Ergonomics and musculoskeletal injury prevention interventions in healthcare: Are they worth it?

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Abstract

Background: Evidence regarding the value of ergonomics and other musculoskeletal injury prevention interventions in the healthcare sector is mixed. A systematic review of papers published between 1990 and 2006 found only moderate evidence that such interventions are effective from an economics perspective. Aim: The aim of this study was to update these findings. Method: The OvidSP journal database was searched for papers published between 2006 and 2013 using the strategy and quality assessment method previously applied. Results: The initial search yielded 4417 manuscript ‘hits’. There were 4348 manuscripts that were excluded. The remaining 69 manuscripts were read and a further 67 studies were subsequently excluded. The two remaining studies were considered along with the four identified in the previous review to provide an overall ranking of evidence. Conclusions: The level of evidence on the value of ergonomics and other musculoskeletal injury prevention interventions in the healthcare sector remains moderate, and focussed on the financial impact on employers. This may be partly due to the dynamic and changing nature of the work environment and the lengthy follow-up times required for studies of this type. A combination of reliable and robust outcome measures, supported by evidence of cost impacts for the individual and the health service, as well as employers, would provide fuller analyses of the value of such interventions.

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Background

Healthcare environments are inherently complex and demanding work settings and pose significant Occupational Health and Safety (OHS) challenges. Known hazards of healthcare work have been categorised as ergonomic, physical, chemical, biological and psychosocial. The most prevalent of these are ergonomic hazards which typically include the handling and movement of patients and equipment. Injuries related to these activities result in musculoskeletal disorders, which are among the most prevalent and costly of work-related injuries [1, 2].

However, evidence for the effectiveness of ergonomics and other musculoskeletal injury prevention interventions is mixed. The results of several systematic reviews have provided only partial to moderate evidence of their effectiveness. A 2012 systematic review conducted by Hoe et al [3] considered the evidence for the effectiveness of ergonomics interventions in the prevention of work-related musculoskeletal disorders of the upper limb and neck in a range of industrial sectors including transportation, call centre operations and healthcare. While they reported that there was moderate quality evidence [4] for interventions specifically to reduce the incidence of neck/shoulder discomfort they found only very-low to low-quality evidence that other ergonomics interventions were effective. Similarly a systematic review of participatory ergonomics interventions across a variety of sectors found only partial to moderate evidence for its effect in reducing self-reported symptoms, workers’ compensation claims and sickness absence [5].

Even when evidence for the effectiveness of ergonomics interventions does exist it is of little use if organisations do not implement them. Reasons for the lack of implementation may include issues of cost and perceived effectiveness [6]. Among senior managers with budgetary responsibilities and constraints, the cost-effectiveness of proposed interventions from the perspective of the firm, may be compelling.

Measures of intervention effectiveness include a range of outcome indicators. These frequently include the use of self-report questionnaires which are completed pre- and post-intervention. Changes in these measures are then used to demonstrate the effectiveness of the intervention. Objective outcome indicators commonly include changes in injury rates, medical costs and days of work lost [7, 8], providing partial information on direct monetary cost savings to the employer. What is frequently lacking, however, are measures of both the health benefits and costs to the health system and the worker.

In 2009 Tompa et al [9] systematically reviewed ergonomics and other musculoskeletal injury prevention interventions with economic analyses. Their review identified only four medium-quality interventions in the healthcare sector published between 1990 and 2006. They concluded that there was moderate evidence that ergonomics and other musculoskeletal injury prevention interventions in the healthcare sector are worth undertaking for economic reasons. This paper provides an update of those findings, with an expanded assessment of the identified, evaluated intervention studies.
Method

The OvidSP journal database was searched using the keyword search strategy described by Tompa [9]. OvidSP was used as it incorporates the MEDLINE, EMBASE AND BIOSIS databases used in Tompa’s review. These three databases yielded more than 95% of the initial ‘hits’ in their review and identified all of the ergonomics and other musculoskeletal injury prevention intervention studies reviewed. This strategy was based on four criteria – 1. type of study; 2. study setting; 3. study outcome measures; and 4. economic analysis used. One keyword from each category was required in the title, abstract or keywords. For inclusion studies needed to be published in English, in a peer-reviewed journal since 2006. While Tompa’s review also included studies published in 2006, articles published in the year 2006 were included our search strategy to allow for any publishing ‘time-lag’. Studies were excluded if they were undertaken in a developing country, had a military context, or if the intervention was focussed on outcomes which were not directly related to work health outcomes.

