Ergonomics Program (Seven Steps – Niosh Approach) to Prevent Work Related Musculoskeletal Disorders in a Chemical Companies in Chile. Experiences 2009 to 2014.

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Practitioner Summary: the aim of this case study is to describe the experience in the implementation of Ergonomics Program to prevent Work related Musculoskeletal Disorders in a Chemical Companies in Chile. The technical base considers the development processes of musculoskeletal disorder theory, local rules, and technical issues related with ISO and UNE Standards as well as evaluation of indicators about system, health, and ergonomics aspects. In conclusion, the implementation of Ergonomics Program includes a multifactorial strategy. The participatory ergonomics and systematic treatment of the information is required to obtain positive results.

Keywords: Ergonomics Program, Work Related Musculoskeletal Disorders, Industry

1. Introduction

The epidemiological studies describe that low back disorders and upper extremity musculoskeletal disorders are related to physical risk factors at work. Knowing the risk factors, their multidimensionality, and the attributable fraction regarding the occurrence of diseases is important to design preventive measures in order to reduce the incidence. In that context, based on the epidemiological evidence, the low back disorders are related to manual material handling, heavy physical load, and whole body vibration. In the case of upper extremity, musculoskeletal disorders are related to repetitive movement, force, cold, and vibration. (Punnet, L. 2004)

The Ergonomics Program integrates all levels of organization, sets priorities, and ensures national and international regulatory standards. Aspects such as technological and production process changes and management, as well as nature of production processes at several industries, force to have greater knowledge related to assessment and intervention strategies.

These programs must be approached from two points of view. First, the traditional approach to better health and condition at work. Second, the efficiency of system, based at economic benefits and the balance between health and productivity. The results of these programs can be evaluated through assessment of error decrease, rotativity reduction, skill improvement, and increased production.

In Chile, the Ergonomics Program in production processes is applied at several companies. A common denominator is the presence of a management system for health and safety. In this context, the program considers the national regulations: Chilean Law n° 20.001 (Maximum Weight Load), D.S n° 594 (Work Related Musculoskeletal – Upper Extremity) and Law n° 16.744 (Accidents and Occupational diseases) and ISO and UNE Norms.

This case study will describe the principal elements of ergonomics program and experiences in plants located in the city of ConCón, Santiago, and Puerto Montt in Chile, three plants dedicated to the production of chemical products and packaging components for the industry respectively. The adopted strategy aims to have a clear vision of progress and propose a systematic accompaniment in the processes of multidisciplinary intervention. In the period between 2009 and 2011 the strategy was focused specially at the diagnosis, later multidisciplinary intervention.
2. **Program goals and elements**

The goal of the Ergonomics Program is to prevent musculoskeletal disorders at production processes. The key issues are to systematically develop the identification, assessment and risk control factors in all plants and respective areas as well as maintaining this effort in time. The ergonomics program should consider a balance between health and productivity in all processes.

Two stages are relevant in the development of ergonomics program:

1-Diagnosis Stage: In this stage the fundamental action considers:

- Development of a Systematic Classification of Production Processes.
- Study of musculoskeletal health condition of workers
- Analysis of medical licenses and technical criteria in the production processes
- Identification of Physical Risk Factors
- Development of an Ergonomics Index
- Establish priorities through technical and health criteria
- Specific Assessment with standardized methodologies.

2-Intervention Stage: In this stage the fundamental actions considers the Seven Steps of Ergonomics Program (Niosh 1997). These processes were led by the Ergonomist interacting with all the Organization.

The table below describes key aspects of each of the above steps. (Table 1).

<table>
<thead>
<tr>
<th>Stage</th>
<th>Name of Ergonomics Program</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Identification of Risk Factor</td>
<td>Development of a method related to an Ergonomics Index, and the result of the assessment with standardized methodologies to establish priority in the intervention.</td>
</tr>
<tr>
<td>2</td>
<td>Transversal Commitment</td>
<td>Participation of all workers of the company in the development a participatory strategy.</td>
</tr>
<tr>
<td>3</td>
<td>Training</td>
<td>Action in Situ and the instruction to all workers related to the fundamentals in ergonomics at work</td>
</tr>
<tr>
<td>4</td>
<td>Data Collection</td>
<td>Application of local rules and methodologies related to physical ergonomics in manual material handling, posture, repetitive movement, and physical workload</td>
</tr>
<tr>
<td>5</td>
<td>Identification of Effective Controls</td>
<td>Assessment based on the structure of initial diagnosis and the comparison of Ergonomic Index, distributed by Industrial Plant and specific areas</td>
</tr>
<tr>
<td>6</td>
<td>Health Management</td>
<td>Specific management of health related to perception of musculoskeletal discomfort and fatigue</td>
</tr>
<tr>
<td>7</td>
<td>Implementation of New Processes</td>
<td>Implementation of ergonomics criteria in the design and development of new processes.</td>
</tr>
</tbody>
</table>

3. **Implementation Strategy and Methodology – Five-year experiences**

### 3.1 Ergonomics Committee

Establishing an Ergonomics Committee by Plant to lead the Ergonomics Program was the way to develop different action. This Committee are integrated by a Ergonomist, Occupational Physician, Safety Manager, leaders of such areas and worker representatives. This Committee assumes a management commitment related with technical and organizational processes. The Committee responsibility is the development of seven steps in Ergonomics Program.
The experience shows that the Ergonomics Committee allows defining organizational decisions through multidisciplinary approach. This allows the organization a cross communication associated with implementation of ergonomics in production processes.

