

PREVENTION OF WORK-RELATED MUSCULOSKELETAL INJURIES IN CONSTRUCTION INDUSTRY

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Abstract. : Many construction work tasks are physically very strenuous, and the incidence of work-related musculoskeletal disorders (WMSDs) among construction workers is considerably higher than that in most other occupations. The aim of the research project presented in this paper was to contribute to an understanding of a healthy construction workplace brought about by the best practices implemented by large construction sites. From a preventive perspective, a model for the construction workplace system balance was used to identify the successful strategies.

To identify the successful strategies in the Swedish industry to prevent WMSDs, several construction projects were investigated through interviews, site observations and company's documents study. In every construction project, six areas, (i.e., planning, technology used, work organisation, physical work environment, work tasks and the individual worker) of the construction workplace system balance were investigated.

Numerous successful strategies both in pre-production and production phases of construction projects were identified in the six different areas of the construction workplace system balance; however there seems to be a significant need for good practices in the systematic work environment management. Further, the implications of some remuneration methods on the production schedule were perceived as detrimental to musculoskeletal health of construction workers.

Keywords: Work-related musculoskeletal disorders, best practices, construction workplace, health promotion, ergonomist.

1. Introduction and Background

The Swedish construction work environment is regarded as the safest in the world (Flanagan *et al.* 2001) as far as the working conditions and musculoskeletal health are concerned. Nevertheless, there are still work environment related health problems to be tackled. Public debate in recent years has focused increasingly on work environment issues. Although this alone cannot account for the large number of long-term sick leaves, it is surely one of several factors involved, and a multi-aspects improvement of the workplace is seen to be the most important single measure for reducing the incidence of ill-health such as musculoskeletal disorders.

Work-related musculoskeletal disorders (WMSDs) are described as a whole range of disorders which are not typically the result of an acute or instantaneous event, but which are the result of a chronic development. Various risk factors,

including personal characteristics (for example physical limitations) as well as societal factors may contribute to the development of these disorders (Armstrong, *et al.* 1993). WMSDs affect a wide variety of construction occupations, and are not specific to any type of job of work activity. Different construction trades are exposed to various kinds of physical workload, involving different parts of the body (Holmström *et al.* 1995) and the incidence of WMSDs is considerably higher than in most other occupations (Schneider 2001). Risk factors which can cause or which may have an association with WMSDs include repetitive, forceful or prolonged exertions of the hands, frequent or heavy lifting, pushing, pulling or carrying of heavy objects and prolonged awkward postures. According to Djupsjöbacka *et al.* (2004) and Kaminskas (2007), physical risk factors encompass work postures, heavy dynamic work, light repetitive work, static work, vibrations, temperature, lighting and noise; whereas psycho-

logical factors include work demands (time pressure, difficult work tasks), influence, social support (from the supervisor, work mates), salary and rewards, work times and role allocation/ambiguity.

Large numbers of construction workers are still leaving the industry before the retirement age due to WMSDs (Samuelsson and Andersson 2001). But there is however an emerging hope in this industry's workplace, as it was recently reported by *Byggnads Arbetaren* (2006) that the number of WMSDs in the construction sector continued to drop for a third year in a row. Between 2003 and 2005, the number of reported work-related diseases, WMSDs being accountable for the majority of them, has fallen 30 percent. Bengtsson *et al.* (2002) attribute this improvement partly to the emerging construction workplace culture of health promotion which focuses on a number of the surrounding and individual-related factors. Menckel and Österblom (2004) explained that health promotion focuses more on creating supportive environments and conditions for a better health for all for example on the worksite.

2. Research objectives

There were two general objectives underlying this research study. In the absence of enough information about good industry practices promoting musculoskeletal health, the first objective consisted of identifying and describing strategies and activities (i.e. best practices¹), which have proven to be successful in the fight against the development of work-related musculoskeletal injuries in the construction industry. The second objective was to formulate recommendations significant to WMSDs prevention and specific to the construction work environment; in order to bring about immediate actions or to guide further research studies on identified issues.

3. Research study boundaries

The research study focused on the issue of WMSDs in the construction industry, because these injuries still constitute a large portion (currently 73 percent) of all work-related diseases reported among construction workers (Samuelson and Lundholm 2002). The focus of this research was on the following construction trades: scaffolding erectors, concrete workers, carpenters, roofers, carpet layers, electricians, plumbers and heavy machines operators. Several occupational groups were not included in this study; this delimitation was based on

the choice of occupational categories that have been mostly affected by musculoskeletal injuries and with a higher average of sick leave days due to WMSDs (Samuelson and Lundholm 2002; 2006).

This study was further limited to housing construction projects, which meant that roads, tunnels and bridges construction projects were excluded.

4. Methods

4.1. Research design

Ninety in-depth semi-structured interviews were conducted with construction workers, contractors, sub-contractors, designers and developers working with specific construction projects selected for the study. With the help of an interview guide and within the framework of six different areas, the interviews were conversational and open-ended, typically varying between 45 and 90 minutes in duration. Interviews were all conducted by the same interviewer (an ergonomist). The discussions were tape recorded and transcribed.

