Interventions for the primary prevention of work-related carpal tunnel syndrome


Authors' objectives
To evaluate interventions for the primary prevention of work-related carpal tunnel syndrome (CTS).

Searching
Relevant studies from peer-reviewed journals, technical and government reports, and unpublished reports were retrieved. MEDLINE, EMBASE, CINAHL, NIOSHTIC and PsycINFO were searched. Additional information sources (which were not stated) were identified by checking pertinent articles and the reference lists of retrieved articles.

Study selection
Study designs of evaluations included in the review
Only studies with some form of comparative data were included. Studies without strong research designs were included in order to illustrate the current state of the art in this area. Studies that described only diagnostic techniques, clinical management, or risk factors among a group of workers with CTS, were excluded.

Specific interventions included in the review
Studies had to include one or more engineering, administrative, or personal interventions. The interventions were classified according to the control implementation strategy recommended by the National Institute of Occupational Safety and Health (see Other Publications of Related Interest). Engineering interventions were defined as 'engineered or physical manipulations of sources for occupational hazards or routes of exposure to them'. These included alternative keyboard designs; computer mouse designs and wrist supports; keyboard and mouse support systems; and tool redesigns. Administrative interventions were defined as 'any management initiative which modified the work process or work exposure to reduce work-related musculoskeletal disorder (WRMSD) stress'. These included job rotation or establishment of an ergonomics task force. Personal interventions were those which addressed worker behaviour, education, or training. These included ergonomics training, wearing of wrist splints, electromyographic biofeedback, and on-the-job exercise programmes. Multiple component interventions involved more than one type of intervention. These included workstation redesign, modification of tooling, establishment of an ergonomics task force, job rotation, ergonomics training, and restricted duty provisions. The settings were either actual workplaces, or laboratories that simulated a workstation configuration and activities.

Participants included in the review
Studies had to include initially asymptomatic participants. The participants included in the review were adults who were either working or of working age.

Participants in the included engineering intervention studies included typists (touch, experienced, trained), VDT workers, clerical workers, office workers, volunteers, and computer mouse users.

Participants in the included personal intervention studies included workers in a financial institution, a hardware manufacturing firm and a garment manufacturing firm, and volunteers.

Participants in the included multiple component intervention studies included workers in trailer assembly, a meat packing plant, a medical device assembly plant, a small parts assembly plant, an electronics assembly plant, an automotive plastics plant and a telecommunication manufacturing plant, and workers using rivet guns in aircraft manufacturing.

Outcomes assessed in the review
The authors did not specify any inclusion criteria relating to outcomes assessed. The outcome measures included the incidence, symptoms, or risk factors for CTS, or a WRMSD of the upper extremity that included CTS in the definition.
How were decisions on the relevance of primary studies made?
Two of the authors reviewed each of the titles and abstracts. Studies that potentially met the inclusion criteria were identified and selected for further review. Teams of two authors then reviewed each study, and any disagreements were resolved by consensus among all authors.

Assessment of study quality
The authors did not state that they assessed validity. However, some information relating to the validity of the included studies was presented in the tables and text of the review.

Data extraction
The authors do not state how the data were extracted for the review, or how many of the reviewers performed the data extraction.

The categories of data extracted from each study included author, year, study design, population, intervention, outcome(s), statistical analysis, results and comments.

Methods of synthesis
How were the studies combined?
A narrative synthesis was undertaken with studies grouped according to intervention classification. Publication bias was not assessed.

How were differences between studies investigated?
Differences between the studies were discussed in a narrative.

Results of the review
Twenty-four studies with a total of 10,120 participants were included: 1 randomised controlled trial (RCT; 193 participants), 10 controlled laboratory trials (297 participants), 2 controlled trials (40 participants), 2 pre-test post-test controlled trials (78 participants), and 9 pre-test post-test uncontrolled trials (9,512 participants).

Engineering interventions (12 studies).
Among studies that assessed discomfort, the 'Comfort' keyboard was found to be less comfortable than the standard keyboards, while the 'Kinesis' and 'TONY!' keyboards were found to be more comfortable. Two studies found that the split, adjustable keyboard configuration was more comfortable, decreased fatigue, and increased relaxation of the arms and hands while typing. However, two studies did not detect any significant differences in the pain reported by participants with alternative keyboard designs. Two studies found that the participants perceived less pain and greater control of their typing with the use of a wrist rest while using the alternative keyboard. However, this finding was contradicted by another study.

In terms of postural benefit, studies consistently identified a reduction in ulnar deviation and muscle group activity among the alternative keyboard designs. However, one study found the 'Comfort' keyboard to increase wrist extension beyond the preferred neutral position, while another study found similar results for the 'Truform' keyboard. Analysis of other measures indicated there was no difference in physiological effects or performance among keyboards. Alternative keyboard studies found inconsistent evidence of a reduction in pain, fatigue or other clinical effects relative to the standard keyboards, although for several keyboard designs, wrist posture tended to be more neutrally aligned.

Full motion forearm supports were not associated with an effect on hand or wrist posture, although one study reported that the negative slope keyboard support resulted in a significant 14-degree reduction in wrist extension; no difference in ulnar deviation was observed. One study found that the negative slope support helped keep users hands inside a 'neutral zone' of movement. However, a wrist rest and articulating keyboard tray did not show an effect.

