

# Posture Analysis Using the Rapid Entire Body Assessment (REBA) & Nordic Body Map (NBM) Methods to Reduce the Risk of Musculoskeletal Disorders (MSDs) in Automotive Company

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## ABSTRACT

*This study aims to identify the operator's posture at work, determine the factors that influence the occurrence of musculoskeletal disorders (MSDs) complaints, and give suggestions for improving the postures. The method used in the research is Nordic Body Map (NBM) and Rapid Entire Body Assessment (REBA). Material handling processes carried out by some operator's production in the line press magazine stamping could be affected body postures. If the company does not carry out an analysis of the situation, it could be impacting the risk of Musculoskeletal Disorders for the operator who is working in this area. Process manual handling was carried out 4800 cycles in a day (8 hours of work) with a bent posture, causing complaints of musculoskeletal disorders (MSDs). The results of Nordic Body Map (NBM) questionnaire processing results scored 75 and 81 points, and the second activity was the REBA assessment when the operator took material from the train. The REBA score was 8. The results of this study have high scores for NBMs and REBAs, requiring investigation and changing work attitudes.*

**Key Words:** Musculoskeletal disorders (MSDs), Nordic Body Map (NBM), Posture Rapid Entire Body Assessment (REBA),.

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## 1. INTRODUCTION

The process of transferring material from the blank process to the machine magazine is done manually, where the operator takes the product from the product train, and then it is placed and arranged on the machine table. In one train there are 90 - 100 pieces of piles of material pieces that must be moved with a repetition time of moving one train between 7.5 minutes to 9 minutes and it is carried out for 8 hours every day. In one day, the operator transfers the material from the train to the magazine machine table 4800 times. From the observations, the production operator bends down while doing activities, namely during the manual material handling process, taking material from the train, and arranging it on the machine. A posture that is not ergonomic and carried out repetitively manner, causes complaints of musculoskeletal disorders that are felt by the operator, including neck pain, back pain, and low back pain.

## 2. METHODOLOGY

This study used the Nordic Body Map (NBM) and Rapid Entire Body Assessment (REBA) methods. The first data is regarding the worker complaints. Workers' complaints were obtained from the Nordic Body Map questionnaire. The second data processing is in the form of body posture and the work activities carried out by the magazine stamping press operators. With the help of a camera, an image could be obtaining that can measure the angles of posture when the operator is doing work. After getting the

data in the forms of the operator's posture while working, the Rapid Entire Body Assessment (REBA) score could be calculating. The total sum of all parts will show the REBA value experienced by the operator, then look at the table of REBA score values. It will be known at what level the musculoskeletal disorders risk experienced by the operator of the stamping press magazine.

### **2.1 Ergonomics**

Ergonomics is a discipline that examines the strengths and limitations of human characters. Then use the information in designing facilities, machines, products, environments, and work systems to achieve good quality work while still paying attention to safety, health, and comfort for humans [1]. The goal of ergonomics is to fit between the needs of the design, development, implementation, and evaluation of human and machine systems and the physical environment to make it more productive, safe, comfortable, and satisfying for the users [2], [3].

### **2.2 Musculoskeletal Disorders**

Musculoskeletal complaints are complaints of the parts of the skeletal muscles that are felt by a person ranging from very mild complaints to very painful. If a long time received static loads repeatedly, the muscles could cause complaints in the form of damage to joints, ligaments, and tendons. Complaints of this damage are usually termed complaints of musculoskeletal disorders (MSDs) or injuries to the musculoskeletal system [4]. There are several factors that can cause skeletal muscle complaints, including excessive muscle stretching; repetitive activity; and unnatural work postures, such as the movement of the hands raised, the back bent, the head raised, and so on.

### **2.3 Posture**

Posture is the relative position of a certain body part when the operator works, which is determined by body size, the design of the work area, and the size of the equipment / other objects used while working [5], [6], [7]. Posture and movement play an important role in ergonomics [8]. An awkward posture can cause fatigue and discomfort at work [9]. Awkward posture when working and done in the long term can cause injury and complaints to the skeletal muscle and nerve tissue [10]. Based on body position, body posture when working in ergonomics consists of:

- a. Neutral posture, which is a posture in which all parts of the body are in a proper position and muscle contraction is not excessive, so that parts of the body organs, soft tissue nerves, and bones do not experience excessive shifting, compression, or contraction.
- b. An awkward posture, a posture in which the position of the body (legs, joints, and back) significantly deviates from a neutral position when performing an activity due to the limitations of the human body, resisting loads for a long time [11]. The awkward posture will cause mechanical stress on muscles, ligaments, and joints, causing pain in the skeletal muscles.

