Quality of Work and Products in Enterprises of the Future / Qualität von Arbeit und Produkt in Unternehmen der Zukunft
Edited by H. Strasser, K. Kluth, H. Rausch and H. Bubb
Ergonomia Verlag, Stuttgart, 2003

Using On-Site Observations for Low Back Related Work Load Assessment – Methodological Issues

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Abstract: On-site ergonomic observations have been selected as the core method to assess workload exposure within a cohort study over etiologic and prognostic determinants of work related back pain. Self reports collected through a questionnaire may offer a cheaper proxy for exposure assessment but they have been shown not to provide reliable data to ensure a correct classification of subjects in different exposure groups.
The design of an observation protocol raises several methodological issues. First a choice has to be made between direct or delayed observations using video recordings. In comparison to direct observations, delayed ones allow a more precise measurement of duration and frequencies of each activity but are time consuming, costly and lack the 3D vision of the worker posture. When opting for direct observations, a discontinuous capture modality seems to offer the best choice if one makes use of an exhaustive coding grid that will ensure the observations content validity. A second issue concerns the trade-off to be found between the observation accuracy (using the shortest possible time interval) and the observer mental load.
A third issue is how to best sample the work activities: using a task-based or a randomized time sampling technique? According to the literature, within-group variance seems to be less with a fixed number of observation periods randomly distributed over the work shift. When this last approach is selected, a further issue refers to the optimized balance between the number of workers to sample in each job category and the number of observation periods per worker. Recent studies using a bootstrapping technique provide promising solutions to this last question.

1. Introduction

The on-site observation methodology is part of a workload exposure assessment strategy developed for a follow up epidemiologic study funded by the Belgian government (OSTC PS/12/26). This study, led by several research centers[1], aims to assess the respective role of personal psychological characteristics, and work-related physical and psychosocial factors on the occurrence of low back pain among 972 young (<31 yr) and pain free workers from either health care or distribution sectors.

Individual work load is first assessed by means of a self-administrated questionnaire. Whereas a questionnaire is easy to apply, in a repeated measures design, to a large sample of subjects, it is well-known that, in comparison to the observations, the collected data are not reliable enough to ensure a correct classification of subjects in different exposure groups (12). An observation methodology has thus been developed but only concerns a sample of the study subjects in each job category because of cost limitations. The design of such an observation protocol raises several methodological issues which are discussed here.

2. Observation methodology

Three recent reviews (2;7;8) have first been analyzed in order to define the observation principles like the choice between direct or delayed observations and between a continuous or

[1] *IDEWE Occupational Health Services, Leuven; Department of Occupational Medicine, Catholic University of Leuven ; Department of Public Health, University of Liège , and Departments of Psychology, University of Gent and Catholic University Leuven (Belgium).*

discontinuous capture mode. Once these principles defined, six observation methods (1;4;10;11;13;15) have been selected and analyzed to find the best trade-off between the observation accuracy and the observer mental load and to select accordingly the suitable observation period characteristics. A last issue concerns the sampling strategy of the observation periods : which of either a task-based approach or a randomized time-sampling technique is the most accurate in assessing work activities?

2.1 Observation principles

It first appears in our review analysis that, when using a computerized grid the choice of a single observer can be made to avoid the inter-observer variability bias. However, according to Kilbom guidelines (7), in that case the number of variables simultaneously observed should be lower than 10 and the trunk posture variables should be assessed using a maximum of 3 categories. Moreover, the single observer must be well-trained to its grid and an intra observer reproducibility test should be made. (1) The grid as used in the present study is shown in Fig. 1. In order to ensure the grid content validity, this grid takes into account the low back pain risk factors (whole body vibration, manual handling, trunk bending and twisting and static work posture) (3). Five different variables are analyzed (or 11 if *basic motor action* is considered as a 7 variables group) and the trunk posture variables are classified into 2 and 3 categories.