Some functions of the committee are: analyse priorities, difficulties, and advances in different areas, and management decision-making.

### 3.2 Elements of Ergonomics Program

#### 3.2.1 Stage 1. Risk Factor identification

This stage is relevant to the successful implementation of Ergonomics Program. At this Stage, procedures are: to execute systematic classification process, identify trades, and identify risk factors associated with work-related musculoskeletal disorders.

**Systematic Classification Process / Trades**

This process allows identifying trades and related risk factors. To develop a systematic classification process the scheme of Buchholz must be followed (Buchholz, B. 1996; Paquet, V. 1999; Cerda, E. 2006)

<table>
<thead>
<tr>
<th>Table 2. Systematic classification processes</th>
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</thead>
<tbody>
<tr>
<td><strong>Concept</strong></td>
</tr>
<tr>
<td>Stage</td>
</tr>
<tr>
<td>Trade</td>
</tr>
<tr>
<td>Tasks</td>
</tr>
<tr>
<td>Activities</td>
</tr>
</tbody>
</table>

The relevance of this classification is given because the risk analysis is aimed at carrying out a critical and specific assessment of trades-tasks-activities, in order to obtain a suitable risk approach.

This step allows a systematic processing of information, tracking, and analysis of effective controls.

**Identification of Risk Factor**

Identify risk factors in order to develop an ergonomics index table. This identification considers 143 criteria associated with 11228-1-2-3 ISO Standards, UNE 1005-2, Chilean Law nº 20.001 and D.S nº 594. The implementation of this matrix is performed at task and areas. The main risk factors to analyse are manual material handling, repetitive motion, posture, force, and heavy physical work. To identify risk factors a study of direct observation and graphic record of tasks should be done.

The Ergonomic Index Table integrates partial and global index of tasks and areas, this procedure allows performing prioritization in intervention. Ergonomic Index is described as the calculation based on the ratio between the number of criteria (Physical risk factors) present in the studied task and the total number of criteria specified in the matrix. (Table 3).

The pattern of tasks and areas in the matrix, allows an interpretation of risk factors and therefore better decision-making strategies and future actions. The next step is to build a risk map of involved tasks and areas.

<table>
<thead>
<tr>
<th>Table 3. Ergonomics Index</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Level</strong></td>
</tr>
<tr>
<td>0 - 0,15</td>
</tr>
<tr>
<td>0,251 – 0,50</td>
</tr>
</tbody>
</table>
In this case study, during the period between 2009 and 2014, a substantial improvement in working conditions was obtained in each of the Plants. This is expressed in an increase in green range of criteria. These results changed plant priorities during the respective period. The analysis strategy using indexes allows an ergonomic risk management prolonged in time. The strategy allows knowing the priorities in plant modifications, allowing the organization to optimize resources and facilitate the organization of intervention processes.

3.2.2 Stage 2. Transversal Commitment
A participatory ergonomics strategy is essential. The inclusion of each of the actors optimizes the intervention strategies considering the role of each in the organization. In this context, the inclusion of workers, allows to raise risk-factor information or ideas for improvement. The participation of leaders allows planning, identifying critical aspects, systematize intervention actions, and link actions of ergonomics program to other programs such as safety, health, and environment.

During the period between 2009 – 2014 crosswise commitment consolidates by integrating the different organizational actors during field activities and technical meetings, providing them clear and transparent information.

In this case study, in Puerto Montt are 60 collaborators with 8 leaders and Head Plant. In Santiago are 163 employees with 12 leaders and CEO. In ConCón are approximately 15 leaders and more of 50 employees.

3.2.3 Stage 3. Training
The strategy at this stage was to train workers on strategies for self-care by teaching fundamentals of ergonomics, prevention, and self-care at workplace. For the leaders, the strategy was to teach fundamentals of ergonomics, provide competence to implement and promote prevention strategies aimed at ensuring safe and healthy attitude at workplace. Both training strategy had a strong emphasis on practical activities.

During the described period, all employees, considering plant workers and leaders were trained except those who had joined recently. The level of training reached over 90% of the allocation of plant.

3.2.4 Stage 4. Data collection
In this stage, the strategy is the application of local rules and the methodology related to physical ergonomics risk factors – Manual material handling, posture, repetitive movement and heavy physical workload.