In order to provide a level of consistency with the quality assessment process used by Tompa et al [9] each of the four healthcare-related papers they identified were reviewed by one of the authors with expertise in ergonomics interventions using Tompa’s 14 questions and accompanying 5-point Likert scale (Appendix 1). When these results were compared with those previously published they did not vary by more than 10% and did not change the quality ranking. Each of the papers identified in our search were subsequently reviewed independently by two of the authors – one with expertise in ergonomics interventions (PR) and the other an experienced health economist (JK). The average of the overall scores for the 14 questions for each of the reviewers provided a final study score. As described by Tompa et al, a final study score between 1 and 2.4 was rated as low quality evidence; a score between 2.5 and 3.4 was rated as medium quality evidence; and a score between 3.5 and 5 was rated as high quality evidence [9].

Only studies with scores of 2.5 or greater were retained and added to the evidence synthesis process to produce an overall ranking for the level of evidence. This ranking utilises a 5 category scale for strong, moderate, limited, mixed and insufficient evidence. Details of the ranking algorithm have been previously published [9].

Results

The OvidSP search resulted in 4417 hits. These were individually scanned and 4348 were subsequently excluded.

Table 1: Reviewed Studies: intervention, study design, and results summary

<table>
<thead>
<tr>
<th>Study Reference: Quality (Score)</th>
<th>Time Span</th>
<th>Description of Intervention</th>
<th>Study Design</th>
<th>Perspective</th>
<th>Costs of Intervention</th>
<th>Key Outcome Measures</th>
<th>Type of Economic Evaluation and Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gundewall (1993)[12] Study quality: Medium (2.7)</td>
<td>13 mths</td>
<td>The effect of an exercise program on work absence due to back pain</td>
<td>Randomised control trial</td>
<td>Employer</td>
<td>Physiotherapist time (cost not specified)</td>
<td>Days lost due to back pain</td>
<td>Cost benefit analysis 1.3 days of work were gained by the training group for each hour of physiotherapist time</td>
</tr>
<tr>
<td>Evanoff et al (1999)[13] Study quality: Medium (2.57)</td>
<td>6 mths</td>
<td>The effect on workers’ compensation costs following the introduction of a participatory ergonomics team</td>
<td>Pre and post-introduction, controlled</td>
<td>Employer</td>
<td>Equipment and wages for time spent on team activities (US$5000)</td>
<td>Workers’ compensation costs</td>
<td>Cost consequence analysis Intervention cost of US$5000 resulted in savings of US$22,758</td>
</tr>
<tr>
<td>Collins et al (2004)[14] Study quality: Medium (3.35)</td>
<td>72 mths</td>
<td>The effect on musculoskeletal injuries following the introduction of mechanical lifting equipment, training and policies</td>
<td>Pre- and post-introduction, uncontrolled</td>
<td>Employer</td>
<td>Capital investment (US$143,556) Worker training (US$15,000)</td>
<td>Workers’ compensation costs</td>
<td>Cost benefit analysis Payback period of less than 3 years</td>
</tr>
<tr>
<td>Chokhar et al (2005)[15] Study quality: Medium (2.9)</td>
<td>72 mths</td>
<td>The effect on workers’ compensation costs following the introduction of overhead ceiling lifts</td>
<td>Pre- and post-introduction, uncontrolled</td>
<td>Employer</td>
<td>Capital investment (CAN$344,323)</td>
<td>Workers’ compensation costs</td>
<td>Cost benefit analysis Payback period of between 0.82 and 2.50 years</td>
</tr>
<tr>
<td>Alamgir (2008)[10] Study quality: Medium (2.82)</td>
<td>120 mths</td>
<td>The effect on workers’ compensation costs was compared pre- and post-introduction of overhead ceiling lifts in three long-term care facilities</td>
<td>Pre- and post-introduction, uncontrolled</td>
<td>Employer</td>
<td>Capital investment (CAN$1,081,410)</td>
<td>Workers’ compensation costs</td>
<td>Cost analysis Payback period estimated at 6.3 to 6.2 years when based on direct costs. When indirect costs were included the payback period was 2.06 to 3.20 years.</td>
</tr>
<tr>
<td>Roelofs et al (2010)[11] Study quality: High (4.08)</td>
<td>12 mths</td>
<td>Lumbar support belts were made available to home care workers with a previous history of self-reported lower back pain</td>
<td>Randomised control trial</td>
<td>Employer</td>
<td>Cost of lumbar support belts (€56.40 each)</td>
<td>Direct healthcare costs. Direct non healthcare costs and loss of production costs</td>
<td>Cost analysis Mean direct healthcare costs reduction of €235 in the intervention group.</td>
</tr>
</tbody>
</table>

