the incidence of back pain in both the comparison groups (68.3% - 81.8%, 55.6% - 75% respectively) (p&lt;0.1)</td>
</tr>
<tr>
<td>Daltroy et al. 1993</td>
<td>Stepwise backward regression</td>
<td><strong>Partial association</strong>&lt;br&gt;Greater knowledge of safe lifting and posture in intervention group (mean score 4.2 out of 8) than controls (mean score 2.8 out of 8) (p&lt;0.0001).&lt;br&gt;No significant effect found on how they completed lifting on the job, maintained posture on the job, engaged in exercise/stress reduction off the job or if they had a tried back at the end of the day.</td>
<td>See Daltroy et al. (1997) for findings relating to WRMSDs reduction / prevention</td>
</tr>
<tr>
<td>Daltroy et al. 1997</td>
<td>Extended log linear model</td>
<td><strong>Partial association</strong>&lt;br&gt;Increases in knowledge of safe behaviour for the intervention group compared to controls, however, no significant improvements in actual behaviour</td>
<td><strong>No significant association</strong>&lt;br&gt;No significant difference between the intervention group and the control group was found for rates of primary low back injury and other musculoskeletal injuries.</td>
</tr>
<tr>
<td>Fanello et al. 2002</td>
<td>Chi-square tests</td>
<td>82% of trained respondents thought that they now paid more attention to their gestures and postures than before the training program. However, 75% of these respondents were dissatisfied with the training</td>
<td><strong>Significant association</strong>&lt;br&gt;Rate of LBP remission was higher among the intervention group than the controls (36% compared to 17%; p&lt; 0.05).&lt;br&gt;The control group suffered a longer duration of LBP after two years (49% compared to 30%; p= 0.01)</td>
</tr>
</tbody>
</table>

Note: LBP – low back pain
Table 3: Narrative synthesis of results for the included articles

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<tr>
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</thead>
<tbody>
<tr>
<td>Feldstein et al. 1993</td>
<td>Student’s t-tests</td>
<td>No evidence provided</td>
<td>Partial association</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Both composite back pain scores decreased for the intervention group but not for the controls (p=0.20, p=0.78 respectively).</td>
</tr>
<tr>
<td>Hartvigsen et al. 2005</td>
<td>Chi-square tests Regression &amp; Logistic Regression Models</td>
<td>Over 94% of the intervention group stated that they used relevant transfer techniques in their daily work. Interestingly, for the control group this figure was 93%.</td>
<td>No significant association</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>No significant differences were found between the intervention and control group for “Number of days with self reported LBP during the past year” (p=0.88, $\chi^2$ test) and “number of episodes of LBP” (p=0.84, $\chi^2$ test).</td>
</tr>
<tr>
<td>Jensen et al. 2006</td>
<td>Analysis of variance (ANOVA)</td>
<td>No evidence provided</td>
<td>No significant association</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>No significant differences found between the two interventions groups and controls for LBP during the past year (p=0.10, p=0.85) or during the past 3 months (p=0.16, p=0.64).</td>
</tr>
<tr>
<td>Johnsson et al. 2002</td>
<td>Student’s t-test Chi-square tests</td>
<td>92% of respondents to the follow up questionnaire, “mostly or always used the new technique.”</td>
<td>Partial association</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Decrease in perceived exertion when transferring a patient from “Bed to chair” in the follow up data (p≤0.05). No decrease found for prevalence of musculoskeletal problems and job strain.</td>
</tr>
<tr>
<td>Reddell et al. 1992</td>
<td>Analysis of variance (ANOVA)</td>
<td>No evidence provided</td>
<td>No significant association</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>There was no significance of treatment group differences on Total cases injury incident rate (p&lt;0.1509).</td>
</tr>
</tbody>
</table>

Note: LBP – low back pain
Table 3: Narrative synthesis of results for the included articles

<table>
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<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Van Poppel et al, 1998</td>
<td>Chi square tests</td>
<td>73% (n=104) lifted as taught some of the time, 11% (n=16) always lifted as taught &amp; 11% (n=15) never lifted as taught.</td>
<td>No significant association</td>
</tr>
<tr>
<td>Videman et al, 1989</td>
<td>Students t tests, Chi-square test (Mantel-Haenszel) Logisitic regression &amp; Log linear analysis</td>
<td>Significant association Nurses in the intervention group scored higher in skills assessment (mean: 1.31, SD: 0.77) than the controls (mean: 0.50, SD: 0.55) (p&lt;0.001).</td>
<td>Partial association Increase in the cumulative incidence of back pain among both intervention and control groups during training and during the first year after qualifying. Rate of back injuries during first year of study was 11% in the intervention group and 19% in controls.</td>
</tr>
<tr>
<td>Warming et al, 2008</td>
<td>Linear regression model</td>
<td>No significant association In the Intention-to-treat analysis, knowledge of transfer technique showed no significant differences between the intervention and control group at follow up.</td>
<td>No significant association In the intention-to-treat analysis, experienced LBP showed no significant differences between the intervention and control group at follow up.</td>
</tr>
<tr>
<td>Yassi et al, 2001</td>
<td>Multiway repeated measures analysis of variance (ANOVA) models Cox proportional hazard model</td>
<td>No evidence provided</td>
<td>No significant association At the 12 month follow up, only one of the intervention groups reported a significant decrease in the frequency of work-related low back pain (p=0.012) and shoulder pain (p=0.012) from baseline. Injury statistics were not significantly altered when compared to previous years (Mantel Haenszel x², all P &gt; 0.05).</td>
</tr>
</tbody>
</table>