The specificity of the evaluation at this stage is greater than in the risk identification stage. The identification stage aims at managing the risk associated with priorities; the evaluation stage aims at carrying out specific interventions in areas and tasks. At this stage is relevant the legal compliance of tasks as well as the analysis of specific variables that increase risk.

During the period between 2009 – 2014 the data collection was performed in 15 areas at the Santiago Plant, 13 areas at Puerto Montt Plant and 7 areas at ConCón Plant.
The following table shows the main methodologies used for specific data collection:

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Methodologies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manual Material Handling</td>
<td>MAC, Liberty Mutual Tables, NIOSH Equation, REBA</td>
</tr>
<tr>
<td>Posture</td>
<td>OWAS, RULA</td>
</tr>
<tr>
<td>Repetitive Movement</td>
<td>Check List OCRA, Strain Index</td>
</tr>
<tr>
<td>Force</td>
<td>Borg’s Scale</td>
</tr>
</tbody>
</table>


3.2.5 Stage 5. Identification of effective controls

The analysis of effective controls is based firstly on the impact of ergonomic index and secondly on impact indicators of applied methodologies.

In turn, incidence of work-related musculoskeletal disorders is an indicator to analyse the evolution of musculoskeletal disorder prevention.

Finally, another indicator to measure the Ergonomic Program impact is the measurement of efficiency in different tasks, measured through from four tracks: improvement in production quality, waste reduction, lost-work time reduction, and task difficulty reduction measured through the effort and discomfort perception in body segments. (Goggins, R. 2008)

3.2.6 Stage 6. Health management

In this context, the action strategy is to focus on the first and second stage of musculoskeletal disorders time progression theory described by Marras (Table 5). The first stage of this theory is the physical load; in this stage, in order to prevent work-related musculoskeletal disorders, the action must be focused in technical aspects and ergonomics criteria. The second stage is related with the discomfort; the actions must be focused on the employee self-care during working hours through prior training, and promotion of direct communication with supervisors, Ergonomist and Health-Safety Department. (Marras, W.S. 2000, Kumar, S. 1999)

<table>
<thead>
<tr>
<th>Stage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Physical load</td>
<td></td>
</tr>
<tr>
<td>2 Discomfort</td>
<td></td>
</tr>
<tr>
<td>3 Symptoms</td>
<td></td>
</tr>
<tr>
<td>4 Disorder (Injury or Illness)</td>
<td></td>
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<tr>
<td>5 Incident (Report)</td>
<td></td>
</tr>
<tr>
<td>6 Restricted day</td>
<td></td>
</tr>
<tr>
<td>7 Lost days</td>
<td></td>
</tr>
<tr>
<td>8 Disability</td>
<td></td>
</tr>
</tbody>
</table>


3.2.7 Stage 7. Implementation in new processes

At this stage the base is a multidisciplinary work to implementing new work systems. The criteria of national and international standards are relevant in the processes of this stage. The procedure is based on regular technical meetings with engineering teams, supervisors, and health and safety department.

The actions to improve organizational crosswise commitment are key to the success of this phase.
3.3 Focus for 2015-2016

Whereas during the period described in this case study, the strategy for control and prevention through engineering aspects considering human – machine interface and environment was emphasized, the next period will focus on decision-making considering specifically three aspects: Predisposing, Enabling and reinforcing. (Table 6).

<table>
<thead>
<tr>
<th>Table 6. Decision Making Strategy (DeJoy, D. 1990)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factor</td>
</tr>
<tr>
<td>Predisposing</td>
</tr>
<tr>
<td>Enabling</td>
</tr>
<tr>
<td>Reinforcing</td>
</tr>
</tbody>
</table>

4. Lessons Learned

The main reason for implementing an Ergonomics Program is the difficulty of technicians to develop a continuous and systematic work independently. Once implemented the Ergonomics Program, technical support is provided and control interventions are more effective. Alongside this, a more participatory process is achieved.

To achieve a systematic work, is fundamental the execution of a systematic classification of the production process. Without this classification is complex maintain a systematic work plan and a continuous information updating process.

It is important to perform a priority management strategy employing a partial and global ergonomics index, because, if not done, establishing priorities and then developing an assessment procedure will require more time and resources. This procedure improved process management and allowed organization prioritize interventions and develop a plan of resource utilization.

Using basic theories associated with the development of musculoskeletal disorders preventive strategies can be developed.

The structuring of an ergonomics program based on the seven steps and the integration of national and international regulatory requirements is feasible.

The maintenance of the ergonomics programs depends on the ability to demonstrate effective controls and progression of the intervention in time.

The increase of knowledge of different statements of company allows the organization to seek internal solutions and decrease overall implementation cost.

5. Conclusion

The approach used has been effective in reduce Ergonomics Index and maintain work-related musculoskeletal disorders at low level.

Regardless of the area or Plant, without a transversal commitment this Ergonomics Program would not have achieved the level of success that it has.

Acknowledgements

The authors would like to acknowledge the partnership of the companies AISLAPOL S.A and Group BASF.
References


