WORKPLACES REDESIGN IN A FOOD INDUSTRY TO MINIMIZE MUSCULOSKELETAL INJURIES IN WORKERS

Planas, A.E.
Ducun, M.
Tomás, J.A.
Azcona, I.

Mutua Universal

Abstract

Musculoskeletal disorders are a cause of concern not only because of the health effects on individual workers but also because of the economic impact on businesses and social costs. More than 70% of occupational diseases and 33% of accidents declared at work with days off work are musculoskeletal. Working layouts and processes, awkward postures, high demand repetitive movements, sustained efforts, insufficient muscular rests, are responsible for these losses. Optimal workplace design, selection of appropriate equipment and the ability to predict musculoskeletal load and physical demands of each process are key tools to prevent the emergence and development of injuries. A case study conducted in a food industry which recorded continuously days off work because of epicondylitis and wrist tendinitis is presented. The factory had old machines, without economic possibilities of being renewed. Muscular and biomechanical demands on workers, ergonomic risk factors and characteristics of various production processes were analyzed. Workplaces were redesigned, accessories to the old machines were joined and production processes were changed. As a result, a performance improvement, an increase in productivity and the disappearance of days off work because of epicondylitis and tendinitis were obtained.

Keywords: redesign, workplace, ergonomics, musculoskeletal, off work

1. Introduction

This case study is presented as a result of an ergonomic analysis carried out in a food industry dedicated to packing and distribution of snack products. In the last year 49 work accidents with days off and 3 accidents with relapse were registered for a staff of 390 workers. The incidence rate was 125.6 accidents every 1000 workers, this number is higher than the average one in its activity sector that was 107.4. 34 of such accidents were musculoskeletal and mainly located at hands, arms and back. Several cases of epicondylitis and tendinitis in wrist were diagnosed. In addition to accidents with leave, workers expressed to suffer from discomfort in hands, wrists, forearms, lumbar spine, cervical spine and legs.

Activities related with the most of the injuries where located at packing products line. The main part of these activities involved picking up packets from a conveyor belt, putting them into
boxes or bags by hand according to its size, closing boxes or bags by hand and putting them into a pile to transport them. A packet weighted between 100 g (the lightest) and 1 Kg (the heaviest), conveyor belt speed was regulated according to this parameter.

Afterwards a detailed analysis of the ergonomic risks in the packing line was developed. It was found that the critical activity was the packing of nuts in 1 Kg packets. Workers exerted repetitive movements of fingers, hands and forearms in addition of high and continuous forces, standing for a long time in the same place.

2. Objective

Once workplace environment and processes causing injuries and discomfort in workers were identified, a collection of changes in procedures and layout of the workplaces were suggested, specially the redesign of packing nuts in packets with the greatest weight.

The objective of this work is to valuate quantitatively the improvement achieved in muscular activity and energy worker solicitudes by the comparison of the old packing workstation design with the new packing workstation redesign. This previous assessment before implementation will be useful to guarantee the investment.

3. Methodology

To detect risk factors related to the old design and to check the improvement related to the new design has been applied the following methodology:

- Register of conditions of the packing line during work in the food industry.
- Simulation of working conditions at laboratory, comparing both ways of carrying out the process: old design and redesign.
- Film of the work processes.
- Register of muscular activity of muscular groups responsible for movements and forces.

4. Results

4.1. Old Design

Packing nuts operation involves opening a plastic bag, taking 1 Kg nuts packets from the conveyor belt, one by one, putting them into the plastic bag, getting the full bag into a knot, and putting it into the container for finished products (see Figure 1). This cycle lasts 18 seconds on average. Each worker handles on average 1000 Kg per hour (16,6 Kg/min). There is not a stipulated break for a rest, workers only take a break when a change of product is made.
Risk assessment for this workplace yields the following results:

- High probability of developing specific injuries in distal parts of upper limbs (epicondylitis, de Quervain’s disease, carpal tunnel syndrome, trigger finger) and other non-specific injuries. According to Moore and Garg (Moore, 1995), it has been obtained a strain index of 72.

- High manual forces related to repetitive handling of heavy products, higher than 1.6 times values recommended by Snook and Vaillancourt (Snook, 1995) for similar tasks. The workers’ hands are tensed during 62% work cycle.

- Awkward postures for hands and wrists. Flexo-extension movements for right hand ranged between 40° extension and 50° flexion, and for left hand between 70° extension and 30° flexion. Lateral wrist movements ranged between 15° radial deviation and 40° ulnar deviation for left wrist, and between 35° radial deviation and 30° ulnar deviation for right wrist. All these movements exceed completely limits recommended by UNE-EN 1005-5:2007.

- Flexion of neck and back, in a static and continuous way, with values higher than limits recommended by UNE-EN 1005-4:2005.