*Studies are defined as cost analyses if they only consider the financial benefits (i.e. cost savings) associated with an intervention, and not any non-financial benefits, such as improved health.*
The remaining 69 articles were read in full and a further 67 studies were excluded following the application of the inclusion/exclusion criteria. The two remaining studies [10, 11] were considered along with the four identified in Tompa et al’s previous review. Table 1 provides an outline of the included studies and the calculated study quality scores.

In the systematic review conducted by Tompa et al [9] four medium quality studies were identified (Table 1 – unshaded boxes). Two of these interventions evaluated the effect on workers’ compensation costs following the introduction of mechanical lifting aids. One of these evaluated the effect following the installation of overhead ceiling lifts [15], while the other evaluated the effect of a ‘best practices’ musculoskeletal injury prevention program which included the introduction of mobile mechanical lifting equipment [14]. Despite the substantial capital costs associated with these interventions - CAN$344,323 and US$158,556 - payback periods were calculated as 2.5 and 3.0 years. The cost of implementing a participatory ergonomics program was US$5000 over a 2-year period with workers’ compensation costs savings of US$22,758 [13]. The costs of a physiotherapist led exercise intervention were not provided, however for those in the intervention group 1.3 days of work was gained for each hour of physiotherapist time [12].

The more recent and newly identified studies evaluated an intervention to reduce workers’ compensation costs following the introduction of overhead ceiling lifts [10] and a cost-benefit analysis following the introduction of lumbar support belts [11]. The intervention costs for the overhead ceiling lifts was CAN$1,081,410 with a payback period of between 6.3 years (calculated using direct cost savings only) and 2.06 years (calculated using direct and indirect costs). Intervention costs were not reported by the other study, however direct compensation costs were US$266 lower for those workers who were provided with lumbar support belts. These studies were ranked as medium and high quality respectively and thus included in the evidence synthesis.

Based on these results we conclude that there continues to be only moderate evidence that ergonomics and other musculoskeletal injury prevention interventions in the healthcare environment are worth undertaking, when analysed from the employers’ financial perspective.

Discussion

In their systematic review of ergonomics and other musculoskeletal injury prevention interventions with economic analyses published in the peer-reviewed literature between 1990 and 2006 Tompa et al [9] identified no high quality, and only four moderate quality healthcare-based studies which included economic analyses. This paper has reported an update of their findings, identifying only two further studies. Using identical criteria to that used by Tompa et al, one study was ranked as high quality [11] and the other as moderate quality [10].

Each of the identified studies focussed on musculoskeletal injuries as the result of patient handling/lifting, which pose the greatest risk to staff and the highest economic burden on employers [1, 2]. The nature of the interventions ranged from engineering solutions such as the installation of overhead ceiling lifts [10, 15] to the provision of lumbar support belts [11]. The time span for data analysis ranged from six months [9] to 120 months [10]. With the nature of work-related musculoskeletal injuries, which are typically of slow onset, and take several years to develop [16] it could be anticipated that those studies with longer periods of analysis would provide stronger evidence. However, while half of the studies [10, 14, 15] incorporated a long time period (up to 10 years), these studies were uncontrolled and included retrospective analyses of injury costs and claims. The uncontrolled nature of these studies, conducted in a dynamic work environment, hinders a full evaluation of the intervention, where the effect could be attributed to other factors. This limitation is acknowledged by several authors [10, 15]. Other factors include staff turnover, patient/worker profile and the introduction of new policies and procedures. If robust intermediate end-points could be identified the limitations inherent in uncontrolled long follow-up times could be reduced.

