**Barcenilla A, March L M, Chen J S et al. Carpal tunnel syndrome and its relationship to occupation: a meta-analysis. Rheumatology (Oxford). 2012;51(2);250-61.**

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Design: meta-analysis of observational studies

Purpose of study: to examine associations between work place exposure to force, repetition, vibration, wrist posture, and combinations thereof to the development of CTS

Structure of comparisons:

* Population: workers in any occupational setting
* Exposures: workplace exposures to hand force, repetition, vibration and wrist posture, combinations of force/repetition
	+ Keyboarding and computer use were excluded from the exposures under consideration
* Outcomes: CTS under various case definitions
	+ NIOSH definition required symptoms of CTS (paresthesias, pain, numbness) together with clinical signs (Tinel’s sign, Phalen’s sign, or (*optionally*) nerve conduction studies indicating nerve dysfunction across the carpal tunnel
	+ A more conservative definition was also used, *requiring* the presence of abnormal nerve conduction findings showing median nerve dysfunction across the carpal tunnel in addition to CTS symptoms or clinical signs
* Study types: observational studies were eligible provided that they were original articles which reported exposure-CTS measures of effect in terms of odds ratios (OR) or relative risks (RR)

Study selection:

* Databases in literature search were MEDLINE and CINAHL up to December 2009
	+ Main search terms were CTS, carpal tunnel syndrome, median nerve entrapment or neuropathy
	+ In addition, a wider spectrum search was conducted using the terms cumulative trauma disorder (CTD), repetitive strain injury (RSI) and occupational overuse syndrome
* Two authors read study abstracts and made the decision to include or not to include, with a third authors resolving any differences of opinion
* Two authors also assessed risk of bias of included studies using the Cochrane criteria commonly used in assessing interventional trials: selection bias, attrition bias, performance bias, measurement bias, and reporting bias
* Summary effects across multiple studies were calculated as pooled odds ratios with 95% confidence intervals using random-effects models for hand force, repetition, combination of force/repetition, hand vibration, and wrist position
* Heterogeneity between studies was calculated for all studies combined, and separately for studies which used a more conservative case definition of CTS, in which nerve conduction studies were required for inclusion in the analysis

Principal results:

* A total of 37 articles were included in the analysis
	+ There were 28 cross-sectional studies, 5 case-control studies, and 4 cohort studies
* Using the NIOSH case definition, the authors found elevated odds ratios for most exposures
	+ For hand force, the OR from 13 studies was 2.18 with 95% CI 1.47 to 3.25
	+ For repetition from 25 studies the OR was 2.30 with 95% CI 1.75 to 3.01
	+ For force in combination with repetition from 9 studies the OR was 2.03 with 95% CI 1.43 to 2.89
	+ For vibratory tools from 12 studies the OR was 2.73 with 95% CI 1.90 to 3.92
	+ For abnormal wrist posture from 7 studies the OR was 2.69 with 95% CI 1.32 to 5.49
* However, there was very high heterogeneity among studies for all of the occupational exposure-CTS relationships for force, repetition, vibration, and wrist posture
* For this reason, odds ratios were calculated separately for the studies using the more restricted CTS case definition requiring abnormal nerve conduction studies
	+ When this more conservative definition was used, heterogeneity was resolved for repetition, force + repetition, and use of vibratory tools, but was not resolved for force alone or for wrist posture
	+ The odds ratios remained elevated for the new analyses for repetition, force + repetition, and use of vibratory tools after heterogeneity was thus resolved and were consistent with the OR from all studies combined
* For hand force alone, the heterogeneous OR of 2.18 from 13 studies was resolved when the authors distinguished between studies utilizing two distinct measures of force: quantitative grading (such as in terms of kg of force) and qualitative categorizing (force classified as present or absent)
	+ Four studies were separated out which used force as a yes/no variable, and the resulting homogeneous OR was 6.00 with 905% CI 3.55 to 10.15
* Meta-regression techniques were used to identify the sources of heterogeneity, and three variables were found to account for most of it: CTS case definition, risk of bias, and country in which the study was conducted
* This meta-regression identified some noteworthy sources of heterogeneity for force
	+ For the 13 all-inclusive studies, the OR was 2.18 with CI 1.47 to 3.25
	+ For a conservative definition of CTS and country=USA, the OR from 2 studies was 1.76 with CI 0.36 to 8.62
	+ For a conservative definition of CTS and country=non-USA, the OR was 6.13 with CI 3.21 to 11.73
	+ For a conservative definition of CTS and country=non-USA, the OR from 3 studies was 6.13 with CI 3.21 to 11.73
	+ For a conservative definition of CTS and country=non-USA and risk of bias=low, the OR from 1 study was 4.75 with CI 1.95 to 11.58
	+ Because both of the studies from the USA with a conservative definition of CTS were at low risk of bias, the OR for this category was 1.76 with CI 0.36 to 8.62

Authors’ conclusions:

* The results of this meta-analysis are consistent with biomechanical hypotheses which predict that hand force and repetition increase the risk of CTS in the workplace
* For a stringent definition of CTS, requiring nerve conduction abnormalities in addition to symptoms and clinical signs, vibratory tools and hand force greatly increase the risk of CTS
* There are numerous limitations with the meta-analysis due to the fact that so many studies collected information about exposures retrospectively and were not able to control for potential confounders
* No information could be extracted which could quantify the exposure-CTS relationships in terms of the duration or dose response, meaning that there was no way to say what level of exposure is safe, especially when combinations of factors are involved
* Therefore, there is a high priority to conduct well-documented prospective studies of inception cohorts just beginning work in high-risk occupations
* Workers’ compensation authorities should recognize these relationships, and highly repetitive wrist or hand work should be avoided with regular rotation of tasks and appropriate rest periods

Comments:

* Although a large number of studies was considered, there are some important limitations which are reflected in the column for “method used for exposure estimate” in Table 1
	+ 28 of these used job title to estimate exposure and 5 used self-report of exposure, while only 3 used observation of the range and number of movements
* The method of assessing risk of bias is far from transparent, and there is no table indicating which criteria were satisfied for the included studies; the criteria were taken from the Cochrane Risk of Bias Tool for assessing the quality of randomized clinical trials, and there is insufficient information concerning how they were translated into the observational study frame of reference
* The effect measure was constrained to be expressed in terms of odds ratios, requiring the authors to dichotomize exposures into yes/no categories, whether the original studies did so or not; there is a lack of transparency concerning how this was done
* One valuable contribution of the study is found in Table 3, where the sensitivity analyses showed the different odds ratios obtained for force when a conservative definition of CTS was used in the USA (OR=1.76 with CI from 0.36 to 8.62) versus when the studies were done outside the USA (OR=6.13 with CI 3.21 to 11.73)
	+ In this instance, the location of the studies not only changes the effect size for force, but also makes the difference between a statistically significant and non-significant summary odds ratio
* The study contributes little to the causation section of the guideline, since there is no light to be shed on the question about how many hours of exposure or what levels of force and repetition are likely to account for the development of CTS in at-risk workers

Assessment: inadequate for evidence concerning the contribution of workplace exposures in relation to CTS (non-transparent calculation of summary odds ratios, overuse of studies with grossly inadequate measures of exposure (job titles), and lack of duration or dose information