In addition to the interviews, site observations and companies' documents study were performed, with the stated objective of these three investigative tools being to identify good practices conducive to musculoskeletal health of construction workers.

4.2 Sample

Thirteen large construction sites in different regions of Sweden were chosen. Construction workplaces were selected on a convenience basis from the Swedish construction industry and were invited via telephone or e-mail to participate in the study. A criterion for participation was that construction projects/organisations had distinguished themselves in one or more areas, namely, planning, work organisation, technical aspects, work tasks, and physical environment. Another selection criterion was the size of the construction workplace, because the research study was limited to construction sites with at least fifty construction workers.

4.3. Analysis

The data was analysed by sorting material into the different aspects affecting the musculo-skeletal health of the construction worker, as depicted in the construction workplace system balance (see Fig 1).

Further analysis of the data material happened through the identification of best practices. Belle (2000) asserted that it is critical for improving performance that benchmarking singles out those practices that have proved to be the best in a given area.

5. Results

Because of the brevity and the specific focus of this paper, only the results pertaining to the successful strategies or best practices will be presented in the paper. These were jointly identified through site observations, documents study, and interviews with 94 participants of whom, 70 have at least 15 years of work experience in the construction industry, and the rest had worked at least 3 years in the industry.

¹ Best practices or good practices are those implemented solutions to prevent the exposure of workers to risks during construction activities. (http://agency.eu.int/news/press_releases/en/19_04_2004/index.htm).

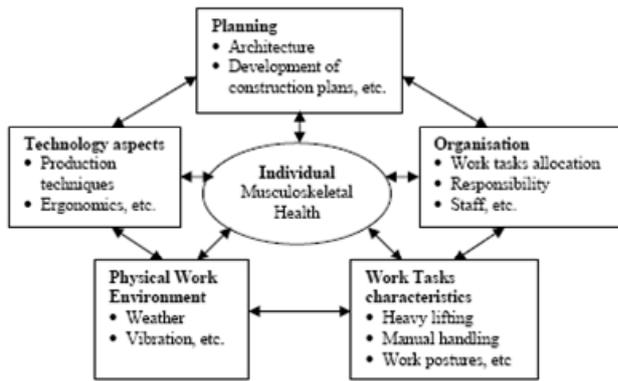


Fig 1. Aspects affecting the work-related musculoskeletal health of the individual construction worker (Rwamamara 2005).

5.1. Identified best strategies or best practices

5.1.1. Planning

At every construction workplace, a compulsory Work Environment Plan (WEP) is laid down by the developer although the implementation of WEP is delegated to the principal contractor.

A long term planning of health issues starts with the preliminary hazard analysis of construction activities. This risk analysis makes it easier to schedule and select appropriate mechanical aids such as cranes and personnel and material hoists. A high level master schedule maintained throughout the project is coordinated with the short-term/look-ahead schedules to manage detailed flow. A common requirement during planning and scheduling is to match the product, the process, work methods and the promotion of health issues at the workplace.

In planning for industrialised construction, which is more often the case in Swedish large construction workplaces, more attention is paid to the building components design and ease of installation, thus prefabrication is preferred to the traditional construction which entails heavy lifting, awkward postures and repetitive tasks.

During the pre-production planning stage of preventive measures, worker's views and risks from previous projects are taken into account.

5.1.2. Work and workplace organisation

Depending on how large the construction workplace is, the management is made up of the site manager and the supervisors. The organisation is a flat hierarchy and site managers are not only responsible for the production matters but also for economic and work environment issues. Construction workplaces currently have a more streamlined organisation with a system of cooperation based on negotiation.

Healthy organisations included regular meetings between various groups e.g. the main contractor and sub-contractors and a good flow of information on different health and safety issues between for example work supervisors and construction workers. This was made easier by the flat organisational system

For more effectiveness in dealing with WMSDs issues, worker representatives and work team leaders are offered regular training through health and safety courses which provide updated knowledge about health promotion and WMSDs prevention measures.

The consultation of construction workers is of a paramount importance as site managers asserted that workers are resourceful and well worth listening to.

5.1.3. Production technology

Special production techniques were discussed in the interviews and were observed on construction sites; some of these techniques are not commonly available in all construction workplaces. During discussions with both the management and construction workers; the production hall system, the Automatic Climbing System-Platform (ACS-P) and the off-site pre-assembly, were identified as special production techniques. Use of these innovative production techniques minimise risks of heavy manual material handling, repetitive tasks, awkward work postures and slips and falls; thus eliminating the exposure to some of the WMSDs risk factors. Other aids include remote-controlled concrete pumps and traverses (used in production halls), roof-lifting crane systems, personnel and material hoists, carrying aids such as cables wagons and carpet rolls carriers

Other than the mechanical aids, large Swedish construction workplaces have invested a lot in ergonomically-designed and light hand tools, in order to reduce vibration and awkward postures.

