Exposure Assessment of Low Back Disorders: Manual Material Handling Limits

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1 INTRODUCTION

There are numerous regulations and standards on prevention of work-related musculoskeletal disorders (WMSDs) affecting millions of workers and workplaces. Almost all of them are based on principles of biomechanics, psychophysics, and physiology with the common goal of designing tasks in the way that the stresses imposed upon the majority of the workforce are below the threshold for fatigue, discomfort and injuries (Ayoub and Dempsey 1999).

Quite often it is difficult to collect all the needed data for a proper exposure assessment on a single task, and major difficulties are encountered in exposure assessment of multiple tasks. Sure enough, magnitude (intensity), frequency, and duration of exposure can be difficult to measure exactly. In addition some standards and regulations have been established in the laboratory, and the links between empirical research and actual exposure in the workplace are not yet completely validated by epidemiological studies. Nevertheless, it is worthwhile to establish limits for manual material handling activities as they assist industry in the control of low back pain.

2 MANUAL MATERIAL LIFTING LIMITS

There may be a variety of assessment for the various types of manual handling, but it is always possible to calculate a synthetic exposure lifting index or manual handling index (MHI) as a function of major situation variables:

$$\text{MHI} = \frac{\text{Actually handled weight (force)}}{\text{Recommended weight (force)}}$$

Even if it is determined by semiquantitative assessment procedures, the MHI may become an effective tool for defining the consequent preventive measures in accordance with correct prevention strategies, and this may be more important than its role in defining the exposure level of one worker involved in manual handling.

When defining preventive measures, it is convenient to classify MHI results at least according to a model having more than two levels and not a simple dichotomous (yes/no) type. This is because the level of approximation (both intrinsic and in conditions of application) for the suggested methods and procedures calls for a certain amount of caution, especially over borderline results around the value of 1. Then a three-zone model (or traffic light model) appeared to be useful, with the MHI classified as follows:

- *Green zone* (MHI ≤ 0.75) There is not a particular exposure for the working population and therefore no collective preventive actions are required.
- *Yellow zone* ($0.75 < \text{MHI} \leq 1.25$) This is the borderline zone where exposure is limited but may exist for some of the population. Prudent measures are to be taken, especially in training and health surveillance of operators. Wherever possible, limit exposure so as to return to the green zone.
- *Red zone* (MHI > 1.25) Exposure exists and is significantly present. The higher the MHI value, the higher the exposure for increasing numbers of the population. MHI values may determine priority of prevention measures that must in any case be taken to minimize exposure and shift it towards the yellow zone. Training and active health surveillance of operators must be undertaken in any case.

Obviously the definition of the values corresponding to the three zones is somewhat empirical and may also reflect requirements independent of methods and related data generating the proposal; in this sense the limit values may also be modified by taking into account peculiar application requirements but mostly by a critical reflection on their validity, based on concrete application results.

3 LIMITS OF PULLING, PUSHING, AND CARRYING

For manual load handling — pulling, pushing, carrying — the literature describes no equally consolidated procedures, based on multidisciplinary approaches like the NIOSH

procedure for lifting. We suggest ignoring the literature methods and using instead data derived from the specific application of psychophysical methods masterfully summarized by Snook and Ciriello (1991). Here are our three main reasons:

- The data is also expressed with reference to the percentiles of potentially satisfied (even if not necessarily protected) population.
- Data from psychophysical studies is used to develop the NIOSH formula (NIOSH 1981; Waters *et al*. 1993) to assess lifting tasks; in particular, it is used to evaluate the degree of protection or better satisfaction associated with use of the recommended weight limit.
- The data from psychophysical studies is expressed by Snook and Ciriello (1991) with reference not only to the two genders but also to structural variables (height of pushing or carrying areas, distance) as well as to organizational variables (frequency and duration of tasks) which produced well-defined methods according to the different working situations.

Applied in equal conditions, these are the three reasons that led us to prefer psychophysical data, provided it is homogeneous with lifting task procedures and assessment criteria. Pushing and pulling data (conceptually comparable with the recommended weight of lifting task) is referred to forces for activating and maintaining actions. Carrying data is referred to the weight of the carried object. All data is referred to satisfaction of 90% of the population. Values are subdivided according to major structural and organizational variables. With such data available, exposure assessment is rather simple and consists of the following steps:

1. Select the scenario from the figures (kind of task, structural conditions, duration and frequency, gender target) which best fits the actual situation to be analyzed by identifying the recommended force (or weight).
2. Determine in a real situation and under usual operating conditions the force needed to start or maintain a pushing or pulling action. This can be done by using a conveniently interfaced normal dynamometer; for carrying, simply define the weight of the carried object.
3. Define the ratio between the force measured and the corresponding recommended value; this gives the relevant index.

4 CONCLUSION

It is generally believed that persons should not lift more weight than they would be willing to accept based on their own point of view. However, proposing practically acceptable limits for manual material handling tasks may be quite useful for all those involved in applying regulations and standards for prevention of musculoskeletal disorders related to manual load handling. Moreover, there is a need for an epidemiological validation of the proposed limit and for basic and applied research to define which method of aggregation provides the best assessment of exposure to complex jobs involving manual material handling. There is a need for basic and applied research to enhance the methodologies for aggregating multiple-component manual material handling tasks with manual material handling criteria.

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