

The Relationship between Working Conditions and Musculoskeletal/Ergonomic Disorders in a Manufacturing Facility – A Longitudinal Research Study

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Abstract. I have done research on the relationship between working conditions and musculoskeletal/ergonomic disorders in a manufacturing facility. I believe that the biomechanical and psychosocial aspects of work have a significant influence on the individual worker's health and well-being. The work organization at which I have evaluated the employee's health and well-being and collected a large amount of data; which I have analyzed; is at a large manufacturing facility. This research is based upon the Balance Theory Model of Smith & Carayon-Sainfort [2], [3]. This model specifies that the working conditions and other factors outside of work can create a stress on the individual. That stress can have physiological and psychological consequences. If the stress exceeds the individual's capacity, the stress can produce a negative effect on the individual which could result in a strain. This is a bad fit between the individual resources and the work demands. If the stressful exposure continues for a prolonged time period, then this can result in serious musculoskeletal disorders.

Keywords: Human Factors, Ergonomics, Musculoskeletal Disorders, Psychosocial, Balance Theory Model, Applied Field Research, Manufacturing, Assembly, Production Processes.

1 Introduction

The Balance Theory Model is a system view concept for the various elements of a work system, it shows the stress that working conditions can exert on the individual. In the model the elements interact to determine the way in which work is done. At the center of this model is the individual with their physical characteristics, perceptions, personality and behavior. The task, technology, organization, and environment affect the content of the job and the physical demands the job makes on the individual.

2 The Research Purpose

The overall purpose of this research study was to identify the stressful working conditions and control them. Therefore the purpose of an intervention is to control

musculoskeletal disorders, to reduce the stress load, and to eliminate strain. There are a variety of things that can be done in the workplace for eliminating or reducing the occurrence of occupational musculoskeletal disorders. These include engineering redesign, change in work method, administrative control, worker training, exercise, work hardening, and management to reduce exposures.

3 The Research

This research was performed by using a multiple paged questionnaire survey to evaluate three different assembly methods at a large manufacturing facility. Data was collected several times over a period of time; therefore a longitudinal research study design was conducted. These three different assembly methods were exhibited and displayed by these three distinct individual assembly lines. One of these assembly lines consisted of the employee subjects of interest (i.e. the study group). The other two assembly lines served as the control groups for the study group.

The overall aim of this research is to improve the long term health and well being of workers in a manufacturing facility. The overall purpose of this research is to identify the stressful working conditions and control them. Therefore the purpose of an intervention is to control musculoskeletal disorders, in order to reduce the stress load and to eliminate strain.

4 Research Contributions

One of the contributions of this research is to determine the relationship between working conditions and musculoskeletal / ergonomic disorders in a manufacturing facility. Generally the literature on this topic tends to be more heavily concentrated on the office worker, or service provider type of worker. Therefore the area of workers in a manufacturing facility needs further investigation. Generally, the combination of biomechanical and psychosocial working conditions on musculoskeletal pain / discomfort also needs further investigation.

A second contribution is to improve the research techniques and methodology which has been utilized in some previous scientific studies which attempted to control musculoskeletal disorders. Specifically the scientific evidence on interventions to control musculoskeletal disorders has some shortcomings. The lack of sound research methods and the lack of sound research designs are significant shortcomings in some of the existing literature. This position is supported by the National Academy of Sciences paper of Smith, Karsh & Moro [4]. Their paper investigated and reviewed the research on interventions to control musculoskeletal disorders.

A third contribution is that the results of this research study can assist engineers in designing the jobs of workers in a manufacturing facility. The incorporation of both biomechanical and psychosocial aspects on worker job design should reduce the worker's musculoskeletal / ergonomic disorders, and therefore improve the long term health and well being of workers in a manufacturing facility.

5 Literature Review – Summary

In summary, the National Research Council [1] concluded that there is theoretical evidence and some empirical evidence that links psychosocial factors and musculoskeletal discomfort. Stress appears to be a mediating variable that contributes to the development of musculoskeletal disorders. There also exists some theoretical evidence and some empirical evidence that links biomechanical factors and musculoskeletal discomfort.

In conclusion, more research studies need to be done in order to provide an answer to the existence of the link between biomechanical factors and psychosocial factors, and musculoskeletal disorders. Substantial research literature needs to be developed before a definitive answer could be given; yet the link seems very plausible.

