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The relationship between working conditions and musculoskeletal / ergonomic disorders in a manufacturing facility – a longitudinal research study

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Abstract

This research investigates 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 was at a large manufacturing facility. This research is based upon the Balance Theory Model of Smith & Carayon-Sainfort [1, 2]. The overall purpose of this research study was to identify the stressful working conditions and control them. The overall aim of this research is to improve the long term health and well-being of workers in a manufacturing facility.

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Keywords: Human factors; Ergonomics; Musculoskeletal disorders; Psychosocial; Balance Theory Model; Applied field research; Manufacturing; Assembly; Production processes

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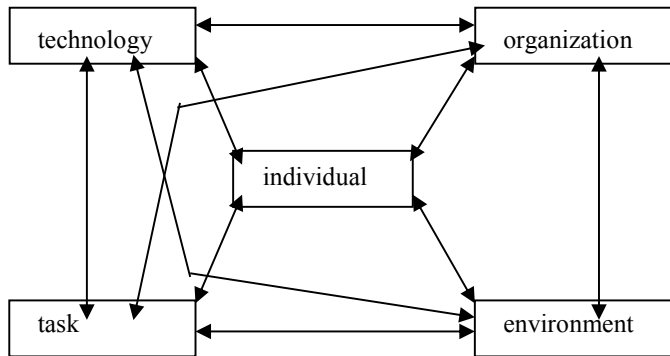


Fig. 1. The Balance Theory Model of Smith & Carayon-Sainfort [1, 2].

1. Introduction

I have done research on the relationship between working conditions and musculoskeletal disorders in a manufacturing assembly facility. I believe that the physical and psychosocial aspects of work have a significant influence on the individual worker's health and well-being. The work organization at which I evaluated the employee's health and well-being was at a large manufacturing assembly facility. This research is based upon the Balance Theory Model of Smith & Carayon-Sainfort [1, 2]. This model specifies that the working conditions and other factors outside of work, can create a stress on the individual. This 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.

The Balance Theory Model of Smith & Carayon-Sainfort [1, 2] is as follows (see Figure 1).

The Balance Theory Model is a system view concept for the various elements of work. The Balance Theory Model shows the stress that working conditions can exert on the individual. These five elements of the Balance Theory Model all interact to define how work will be performed. The individual is in the center of the Balance Theory Model. The individual has physical attributes and characteristics, previous experiences and knowledge, individual attitude and personality, and learned behaviors from which to draw from in order to cope with the working condition stress. The elements of task, technology, organization, and environment all influence the job content of work, the physical effort required of the individual, and the level of stress placed upon the individual [1].

The overall purpose of my research is to try to identify the stressful working condition and attempt to control them. Therefore the purpose of an intervention is to try to control the various musculoskeletal disorders in the work environment. By trying to control the various musculoskeletal disorders in the work environment, you should also attempt to reduce or eliminate the level of stress, and to try to reduce or eliminate the level of strain. There are a wide variety of things that can be attempted in the work environment in order to try to reduce or eliminate the existence of musculoskeletal disorders. These include engineering redesign, work method changes, administrative control, worker training, work hardening, and management organizational work rules to reduce exposures [3].

2. The research questions

Based on my objective to do research on the relationship over time between working conditions and musculoskeletal disorders in a manufacturing assembly facility, the following research hypotheses were explored:

- H1: Self reports of physical aspects of work influence worker's musculoskeletal pain or discomfort. It is anticipated that the relationship will be stable over time.

- H2: Self reports of psychosocial aspects of work influence worker's musculoskeletal pain or discomfort. It is anticipated that the relationship will be stable over time.

3. Literature review

In summary, the National Research Council [4] 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

4. Methodology – Study design

The study was performed by using a multiple paged questionnaire to survey the three different manufacturing 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 manufacturing 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 which was called the study group. The other two manufacturing assembly lines served as the control groups for the study group; these two manufacturing assembly lines were called the control group 1 and the control group 2.

The study group employee's manufacturing assembly method consisted of utilizing an overhead powered conveyor system in order to assemble the product.

The control group 1 employee's manufacturing assembly method consisted of utilizing automatic guided vehicles (AGVs) in order to assemble the product.

The control group 2 employee's manufacturing assembly method consisted of utilizing a gravity roller conveyor (i.e., a manual push line) in order to assemble the product.

5. Data collection

Data was collected from the three manufacturing assembly line employee groups by utilizing a multiple page questionnaire survey. The multiple page questionnaire surveys were designed in order to obtain the information 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:

- A. Job Information (8 questions),
- B. Characteristics of Work Environment (41 questions),
- C. Quality of work Life (5 questions),
- D. Health Information (23 questions),
- E. Ergonomics and Physical Environment (28 questions),
- F. Performance (11 questions),
- G. Demographics (3 questions),
- H. Implementation (3-5 questions) – this section was only given to the study group.

The study group was asked additional questions in order to obtain information regarding their initial response to the new manufacturing assembly method and the new manufacturing assembly method implementation. Obviously the control group manufacturing assembly methods had already existed for several years and therefore implementation questions pertaining to them were inappropriate and unnecessary; since I was only interested in the implementation of the study group manufacturing assembly method.

6. Multivariate Analysis of Variance - MANOVA

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 psychosocial factor discomfort (i.e., negative psychosocial factors).

7. Results

- Hypothesis 1:
 - H1: Self reports of physical aspects of work influence worker's musculoskeletal pain or discomfort. It is anticipated that the relationship will be stable over time.
 - Hypothesis 1 is supported.
- Hypothesis 2:
 - H2: Self reports of psychosocial aspects of work influence worker's musculoskeletal pain or discomfort. It is anticipated that the relationship will be stable over time.
 - Hypothesis 2 is supported.

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 (i.e., the manual push line) consistently exhibits higher self reports of musculoskeletal discomfort, neck/shoulder/back discomfort, hand/arm discomfort, and leg discomfort than the control group 1 (i.e., the AGV line), 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 (i.e., the overhead powered line) 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 of 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.

8. Conclusion

In conclusion, 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.

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.

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