***Table 1**: The observation grid as used in the study*

basic posture	**flexion**	**rotation**	**basic motor action**	**load (kg)**
• standing • sitting • kneeling/squatting	• 0-20° • 21-45° • >45°	• 0° Rot • Rot +	• no action/holding a load • walking /carrying • driving • lifting/lowering • pushing/pulling • throwing • other action	• 0 • 1-10 • 11-25 • > 25

When choosing between direct or delayed observations, it appears that, in comparison to direct observations, delayed ones allow a more precise measurement of durations and frequencies of each activity but are time consuming, costly and lack the 3D vision of the worker posture because of the video recording. Direct observations could thus provide a better cost-effectiveness relationship. (7)

If direct observations are selected, a choice has then to be made between a continuous or discontinuous capture mode. The continuous one provides better accuracy of duration and frequency measurements but increases the observer mental load and implies thus a reduction in the number of observed variables. So far the advantage of a continuous observation over discontinuous ones has not been demonstrated (7). So, a discontinuous capture modality (time-sampling procedure like snap shot) seems to offer the best choice if one want to use an exhaustive grid.

2.2 Observation period definition

When choosing the discontinuous capture way, a trade-off has to be found between the observation accuracy (using the shortest possible time-sampling interval) and the observer mental load. In fact, lowering this interval allows the observer to see more operations of each observed task but asks to limit the number of observed variables and to decrease the observation period duration.

In the literature, the time-sampling interval used in practice varies from 15 sec (11) to 1 minute (1). The PEO methodology (4) uses a 30 minutes observation period and the OWAS methodology guidelines (6) requests a minimum of 100 capture points for each observation periods. On that basis, a 30 minutes observation period and a 15 sec time-sampling interval (120 capture points per period) were considered as being a good compromise.

Moreover, the computerization of the grid (using a *Fujitsu stylistic LT C-500** sensitive screen computer) provides various means to reduce the observer mental load. For instance, in case of a long duration work task, each 15 sec, the software uses the last encoding as a default value for the next encoding. Moreover, the observer is informed of the moment he must look at the worker by a bip and the countdown of the 15 seconds is also shown. There is a *non available* function to cancel the encoding and a *pause* function to interrupt the observation, when needed (i.e. for the worker privacy).

2.3 Sampling of observation periods

Two approaches are possible to sample the work activities of a given job: using a task-based or a randomized time sampling technique. The first strategy involves the observation of each of the tasks of the job the same way (for instance, one observation period per task) and then, the weighting of the data collected taking into account the time proportion of each task *so that each function can be comparable* (14). A task-based approach seems to be logical and accurate but in fact it requires a large preliminary analysis to define the tasks temporal distribution. For jobs involving varying tasks, such analysis is time consuming and will have a direct impact on the actual accuracy of the approach.

The second strategy consists in a randomized distribution of a fixed number observation periods all over the shift, within each job or function, without taking into account the tasks distribution. According to the literature, within-group variance seems to be less with a fixed number of observation periods randomly distributed over the work shift (9) than when using a task by task approach. Hence the choice of using a randomized observation periods distribution was made in the present study. Yet in such an approach, it is absolutely needed to define a fixed number of observation periods and a fixed number of observed subjects per function.

Recent studies using a bootstrapping technique provide several options to define these numbers. Hoozemans and al.(5) have determined for a given number of observation periods the number of observed subject needed to ensure a 5% precision level in a 5-95 percentile range. For instance, to reach this precision level, either 8 subjects (at least) have to be observed during 8 periods or at least 12 subjects during 4 periods. This last option should be an efficient strategy for it allows observing 2 workers a day so that each job category is observed within 6 days instead of 8.

3. Conclusions

The described methodology has been applied to 152 cohort study subjects without any problems for the observer and can thus be considered as feasible. Yet the methodology has still to be validated. If the content validity of the grid is already ensured, the criterion validity must still be tested for several aspects of the grid. The estimation of duration and frequencies with a discontinuous capture methodology can be tested by comparing to simultaneous measurements using a continuous capture mode. The weight (or exerted force) and the trunk angle estimation could also be compared to objectives values respectively measured with a dynamometer and an inclinometer (or goniometer) strapped to the subject trunk. However, a second observer (simultaneously taking these measurements) would be needed for these validation tests. Finally, the results collected using the selected sampling strategy must show a higher variance between job categories than within job categories.

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