Note: LBP – low back pain
4. Discussion

4.1 Overall Findings

The main findings of this systematic review suggest that there has been very little research focusing on the effectiveness of manual handling training on transferring knowledge to employees and the subsequent behavioural change. The scarce research which has been conducted with mainly self-reported measurements, whilst limited, does suggest that whilst employees report understanding and awareness following training, this does not always lead to the expected behavioural change. This review suggests that it cannot be demonstrated that transferring knowledge to employees will lead to a reduction of WRMSDs. This builds on the results of previous reviews, (Clemes et al. 2010, Verbeek et al. 2011), in suggesting that manual handling training appears to be ineffective at reducing WRMSDs. From reading the literature, it can be inferred that achieving the behavioural change expected from training can be a challenge. This could be related to the concern that “training may distract attention from addressing the underlying risks” which may be present in the workplace (McDermott et al. 2012). The findings of this review indicate a need for further research in the area of transferring knowledge to employees during training and subsequent behavioural change of employees following training.

4.2 Quality Assessment

The 13 included articles in this review differed from each other, therefore, to allow interpretation and comparison of the findings, quality assessment was completed on each article to determine the higher quality articles. Nine of the included articles were deemed to

4.3 Effect on transferring knowledge to employees and behavioural change

Overall, the findings suggest that transfer of knowledge to employees occurs, however, not to the level expected and there was no evidence of employee behavioural change. Five of the included articles provided information relating to transferring knowledge to employees and behavioural change for both the intervention and the control group (Videman et al. 1989, Daltroy et al. 1993, Daltroy et al. 1997, Hartvigsen et al. 2005, Warming et al. 2008).

Surprisingly, the findings of Hartvigsen et al. (2005) showed very similar, positive results in both the intervention and control group relating to use of relevant transfer techniques in their daily work. It could be inferred that perhaps the correct techniques learnt by the intervention group were been taken up by their colleagues in the organisation.

Within four of the included articles, only self reported data from trained participants were provided as evidence of transferring knowledge to employees and behavioural change. A large percentage of participants, (73% to 94%), indicated that the training had a positive effect on the manual handling tasks completed in their daily work (Best 1997, van Poppel et al. 1998, Fanello et al. 2002, Johnsson et al. 2002). These results were determined through self reported data, which on closer inspection were focused on assessing the transfer of knowledge to employees and satisfaction with the training course rather than providing an objective measure of employee behavioural change. It is also difficult to accept these results without careful consideration due to the small sample size associated with the percentages in some articles (Best 1997). Four of the articles did not report results relating to evaluation of
transferring knowledge to employees and behavioural change. The current review demonstrates the need for future research to focus on investigating further objective measurements of behavioural change. To achieve this, the area of Ergonomics could look to the area of Health Promotion for existing frameworks and models. This has been completed by Barrett et al. (2005) through their use of the “Stage of Change” model developed by Prochaska and DiClemente (1982) in their study focusing on assessing attitudes and beliefs of health and safety. This model was described by Barrett et al. (2005) as providing “a more structured approach to tailoring ergonomics interventions according to the knowledge, attitudes and beliefs of stakeholders at both individual and organisational levels”.

4.4 Effect on WRMSDs reduction/prevention

Overall, this review suggests that transferring knowledge to employees does not always lead to a reduction of WRMSDs, in the healthcare setting with similar findings for other industries. Contrary to our overall findings, two of the included articles, completed in a healthcare setting, suggest that there may be a positive association between the provision of manual handling training and a reduction of WRMSDs, however, this evidence is limited in several ways (Best 1997, Fanello et al. 2002).

The study by Best (1997) was determined to be of fair quality and had a very small sample size (n=55) with a subsequent high loss to follow up. Hence, there were very small numbers of participants at follow up (n=17). Despite the small sample size, a positive association was found, in that there was a decline in the incidence of back pain in the intervention group and visible increases in the incidence of back pain in both the comparison groups, however, this finding only approached significance at the 10% level (p<0.1). Therefore, this makes it difficult to compare to the other included articles which used the 5% level of significance. In addition, this study was completed on a specific method of manual
handling training (‘Manutention’). Hence, it may not be representative of the effectiveness of other manual handling training methodologies. However, if the positive association could be replicated in further robust research of this methodology, this may change the focus of future research from the effectiveness of manual handling training on the reduction of WRMSDs to determining the most effective methodology of manual handling training.