Newly developed building products such as the self-compacting concrete (SCC) has huge musculoskeletal health benefits for concrete. Furthermore, use of prefabricated modules has reduced the number of work tasks which were traditionally performed on site, thus minimising the occurrence of awkward work postures.

5.1.4. Work tasks

When it comes to improving work tasks by eliminating WMSDs risk factors; using mechanical aids, personal protective equipment (PPE), work rotation within a work group, team work and working with an upright work posture are the common preventive measures. Among the eight trades investigated, only plumbers, electricians and carpenters were found to have several work tasks done above shoulder level; however the management often solves this problem by minimising the exposure level.

5.1.5. Physical work environment

During interviews, many construction workplace managers and construction workers have affirmed that good lighting, good house keeping and having enough work space contribute to a reduction of work-related injuries. The use of new or improved building materials and hand tools has considerably reduced the vibration emissions at the construction workplace.

To accommodate different working heights, the use of lifts and access ramps is very common on construction sites, thus making it easier for workers to transport materials without undue strain.

Performing production tasks in the production hall, in a large tent and working under the weather cover sheets are considerably changing construction activities into weather independent ones, and consequently cutting down WMSDs related to cold weather.

5.1.6. Individual factors

Although, the Swedish construction workforce is an aging one; construction workers indicated that their health was generally good and that they liked their occupations despite the risk factors involved in their jobs. Workers understand the importance of using PPE, applying adequate work methods as well as having good physical fitness in order to minimise risk for WMDS. Besides regular physical fitness, pre-work stretching sessions on sites are considered to contribute to musculoskeletal health among workers.

Through massage and naprapath therapy, the number of those who stayed at home because of muscular pain has reduced. During interviews, the management expressed its satisfaction with the worker's foot anthropometry profile system that has been used to equip their workers with custom-made shoes, thus reducing some of their workers' musculoskeletal problems of the knees and the back.

5. Recommendations and conclusions

The recommendations constitute a proposal on areas where good practices need to be developed in consideration of work-related musculoskeletal health issues.

5.1. Planning

The study showed that developers had very little involvement in the implementation of the WEP. A constant cooperation between the developer and the general contractor is necessary not only on designing the work environment plan but also on implementing it.

A broader worker participation in the pre-production planning should be desired for an optimal input about the potential risks and controls. Furthermore, general contractors should encourage sub-contractors to take part of the pre-production planning to present the identified health risks.

6.2. Work organisation

An effective solution to reduce WMSDs among construction workers should not ignore issues of leadership, remuneration system, employment types and worker involvement.

Training workers in health and safety issues provides a basis for consistent awareness, identification, analysis, targeting and control of WMSDs. Therefore, construction companies should consider providing training to workers, supervisors and site managers through participating in the musculoskeletal disorders control program.

Both the management and the workers need more training to improve their knowledge in Systematic Work Environment management (SWEM)².

6.3. Technical aspects

A greater level of industrialised production and use of assembling techniques for prefabricated modules is recommended to construction companies.

The availability of mechanical aids on the site should depend on the nature of the work tasks to be performed. Construction employers should do an evaluation of cost-effectiveness of the positive effects generated by the accessibility of mechanical aids.

6.4. Work tasks

To reduce production pressures, the principal contractor and his subcontractors should consider providing enough manual labour. By estimating the reduced costs for sick leaves due to reduced workload, the employer should be able to support his staffing strategy.

Employers and workers in partnership should continue addressing these risk factors by both administrative (e.g., management systems and work organization) and engineering (e.g., mechanical aids and ergonomic tools) controls.

Further, the study showed there is a need for an efficient planning that will make the mechanical aids and necessary work tools promptly and readily available to workers to help them perform their work tasks.

6.5. Physical work environment

Findings indicated that a poor and inadequate planning was the first contributor to a bad physical work environment. A dynamic and thorough site layout should be considered in order to accommodate a constantly changing construction workplace. The study indicated there is a lack of coordination of housekeeping. Housekeeping responsibilities should be spelt out in contracts and tender documents. These documents should define the responsibilities and contractors should discuss details.

In line with the study findings it would be reasonable to suggest that the more construction activities are performed in a production hall, the less WMSDs risk factors workers will be exposed to, especially during winter.

6.6. Individual factors

The study showed that workers have different physical work capacities due to their age and muscular strength. Therefore, it is important to consider mapping

² The Swedish regulation on systematic work environment management, SWEM, is a regulation similar to the EU-directive 89/391 which requires a policy, risk analysis, information, division of work tasks regarding the work environment, registration of work-related accidents etc. The Swedish regulation however, is more far-reaching than the EU-directive.

out individual workers' capacities and limitations. Other beneficial measures include workers foot profile system and physical training during work hours.

7. Future research

The following areas require more attention and future research will focus on finding answers to these issues:

Develop improved planning methods that also consider working methods, work space allocation including dynamic site plans of shared

- construction site areas and equipment with the objective to minimise the risk of WMSDs.
- Investigate ways to have a greater and adequate worker participation in the pre-production planning.

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