### **2.4 Nordic Body Map (NBM)**

The application of the Nordic Body Map method uses a questionnaire sheet in the form of a body map. This can be done by interviewing or asking the respondent which part of the skeletal muscle the complaint occurs. Complaints in the form of pain or pain by pointing directly to each skeletal muscle as listed in the Nordic Body Map questionnaire (NBM) sheet. The Nordic Body Map questionnaire (NBM) covers 28 parts of the skeletal muscles on both the right and left sides of the body. Starting from the upper limbs, namely the neck muscles to the muscles in the legs, through this questionnaire, it will be possible to find out which parts of the muscles are experiencing disturbances in the form of pain or complaints of extreme pain [4]. From the Nordic Body Map questionnaire (NBM), a score will be obtained in the form of a total score of all the questions in the questionnaire.

Table 1. MSDs Risk Classification

Likert scale	Total Individual Score	Level of risk	Corrective action
1	28-49	Low	No corrective action is required
2	50-70	Moderate	Later action may be required
3	71-91	High	Immediate action is required
4	91-112	Very high	Immediate thorough action is required

### 2.5 Rapid Entire Body Assessment (REBA)

Rapid Entire Body Assessment (REBA) is a method within the scope of ergonomics [12] that aims to provide an assessment of the risk of posture at work that can cause musculoskeletal related disorders [13]. The data required in this method are body posture, pressure/load used, type of movement, repetition, and hand position while on the move/work [14]. There are several steps taken for the REBA assessment, after obtaining the REBA score it can be seen the level of musculoskeletal disorders (MSDs) risk. The following is a table of final REBA scores that show the level of risk of musculoskeletal disorders [15]

Table 2. REBA Value Table

REBA Score	Level of MSD Risk	Explanation
1	Negligible	A posture that is done is correct and does not need any improvement.
2 - 3	Low	Posture changes may be needed but the changes needed are not all over the body position.
4 - 7	Medium	The worker's posture requires further investigation and immediate changes.
8 - 10	Hight	The posture requires investigation and a change in position because such body posture carries a high risk.
11 - 15	Very Hight	Posture must be changed immediately because it has a very high risk of accidents.

## 3. RESULTS AND DISCUSSION

The results of the Nordic body map questionnaire can be seen in table 3 as follow:

Table 3. Processing of the NBM Questionnaire








No.	Complaint	Complaint Level		Total	Percentage of Complaints
		Operator 1	Operator 2		
0	Pain/stiffness in the upper neck	4	4	8	100,0%
1	Pain/stiffness in the lower neck	3	3	6	75,0%
2	Pain in the left shoulder	3	3	6	75,0%
3	Pain in the right shoulder	3	3	6	75,0%

4	Pain in the left upper arm	3	3	6	75,0%
5	Back pain	4	4	8	100,0%
6	Pain in the right upper arm	3	3	6	75,0%
7	Pain in the back	4	4	8	100,0%
8	Pain in the buttock	2	1	3	37,5%
9	Pain in the buttocks (bottom)	2	1	3	37,5%
10	Pain in the left elbow	3	3	6	75,0%
11	pain in the right elbow	3	3	6	75,0%
12	Pain in the left forearm	2	3	5	62,5%
13	Pain in the right forearm	2	3	5	62,5%
14	Pain in the left wrist	4	4	8	100,0%
15	Pain in the right wrist	4	4	8	100,0%
16	Pain in the left hand	3	3	6	75,0%
17	Pain in the right hand	3	3	6	75,0%
18	Pain in the left thigh	2	2	4	50,0%
19	Pain in the right thigh	2	2	4	50,0%
20	Pain in the left knee	3	2	5	62,5%
21	Pain in the right knee	3	2	5	62,5%
22	Pain in the left calf	3	2	5	62,5%
23	Pain in the right calf	3	2	5	62,5%
24	Pain in the left ankle	2	2	4	50,0%
25	Pain in the right ankle	2	2	4	50,0%
26	Pain in the left leg	3	2	5	62,5%
27	Pain in the right leg	3	2	5	62,5%
	Total	81	75		
	Criteria	<b>High</b>	<b>High</b>		