Fanello et al. (2002), reported that the intervention group had a higher rate of low back pain remission when compared to the control group (p< 0.05). Interestingly, of all the included articles, participants’ opinions towards the training were quite negative, with 75 percent dissatisfied with the training. Whilst the findings seemed promising, the authors did not reflect this positivity in their conclusions. It may be inferred that whilst the training had a positive effect on low back pain remission and duration, if such a large percentage of the participants were dissatisfied with the training, perhaps adjustments may be needed prior to recommending this training in its current form.

Hartvigsen et al. (2005), Reddell et al. (1992), Jensen et al. (2006), van Poppel et al. (1998) and Warming et al. (2008) suggested that manual handling training combined with other preventative measures, such as physical training, lumbar support, low tech ergonomic lifting aids and a psychosocial intervention does not lead to a reduction of WRMSDs. These findings showed that individual preventative measures, used solely or in combination, do not always appear to be effective at reducing WRMSDs. This may be interpreted as indicating that manual handling training alone or even in combination with only one other preventative measure may not be adequate to prevent WRMSDs. This interpretation brings possible future research outside the remit of this review, to perhaps investigating what are the best combinations of preventative measures and training to minimise the risk and prevalence of WRMSDs.
4.5 Limitations of the review

As with all research, this review has limitations. Only publications for which the full text article could be obtained in the English language were assessed for inclusion in this review. This means that other relevant articles published in other languages may have been excluded. Another limitation focused on the article selection and evaluation process. This process was undertaken by a sole assessor, hereby, potentially introducing bias. However, this bias was somewhat mitigated by a repeat of the quality assessment for each article after six months of the initial quality assessment. The included articles generally presented results based on self-reported data in relation to back pain and/or back injuries. This self-reported data is more likely to suffer from recall bias of the participants when compared to the use of company sick leave and injury statistics. In addition, company statistics are more likely to be work-related injuries than the self-reported data as they relate to a specific accident or incident in the workplace. Finally, only articles published in peer-reviewed journals were included in this review. This may mean that relevant grey literature might have been excluded leading to the possibility of publication bias.

4.6 Strengths of the review

However, this review also has key strengths. This review had explicitly stated inclusion and exclusion criteria relating to study design. This was to ensure, in so far as possible, that the final included articles were of a strong study design which had the ability to assess the relationship between a possible cause and an outcome of interest. The final included articles were either of a randomised controlled trial or a non-randomised controlled trial study design. Whilst randomised controlled trials are seen as the ‘gold standard’ for intervention research, non-randomised controlled trials were also included as in some occupational settings randomisation may not be possible (Feldstein et al. 1993, Johnsson et al. 2002).
systematic reviews in the area have included studies without control groups, however, the
authors of one of these reviews discussed that a limitation of their paper was the ‘high
proportion of low quality studies included’ (Clemes et al. 2010). Nine of the thirteen articles
included in this current review were of either excellent or good quality with robust study
designs which provides greater reliability to the results yielded. The search strategy used in
this review applied the search string for retrieving studies of occupational health interventions
by Verbeek et al. (2005) which has a sensitivity of 89 percent and a specificity of 78 percent.
This search string has a focus on back injuries. To ensure that no interventions relating to
shoulder pain and/or neck pain were missed, these search terms were included into the search
strategy and the searches were re-run in each database on 19th July 2013. The results of this
search yielded the same final five papers as in the original search detailed in Figure 1.

5. Conclusion

This review builds on the results of previous reviews, (Clemes et al. 2010, Verbeek et al.
2011), which have suggested that manual handling training does not seem to be effective for
reducing WRMSDs. However, this review focused in more detail on the effectiveness of
manual handling training at transferring knowledge to trainees and leading to the expected
behavioural change in their day to day work tasks. The findings suggest that whilst
employees report understanding and awareness following training, this does not always lead
to the expected behavioural change.

Previous reviews have highlighted the need for high quality randomised controlled
trials (RCT) to investigate the effectiveness of manual handling training on reduction of
WRMSDs robustly (Clemes et al. 2010, Verbeek et al. 2011). Prior to the completion of
these RCTs, research focused on determining why an increase in employee’s knowledge and
awareness after training does not appear to result in the expected positive behavioural change
would be required. Hence, further research to determine what inhibits the behavioural change which would have been expected and how to accurately measure employee behavioural change would be required. This information would be essential to allow for the development of manual handling training which results in both transferring knowledge to employees and the expected positive change in behaviour. Following on from this, the high quality RCTs would be essential to evaluate the effectiveness of this training at reducing WRMSDs. The development of an effective form of manual handling training is an essential component in the reduction of WRMSDs in the working population. This is imperative as it would be expected that this would result in positive health improvements within the general population.
References


