Ergonomic intervention research for improved musculoskeletal health: a critical review

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Authors' objectives
To identify effective ergonomic interventions for improved musculoskeletal health in the workplace.

Searching
The authors searched the titles, keywords and abstracts categories of the MEDLINE (1966-1994), NIOSHTIC (until December 1994), and ARBLINE (until December 1994) electronic databases. The authors also searched the Science Citation Index with respect to 10 references appearing from 1986 to 1990. Books, journals and conference proceedings were manually searched and the reference lists of relevant papers were also examined. Other researchers were contacted (approximately 18 responded) by post requesting relevant literature or references. Non-English language publications were excluded because the authors determined that high quality studies had also been published in English.

Study selection

Study designs of evaluations included in the review
Field studies and ergonomic interventions, where:

1. Data was documented sufficiently to allow repeatability.
2. There was exposure assessment.
3. Results were analysed in terms of the authors' review model (in an exposure-effect manner over at least two levels in the model chain).
4. The method for statistical evaluation was appropriate.

Excluded studies included: short-term laboratory studies of mechanical exposure variables, vocational workplace and tool design studies, experimental workplace modifications, process studies, accident studies, training studies, vibration studies, rehabilitation and epidemiological studies without intervention, and studies not related to the work situation.

Study length varied very widely, ranging from a few days to 11 years in length.

Specific interventions included in the review

Organisational culture interventions (multiple interventions with high stakeholder commitment to reduce identified risk factors) implemented at the community and company levels and modifier interventions (focusing on workers at risk and using measures which actively involve the individual) implemented at the individual worker level. Studies where intervention measures were not described were excluded.

Participants included in the review

Workers in various industrial occupations, including assembly workers, data entry/computer operators, punch press operators, office workers, grocery checkstand (express) workers, sewing machine operators, workers in "repetitive" work, garbage collectors, street sweepers, lorry drivers, film rollers, nurses, automotive workers, food industry or manufacturing workers, electrical utility workers, telecom manufacturing workers, meatpacking workers, chemical production workers, wood industry workers, sheet metal workers, telegraphists, postal workers, medical secretaries, bus drivers, municipal firefighters, home care personnel, printing workers, nursing aides and hospital workers, mine workers, research workers, cleaners, and public employees.

Outcomes assessed in the review

Internal (mechanical) exposure defined as acute physiological and psychological responses such as the development of fatigue or discomfort, acute response defined as persistent discomfort or pain and/or clinical signs, and musculoskeletal
health effects.

How were decisions on the relevance of primary studies made?
The authors do not state how the papers were selected for the review, or how many of the authors performed the selection.

Assessment of study quality
The authors assessed the quality of the included studies on the following criteria: proper statistical analysis; reasonable size of study group; variables generalisable to other settings; consideration of reliability and sensitivity of variables; inclusion of control group; adequate observation period with follow-up measurements; and proper documentation of intervention and intervention process. The authors do not state how the papers were assessed for quality, or how many of the authors performed the quality assessment.

Data extraction
The authors do not state who, or how many of the reviewers, performed the data extraction. Data from papers was extracted into three tables. The papers were classified according to the main intervention focus stated by the authors. In some cases, the authors of this review used their own judgement in classifying the studies. Table 1 included studies of mechanical exposure interventions aiming to change job exposures that are considered harmful using experts to intervene to change mechanical exposure and possibly other risk factors for musculoskeletal complaints. Table 2 included studies of production system interventions aiming to change job exposures that are considered harmful by attempts to improve risk factors including external mechanical exposure by changing the material production system and/or the organisational culture of a company. Table 3 included studies of modifier interventions where the external mechanical exposure is not intended to be changed; instead the workers are put in a better position to deal with existing demands. Data were extracted in the categories of study reference, occupation of participants, type of intervention, study design (design type, control group, intervention group size, and study period), mechanical exposure (methods and dimensions), acute response, musculoskeletal health, findings (mechanical exposure, acute response, musculoskeletal health and other), and impact (documentation, compliance, intervention sustainability, outcome sustainability).