Based on the assessment carried out on each operator, the score for the 1<sup>st</sup> operator has a high level of risk, namely with a score of 81. The 2<sup>nd</sup> operator has a high level of risk, namely with a score of 75. With these results, it is necessary to improve work attitude so that MSDs complaints no longer exist so that operators can work safely, comfortably, and productively.

The REBA assessment of manual handling activities is as follow:

Table 4. REBA Score Calculation Results

Activity	Picture	REBA Sore	Level	Action
1 The operator stands in front of the product material train		2	Low risk	Changes made if needed
2 The operator picks up material		8	High risk	Changes need to be made immediately
3 Operators lift material		6	Medium risk	Changes will be made later
4 Turn the body to the front of the machine		6	Medium risk	Changes will be made later
5 Lift to positioning level		6	Medium risk	Changes will be made later
6 Laying material		6	Medium risk	Changes will be made later
7 Turned towards the train		2	Low risk	Changes made if needed

In the REBA score assessment activity number two, namely, the operator taking equipment from the train has the highest REBA score with a score of 8 (high-risk level) and it is necessary to improve, work attitude immediately to avoid injury/illness to the operator caused by work.

### **3.1 Factors that cause complaints of MSDs**

Based on observations of line magazine punching press producers, interviews, and distribution of questionnaires, as well as assessments based on the Nordic Body Map Questionnaire (NBM) and REBA scores, several factors contribute to MSDs complaints, including:

#### **1. Unnatural Work, Attitude**

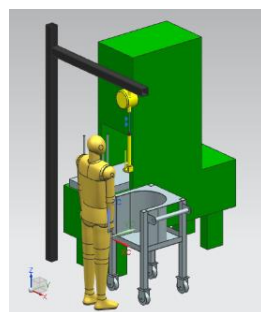
The unnatural work attitude of the magazine stamping press is caused by several factors, among others: the training height is too low, a difficult material extraction process, and high engine positioning

#### **2. Repetitive activity**

In one train, there are 90 to 100 pieces of equipment that should be moved within a repetition period of moving in one train between 7.5 minutes to 9 minutes. If the operators work at least 8 hours a day, it means that the operator will move 54 - 64 trains of equipment in a day. If calculated on the repetition of lifting the material, the operator will lift the material at least 4800 times in the whole day (8 working hours).

### **3.2 Proposed Improvement**

In the assessment of the Nordic body map questionnaire, the points that occupy the 100% risk position are the neck, back, waist, and wrists. And on the REBA score assessment, a high risk activity is number two, namely the production operator taking equipment on the train with a REBA score of 8 (High-Risk Level). Refer to the two assessments, it necessary to make changes to the operator's body posture while working [16]. In this study, the researcher proposed to make changes to the material retrieval system on the train, namely that before the operator has to bend and shift the material to pick it up, it is necessary to made changes to using tools to eliminate this activity. The tools are magnets that are used to attach the sheet of material, an endo spring balancer, which used to provide a pull so that the material can be lifted, and a hollow iron pole that is used to hang tools and rails to move. The proposed design for the process of transferring material from the train to the top of the magazine engine equipment can be seen in Figure 1 as follow:



**Figure 1. Proposed Improvement**

## **4. CONCLUSION**

Based on the data processing of the Nordic Body Map (NBM) questionnaire given to 2 (two) production operators on the line magazine stamping press and body posture data processing of production operators using REBA, this might be seen that the operator's body posture can cause complaints of musculoskeletal disorders in the second activity, namely the operator taking material on the train with a REBA score is 8 (eight) or high risk. 2 (two) factors that cause complaints of musculoskeletal disorders experienced by two-line magazine stamping press operators, namely unnatural work attitudes and repetitive activities. To eliminate the existing MSDs complaints, the researcher's suggestion is to use a tool when transferring material from the train to the magazine engine. Therefore, the operators can work safely and comfortably.

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