In ergonomics practice, interventions which seek to either eliminate or introduce engineering solutions to mitigate the associated risk of injury are preferred to interventions which rely on worker compliance, such as the wearing of lumbar support belts [11]. Studies identified in this review that evaluated elimination or engineering interventions included the installation of overhead ceiling hoists [10, 15] or the purchase of mechanical lifting devices [14]. Despite the higher costs associated with these interventions, payback periods ranged from 0.82 and 6.3 years [10, 15].

The twin objectives of workplace ergonomics interventions are to reduce both the number, and severity, of workplace injuries in order to relieve the personal burden to the injured worker and the economic burden to the employer. A limitation across all but one [11] of the reviewed papers was the focus on financial costs, primarily through workers’ compensation costs. Thus, the evaluations were mostly undertaken from the perspective of the employer. In the absence of additional, and more rounded evidence (i.e. capturing health outcomes across jurisdictions. The retrospective study designs precluded the prospective collection of effectiveness data [10, 13-15].

Various measures have been used to represent the benefits of ergonomics workplace interventions using prospective study designs [17, 18], but these studies have not collected prospective cost data to inform joint comparisons of the costs and benefits of such interventions. Studies measuring the economic effects of workplace interventions have, at best, represented the health benefits in the form of avoided workers’ compensation costs - the criteria for which varies across jurisdictions. The retrospective study designs precluded the prospective collection of effectiveness data [10, 13-15].

Future prospective studies of ergonomics workplace interventions should include control groups, and aim to capture both costs and benefits prospectively. Hard measures of outcome are preferred (e.g. injury rates and quality of life effects), though it is recognised that large samples and follow-up periods may be required to observe significant differences in such measures of outcome. Intermediate outcome measures, including self-reported body part discomfort
and other subjective questionnaires are widely used in professional practice, and reported in the literature [19-21]. While convenient, the relevance of such measures needs to be supported by studies that demonstrate their correlation with hard end-points such as injury rates and reduced quality of life.

**Limitations**

This review sought to update the findings of T ompa et al [9] by applying their search strategy and inclusion/exclusion criteria to peer-reviewed papers published between 2006 and 2014. In T ompa’s review five journal databases were search – MEDLINE, EMBASE, BIOSIS, Ergonomics Abstracts and Business Source Premier. In our review we used the OvidSP journal database – which incorporates the MEDLINE, EMBASE and BIOSIS databases - using the same keyword search strategy described by T ompa [9]. In T ompa’s review more than 95% of their initial ‘hits’ were identified in these three databases, as were all of the ergonomics and other musculoskeletal injury prevention interventions they included. However, there is a possibility that we did not identify suitable studies which were contained within Ergonomics Abstracts or Business Source Premier. All initial ‘hits’ were examined for inclusion or exclusion by a single author (PR), and so some suitable papers may have been incorrectly excluded. In addition, as we chose to replicate a previously used search strategy, any flaws in its initial design would have been repeated in our process.

**Conclusions**

The small number of additional papers identified in our update should not be interpreted as indicating a lack of evaluation in ergonomics interventions in general. Rather it may be indicative of the difficulty associated with undertaking methodologically sound economic evaluations of ergonomics and other musculoskeletal injury prevention interventions. The reliance on retrospective financial outcomes data in the majority of the studies reviewed [10, 13-15] imposed limitations on study design and the interpretation of the findings. While well-designed prospective studies may provide stronger levels of evidence, these are difficult in dynamic and changing work environments, especially where lengthy follow-up times required. For these reasons, ergonomists may be justified in using reliable and robust intermediate outcome measures to generate evidence of the cost-effectiveness of workplace ergonomics interventions.

**References**


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**Appendix 1 – Quality Assessment Questions**

1. Was the conceptual basis of, and/or the need for the intervention explained and sound?
2. Was the intervention clearly described?
3. Were the study population and outcomes clearly described?
4. Rank the means by which selection and confounding are controlled for through study design?
5. Were appropriate statistical analyses conducted?
6. Are exposure, involvement, and intensity of involvement in the intervention appropriate?
7. Are the outcomes included in the analysis appropriate?
8. Were all relevant comparators explicitly considered?
9. Was the study perspective explicitly stated and appropriate?
10. Were all important costs and consequences considered in the analysis, given the perspective?
11. Are the measures of costs and consequences appropriate?
12. Was there appropriate adjustment for inflation and time preference?
13. Was there appropriate use of assumptions and treatment of uncertainty?
14. Did the presentation and discussion of study results include all issues of concern?