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## **Exposure assessment in ergonomic epidemiology**

*Is there something specific to the assessment of biomechanical exposures?*

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In this issue of the Journal the authors of two articles in “ergonomic epidemiology” stress several necessary qualities of exposure data: they must be accurate and precise<sup>1</sup>; the method of exposure measurement must be reliable<sup>2</sup>. All epidemiologists in occupational epidemiology would agree with that: absence of systematic or random error is important, stability of the measure if repeated under identical conditions is important too. Among the expected qualities of exposure data one could add “relevant”; we expect that the exposure data are consistent with what is known (or suspected) about the mechanisms underlying their effect on disease. This is less obvious than it seems; for example, in many situations one can wonder whether the relevant exposure is that of today, or that of last week, or that of twenty years ago, or the cumulative exposure over the twenty last years. Another quality (or limit) has to do with feasibility. If exposure assessment, at an individual level, is very expensive (in terms of money or time) alternative solutions have to be found if the study sample is large. All that is common to all the fields of occupational epidemiology. Then, is there something specific to the assessment of biomechanical exposures? Are the problems met when recording the time spent with the upper arm elevated above 90° very different from those met when assessing the level of past exposure to (for example) formaldehyde or electromagnetic fields, considered as potential carcinogens?

At least the history of research in these domains is different: a decade ago, in the field of occupational risk factors for musculoskeletal disorders, some questions were not discussed: there was no debate on how to use the expertise of ergonomists or specialists in biomechanics for epidemiologic studies; there was almost no research activity on other methodological aspects such as comparisons between questionnaires and direct observation. These questions were almost absent from the first PREMUS (Prevention of Work-related Musculoskeletal disorders) conference in 1992 in Stockholm. One exception was an abstract by Winkel and colleagues from the MUSIC project, who had evaluated a questionnaire estimating physical

workload<sup>3</sup>. The situation was very different in occupational cancer research. The concept of JEM (Job Exposure Matrix) covering an array of chemical substances, job titles and industries, was described as early as 1980<sup>4</sup>. Ten years ago cancer epidemiologists applied specific methods for sampling and analysis of exposure data<sup>5</sup>. In the presentation of the results of a European concerted action on the retrospective evaluation of occupational exposures in epidemiology, in 1993 Goldberg and Hemon gave more than 50 references discussing the measurement of occupational exposures in epidemiological studies<sup>6</sup>. A reason for that early development of methods for exposure assessment could be that, for cancer, difficulties dealing with (past) assessment of exposure were obvious, which motivated occupational hygienists, epidemiologists, and also biostatisticians to find adapted solutions. For biomechanical exposures, the (false) idea that it was enough to use the tools provided by ergonomists and specialists in biomechanics was probably widespread. However, in the last ten years, there has been a remarkable development of research on methodological aspects of assessment of exposure to biomechanical risk factors. Several subjects have been widely studied and discussed: the limits of using job titles to assess exposure<sup>7</sup> and various other aspects of variability of exposure measures<sup>1</sup>, the validity of questionnaires versus observation or measures<sup>2</sup>, the use of aggregated measures<sup>8</sup>, the retrospective assessment of exposure<sup>9</sup>, and other such as bias due to the presence of pain.

The two articles in this issue of the Journal bring interesting results in this field of research: Heinrich and al.<sup>2</sup> compared, in a study population of 87 computer workers, questionnaire data about exposure to postural load and duration of computer use with an observation of the workstation design and posture by a trained observer. They conclude to a low agreement between the two approaches. However, they raise the question of whether the “gold standard” for postural load is the observation technique, since observation is based on short periods of time, and being observed might modify the posture.

Svensson and her colleagues<sup>1</sup> explored an attractive approach to the assessment of upper arm elevation above 90° in machinists, car mechanics and painters. Workers filled diaries with approximately ten preprint tasks, and exposure was evaluated using a TEM (Task Exposure Matrix). The diary worked well, and could be used to take into account the variability of tasks between subjects in the same job, which is a positive result. However, there was considerable within-task variability; in addition the exposure contrast between tasks was relatively small in these jobs. In this situation, spending resources on obtaining task information does not seem to be the optimal strategy.

These two studies suggest important directions for future research:

The first one is the development of simple techniques for assessing biomechanical exposures. There is still no consensus about the validity of questionnaire data to assess postural load <sup>2</sup>. Improving the questionnaires by adding pictures to the questions is probably a good suggestion. It is also necessary to think about the qualities expected from a tool (such as a questionnaire) in the context of epidemiological studies. The most important qualities are not necessarily the same in epidemiology, ergonomics, or biomechanics.

The second direction deals with indirect measures such as JEMs (Job Exposure Matrices) or TEM (Task Exposure Matrix). The main limitations in the development of matrices for biomechanical exposures is the variability of exposures within a job and within a task. However, this is probably the case more for some risk factors than for others. In large scale studies, JEMs might be useful to evaluate levels of exposure among all the subjects in a first step, possibly in combination with more precise assessments in specific subsamples. In addition, adapted statistical methods should be used and developed. Multilevel models should be more widely used <sup>10</sup>. They are adapted to situations where some data were collected at a group level, and also for repeated measures <sup>11</sup>. Methods have also been proposed for combining expert rating and exposure measurement <sup>12</sup>.

For these three aspects, the research needs are partly specific of the field of “ergonomic epidemiology”, but also common with other fields in occupational epidemiology.

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