6 The Study Design

The study was performed by using a multiple paged questionnaire to survey the three different assembly methods at the manufacturing assembly facility. Data was collected several times over a period of time; therefore a longitudinal study was conducted. These three different assembly methods were exhibited and displayed by three distinct individual manufacturing assembly lines. One of these manufacturing assembly lines consisted of the employee subjects of interest (i.e., the study group) which was called the study group. The other two assembly lines served as the control groups for the study group; these two areas were called the control group 1 and the control group 2.

7 The Data Collection

Data was collected from the three manufacturing assembly line area employee groups by utilizing a multiple page questionnaire survey. The multiple page questionnaire surveys were designed in order to obtain the information of desired pertaining to the research questions asked. The multiple page questionnaire surveys were given to both the study group and the control groups.

The multiple page questionnaire survey which was given to the study group and control groups was organized as follows:

1. Job Information (8 questions),
2. Characteristics of Work Environment (41 questions),
3. Quality of work Life (5 questions),
4. Health Information (23 questions),
5. Ergonomics and Physical Environment (28 questions),
6. Performance (11 questions),
7. Demographics (3 questions),
8. Implementation (3-5 questions) – this section was only given to the study group.

8 The Multivariate Analysis of Variance

I concluded from the results from the multivariate analysis of variance (MANOVA) that musculoskeletal discomfort is primarily influenced by psychosocial factors (such as anxiety, and uncertainty), and physical demands. As when psychosocial factors (such as anxiety, and uncertainty), and physical demands increased; musculoskeletal discomfort also increased. It could be implied that musculoskeletal discomfort and psychosocial factors (such as anxiety, and uncertainty), and physical demands are linearly related.

Therefore, when the physical demands are increased, the stress on the individual is increased, and the ergonomic musculoskeletal discomfort is also increased.

Also, when the anxiety and uncertainty are increased, the stress on the individual is increased, and the psychosocial factor discomfort (i.e., negative psychosocial factors) is also increased.

So, an increase in physical demands, results in increased ergonomic musculoskeletal discomfort. And, an increase in anxiety and uncertainty, also results in increased negative psychosocial factors.

9 The Discussion

The control groups appear to be stable over time in terms of musculoskeletal discomfort, neck/shoulder/back discomfort, hand/arm discomfort, and leg discomfort. The control group 2 consistently exhibits higher self reports of musculoskeletal discomfort, neck/shoulder/back discomfort, hand/arm discomfort, and leg discomfort than the control group 1, over the three rounds of data collection. This is to be expected since the human factors, ergonomics, and working conditions of the control group 2 is significantly worse than the control group 1.

The study group exhibited lower self reports of musculoskeletal discomfort, neck/shoulder/back discomfort, hand/arm discomfort, and leg discomfort than the control groups. This is to be expected since the human factors, ergonomics, and working conditions of the study group was significantly better than the control groups.

The control groups appear to be stable over time in terms of the physical aspects of work. The control group 2 consistently exhibits higher self reports of physical demands, repetitive motions, and loading on individual than the control group 1, over the three rounds of data collection. This is to be expected since the human factors, ergonomics, and working conditions on the control group 2 is significantly worse than the control group 1.

The study group exhibited lower self reports of physical demands, and repetitive motions than the control groups. This is to be expected since the human factors, ergonomics, and working conditions of the study group was significantly better than the control groups.

The control groups appear to be stable over time in some of the psychosocial aspects of work. The control group 2 exhibited lower self reports of task control, job control, resource control, and decision control than the control group 1, over the three rounds of data collection. This is to be expected since the human factors, ergonomics, and working conditions of the control group 2 is significantly worse than the control group 1.

The study group appears to be stable over time in some of the psychosocial aspects of work. The study group exhibited greater self reports of task control, job control, resource control, and decision control than the control groups. This is to be expected since the human factors, ergonomics, working conditions, and employee empowerment of the study group was significantly better than the control groups.

10 Conclusion

In summary, there is theoretical evidence and some empirical evidence that links psychosocial factors and musculoskeletal discomfort. Stress appears to be a mediating variable that contributes to the development of musculoskeletal disorders.

There also exists some theoretical evidence and some empirical evidence that links biomechanical factors and musculoskeletal discomfort.

In conclusion, more research studies need to be done in order to provide an answer to the existence of the link between biomechanical factors and psychosocial factors, and musculoskeletal disorders. Substantial research literature needs to be developed before a definitive answer can be given; yet the link seems very plausible.

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