Methods of synthesis
How were the studies combined?
The studies were discussed in a narrative (qualitative) review organised around the three types of intervention summarised in the data extraction tables for mechanical exposure, production system, and modifier intervention studies.

How were differences between studies investigated?
The authors acknowledge that there was considerable heterogeneity found in each of the three groups of studies analysed but no formal test for homogeneity was reported.

Results of the review
Ninety-two studies (92) were included in the review. Twenty (20) were classified as mechanical exposure interventions (Table 1), 32 were classified as production system interventions (Table 2), and 39 were classified as modifier interventions (Table 3). Design types for mechanical exposure included: time series (331 participants), pre/post (1,066 participants), post only (60 participants), cross-sectional (16 participants), and cross-over studies (16 participants), 2 of 20 studies did not report number of participants. Design types for production system interventions were: time series (14,722 participants), pre/post (3,247 participants), post only (24 participants), cross-sectional (41 participants), cross-over studies (44 participants), and case report study (>50,000 participants), 10 of 32 studies did not report number of participants. Design types for modifier interventions were: time series (9,767 participants), pre/post (8,411 participants), post only (371 participants), cross-sectional (482 participants), and cross-over studies (44 participants).

Studies without a reasonable size of experimental group were excluded from the review.

The outcomes (health effects, mechanical exposure or acute response) for the mechanical exposure studies were
The outcomes (health effects, mechanical exposure or acute response) for the production system studies were uncertain and many studies reported health outcome only. It is not known whether a positive change was due to a change in the tendency of reporting complaints rather than improvement in musculoskeletal health. Confounding of mechanical exposure interventions by changes to other risk factors were generally not considered. A possible distinguishing feature of the successful interventions relative to those that failed, is the extent to which intervention ownership is embedded in the company, including company management.

The outcomes (health effects, mechanical exposure or acute response) for the modifier interventions studies were reported under groupings of physiotherapy, health education, relaxation training, work technique, and multiple modifiers. No clear results were reported. In health education, all the included studies reported no improvement in musculoskeletal health associated with health education. There was some evidence that exercise interventions, possibly above a certain intensity level, can improve musculoskeletal health. Short-term effects of relaxation training were uncertain. There were no short-term effects of the instruction programmes in work technique. Modifier interventions that actively involved the worker often achieved positive results.

Authors' conclusions
The review suggests that the following intervention strategies have the best chance of success:

1. Organisational culture interventions with high commitment of stakeholders, utilising multiple interventions to reduce identified risk factors.

2. Modifier interventions, especially those that focus on workers at risk, using measures that actively involve the worker.

The two intervention strategies are representations of the same overall strategy: identifying and dealing with risk factors relevant for the individual at risk.

CRD commentary
The authors have stated the research question and inclusion and exclusion criteria for the review. The literature search is reasonably good. Non-English publications were excluded so it is possible that studies may have been missed. The searches were also partly based on and designed to include a selected set of known references which could have narrowed the search and excluded other relevant studies.

The author has not reported on how the articles were selected, or how many of the reviewers, selected the articles or extracted the data. There is no statistical combination of the data. The authors have stated that there was considerable heterogeneity within the groups of studies and this makes even a narrative summary of the extracted data inappropriate. The review should be viewed with caution because of the missing information on the selection and review process, but can be usefully treated as a literature review of available studies (rather than a combined analysis) in this research area.

Implications of the review for practice and research
Practice: The authors recommend that in practice, all interventions that protect individuals should be considered.

Research: The authors state that further research should investigate the following.

1. The efficacy of the investigated intervention in relation to the ergonomic preventable fraction.

2. Organisational prerequisites for successful implementation of ergonomic interventions.

3. Means to obtain adequate contrasts in interventions targeting mechanical exposure.

The research design should consider scientific quality, a thorough description of the intervention, evaluation of
intervention sustainability and inclusion of both exposure and health effect variables.

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**Record Status**
This is a critical abstract of a systematic review that meets the criteria for inclusion on DARE. Each critical abstract contains a brief summary of the review methods, results and conclusions followed by a detailed critical assessment on the reliability of the review and the conclusions drawn.