4.2. New Design

To solve awkward postures, high forces and repetitive movements, workplace redesign was recommended. To avoid stressful postures in hands and wrists, high strains in muscles and tendons during picking, a new output ramp for the machine was redesign. This new output ramp guided packets to final destination (a bag or a box). Then, workers operation only involved pushing packets, without picking and without handling weights.

Figure 2 shows the redesign recommended for packing into sacks or bags. Figure 3 shows the redesign for packing into boxes. With this new procedure, the final container for nut packets was located at the extreme of the sloping conveyor belt. Nut packets could fall by gravity. Worker only should supervise the operation and help for the correct guide of the packets to the final container. It was recommended an automatic sealing device to avoid manual knotting for bags, because it was proved that this action implied a high physical demand to the worker. Putting the boxes or sacks on a mobile cart could make packets evacuation easier and could avoid a new manual handling.
For packing into boxes, it was proposed to put mobile and adaptable guides suitable to each packet size.

As workers were standing for long periods of time, it was suggested to change the standing workstation for a sit-stand workstation. It was introduced a pedestal stool with adjustable height, to let workers change posture and let legs muscles rest.
4.3. Comparison Old Design – New Design

Packing operation with the old design and with the new design has been analysed in order to assess the physical load for the worker. The activity of muscular groups responsible for movements and postures has been examined for a working cycle. Muscular groups analysed in right and left upper extremities are flexors and extensors of the wrist, biceps brachii, triceps brachii, trapezius and anterior part of deltoid.

Muscular activity has been registered by surface electromyography. To be able to compare between processes, results have been calculated as maximum voluntary contraction (MVC) of the worker.

<table>
<thead>
<tr>
<th>Muscular Activity (%MVC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
</tr>
<tr>
<td>---</td>
</tr>
<tr>
<td><strong>Old Design</strong></td>
</tr>
<tr>
<td><strong>New Design</strong></td>
</tr>
</tbody>
</table>

Table 1: Muscular groups analysed.

Table 2: Muscular activity for each muscular group for old design and new design of packing workstation.
In Figure 4 is shown the comparative graph of muscular activity required in old design and in new design for the packing workstation. For all muscular groups, effort suffered by the worker is smaller in new design than in old design. Numerical values are presented in Table 2.

New design of the packing workstation means a decrease in muscular activity of the right upper extremity of 16% in flexors, 41% in extensors, 70% in biceps brachii, 49% in triceps brachii, 67% in anterior part of deltoid and 43% in trapezius. Also it means a decrease in muscular activity of the left upper extremity of 37% in flexors, 16% in extensors, 32% in biceps brachii, 12% in triceps brachii, 62% in anterior part of deltoid and 44% in trapezius.

Muscular energy demands have been examined in packing to complete the analysis. As it is shown in Table 3 and in Figure 5, the redesign of the workstation implied a decrease of the energy demands in the right upper extremity of 61% in flexors, 72% in extensors, 85% in biceps brachii, 76% in triceps brachii, 85% in anterior part of deltoid and 73% in trapezius. Also it means a decrease of the energy demands for the left upper extremity of 71% in flexors, 60% in extensors, 69% in biceps brachii, 57% in triceps brachii, 81% in anterior part of deltoid and 74% in trapezius.
5. Conclusions

The redesign of the workstation of packing has allowed to reduce between 57% and 85% the muscular energy demands to the worker. Movements and unnecessary manual handling have been avoided, especially manual handling of weights. Postural comfort of workers have improved. This has led not only to higher welfare for workers but the possibility of increase the production rate without risks for health of workers. A small change in the output ramp of the machine, the inclusion of a mobile cart, a device for automatic sealing bags and the purchase of a pedestal stool with adjustable height have allowed this improvement.

A suitable ergonomic intervention implies a very positive cost-benefits relationship for the company. To guarantee the success of the ergonomic intervention is important to know in detail the technical faults of the workplaces and processes design about postures, movements and forces demanded, what risks for heath they introduce, how they become evident, why they are
caused, and also to know which the most suitable options are, their viability and the way of implanting them.

In many occasions, as the case study shown, a detailed analysis of working postures and movements of the worker, the alternatives that a machine could take, the introduction of unsophisticated tools and a small change in the layout of the workplace, all of them without a high economical investment, allow to decrease the musculoskeletal discomfort in workers, to improve the safety at work and to reduce the productive and social costs.

References


Correspondence (for further information, please contact):

MUTUA UNIVERSAL
Laboratory of Ergonomics
Polígono Industrial Arazuri-Orcoyen, Calle C, nº 25, 31170 Arazuri (Navarra), Spain
Phone: +34 948 01 04 70
Fax: + 34 948 01 04 90
E-mail: aplanasl@mutuauniversal.net
URL: http://www.mutuauniversal.net/m10/prevencionindex.html