One study found that the use of a wrist support with a mouse pad improved wrist posture, by minimising the wrist...
extension and radial deviation. Compared with a standard 'forearm pronated' mouse, Barr’s 'forearm neutral' mouse design resulted in significant reductions in forearm pronation, ulnar deviation, range of radial-ulnar deviation, and corresponding muscle activation intensities in one study. However, wrist extension was increased.

There was only one study of a modified tool design that included comparison data, and this investigated the effect of the orientation of the hammer angle on wrist posture. The study found trends of decreasing ulnar deviation at impact, but increasing radial deviation windup. However, this study was limited by a small sample size, lack of adjustment for potential confounders, and intermediate outcome measures.

Personal interventions (4 studies).

One study indicated that the use of a flexible wrist splint raised carpal tunnel pressure among workers, both at rest and during a repetitive task. The splint did not affect the average wrist position.

One study evaluating the use of audible electromyographic biofeedback found no differences in discomfort and motor nerve conduction velocity between the experimental and control groups.

One study examining the impact of an on-the-job strength and flexibility programme found no differences after 10 weeks, in the signs and symptoms of CTS between the experimental and control groups.

In one study, there were no reported cases of cumulative trauma in either the group that was informed of their risk assessment score, or the group that was not informed, 11 months after a WRMSD education programme began.

Multiple component interventions (8 studies).

One study attributed a reduction in WRMSDs in a medical device assembly plant primarily to job redesign; 45.5 WRMSDs per 200,000 work hours were reduced to 7.7 within 1 year. One study reported a reduction in the rate of upper limb disorders (about 20% of which were CTS cases) from 2.1 per 200,000 work hours in 1987, prior to major engineering changes, to 0.1 in 1990. Similarly, one study reported a 9.3% decrease in the number of WRMSDs 6 months after the programme implementation. One study found a 10 to 30% reduction in overall WRMSD symptoms, although there were no apparent differences when specifically considering CTS symptoms. Another study reported a significant decrease in deviations of the wrist and upper limb from neutral postures.

One study identified a significant increase in WRMSD incidence, physician-referred WRMSD cases, the number of production days lost, and the restricted duty days in the first year, although the rates reverted back to or below baseline in the second year. Similarly, one study found an initial increase in plantwide WRMSD incidence, although there was a dramatic decrease in the average severity.

The RCT showed that of a programme consisting of vibration-dampening rivet guns, ergonomic posture training and exercise training, only ergonomic posture training had a significant and beneficial impact on the individual WRMSD risk level. The results also implied that exercise training may benefit individuals in jobs demanding awkward postures or high repetitions, and that vibration-dampening rivet guns may be appropriate for new, but not current, employees.

The included studies exhibited differences in terms of study designs, types of intervention, exposure times, outcome measures, sample sizes, and the range of statistical analyses performed.

Authors' conclusions

Many of the studies had significant methodological flaws that limited the applicability of their results. While results from several studies suggest that multiple component ergonomics programmes, alternative keyboard supports, and mouse and tool redesign may be beneficial, none of the studies conclusively demonstrated that the interventions would result in the primary prevention of CTS in a working population.

Given the societal impact of CTS, the growing number of commercial remedies, and their lack of demonstrated effectiveness, the need for more rigorous and long-term evaluation of interventions is clear.
Funding for intervention research should prioritise RCTs that have the following: adequate sample size; adjustment for relevant confounding variables; isolation of specific programme elements; and measurement of long-term primary outcomes, e.g. the incidence of CTS, and secondary outcomes such as employment status and cost.

**CRD commentary**

The review question was stated clearly and was well supported by the inclusion criteria, although the authors did not specify any inclusion criteria regarding the outcome measures of interest.

The literature search was comprehensive and included searches for unpublished material. However, the authors did not specify whether there were any language restrictions. The validity of the primary studies was not assessed.

The data were appropriately synthesised in a narrative format. Some details of the review process were provided, e.g. how decisions on the relevance of the primary studies were made, whereas other details were not, such as how the data were extracted.

The authors’ conclusions follow on from their findings.

**Implications of the review for practice and research**

Practice: The authors did not state any implications for practice.

Research: The authors state that they recommend the implementation of either RCTs, quasi-experimental study designs with non-random comparison groups, or longitudinal data collection that measures changes in CTS incidence. In addition, they state that the following features should be emphasised in future studies:

1. Designs that allow independent assessment of each programme element.
2. The selection of targeted, high-risk study populations.
3. Surveillance of sufficient duration to affect change in incidence.
4. Appropriate sample sizes to ensure adequate power.
5. Surveillance of CTS incidence rather than the broader category of WRMSD.
6. Statistical testing and adjustment for relevant confounding factors.
7. Consideration of demographic, behavioural, economic, psychosocial, work style and non-occupational factors.
8. Consideration of 'natural experiments' created by interventions at a single site.
9. Measurement of secondary outcomes such as development of bilateral CTS, employment status and particularly cost.

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**Bibliographic details**


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Other publications of related interest

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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.