PHYSICAL WORKLOAD ON WRIST AND FOREARM IN VARIOUS TYPES OF WORK

Hansson, G-Å.; Balogh I.; Ohlsson K.; Granqvist L.; Nordander C.; Arvidsson I.; Åkesson I.; Unge J.; Rittner R.; Strömberg U.; Skerfving S. Division of Occupational and Environmental Medicine, University Hospital, Lund, Sweden

Aims
To investigate the range of physical workload, on wrists and forearms, in various types of work, and to explore various measures, in order to identify the parameters needed to characterize the workload.

Methods
Flexible electrogoniometers were used for measuring positions and movements of the wrists, with a sampling rate of 20 Hz. The 10th, 50th and 90th percentiles of the angular distribution, and the 50th and 90th percentiles of the absolute angular velocity distributions, were used to characterize positions and movements, respectively. In addition, the mean angular velocity, fraction of time with an angular velocity < 1 °/s, and the mean power frequency, were used as measures of movements.

Surface EMG, with a sampling rate of 1024 Hz, was used for recording the muscular activity of the forearm extensor muscles. The RMS value, calculated for epochs of 1/8 s, was used to describe the muscular activity, which was normalized to maximal voluntary contraction (MVE). Muscular rest, i.e. fraction of time with an activity < 0.5 % MVE, and the 10th, 50th, 90th and 99th percentiles of the amplitude distributions were used to describe the muscular activity.

For both the goniometer and EMG recordings, dataloggers, today updated and comprising 512 Mbyte memory cards, enabling whole-day continues ambulatory recordings, were used.

Forty-three types of “office”, “industrial” and “non-office non-industrial” work, both “varied and/or mobile” and “repetitive and/or constrained”, as well as “pauses” were recorded. In total about 700 subjects were involved, and the recording durations ranged from 20 to 340 minutes. The same methods and algorithms have been used for the analysis of all recordings. The mean value, for the subjects performing the same type of work, and the corresponding standard deviation (SD), were used to characterize the load (group mean exposure), and the within-group variation, respectively.

Results
There was a wide range in wrist movements between the different types of work, from 1.4 °/s for office work (mouse-based computer) to 54 °/s for highly repetitive work (50th percentile). Wrist positions, as well as muscular rest (0.2 – 23 % time) and peak load (3.4 – 41 % MVE; 90th percentile) also varied considerably. Even within the work categories, there were large variations for all measures.

All wrist movement measures were highly correlated (|r_s| = 0.82 – 0.99; r_s = Spearman’s rank correlation coefficient), but only weakly correlated to positions (|r_s| = 0.01 – 0.43). Muscular rest and “static load” (10th percentile) were highly correlated (r_s = -0.92), but uncorrelated to peak load (90th percentile; |r_s|=0.05 and 0.08, respectively). The relation between wrist movements and muscular rest depended on work type: most low-velocity work was accompanied by much muscular rest; however, the low velocity for mouse-intensive computer-work was accompanied by very little muscular rest.

There was a considerable contrast, i.e. the ratio, between the range of exposure for the various types of work, and the within-group variation, was large, in all exposure measures.

Conclusions
Direct technical measurements give objective and quantitative exposure data. Provided that the measurement methods per se are valid, they give generic data, i.e. identical position and movement data will be obtained, independent of, whether electrogoniometers, electromagnetic transducers, or electro-optical measurement systems, are used.

The multidimensional character of exposure has to be considered in general exposure/response models: one measure of movements, a second one of the “low-end” muscular load (muscular rest or 10th percentile) and a third one of peak load (90th or 99th percentile), have to be assessed; in addition positions might be measured.

The present data show that the exposure may vary independently for each of the above 3 dimensions, and that a wide variety of combinations of exposures, which represent potential risk factors, occurs in working life.

Thus, the present exposure assessment methods are suitable for establishing quantitative generic exposure/response relations, applying group-based exposure assessment strategies.

The methods are also suitable for: surveillance of physical workload, quantifying the effect of interventions, as well as comparing alternative equipment and working methods.