Analysis of Rapid Entire Body Assessment (REBA) and Nordic Body Map (NBM) on Work Fatigue

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ABSTRACT

Fatigue affects a person's physical capacity, mental, and emotional level, which can lead to a lack of alertness, which is characterized by decreased reaction to something and reduced motor skills. Tired workers tend to have weak attitudes and motivation to work. This situation increases the risk of accidents at work. Fatigue is unique because for the same load the level of fatigue can be different, and anthropometry is also unique because each human individual has a different combination of body sizes. So that analyzing the relationship between these two unique variables is very interesting and becomes a problem that is revealed in this study. Fatigue is divided into mental fatigue and physical fatigue [5]. Mental fatigue was measured using the Nordic Body Map and REBA, where the Nordic Body Map was taken at the time of the static anthropometric position and REBA at the time of the dynamic anthropometric position. While physical fatigue can be observed through the physical condition of workers, namely blood pressure and pulse. The sample consists of 40 welding workers with the same level of education and age. The results of the study: (1) in general, body anthropometry has a significant effect on both physical and mental fatigue; (2) body static anthropometry has a significant effect on workers' mental physical fatigue, (3) body static anthropometry has no significant effect on physical fatigue in terms of workers' blood pressure, (4) body static anthropometry has a significant effect on physical fatigue in terms of the worker's pulse, (5) body dynamic anthropometry has a significant effect on physical fatigue in terms of workers' feelings, (6) body dynamic anthropometry has a significant effect on physical fatigue in terms of blood pressure of welding workers, and (7) body dynamic anthropometry has no significant effect on physical fatigue in terms of pulse workers. Suggestions that there is a need for further research with a review of fatigue from different aspects such as biomedicine, body weight and so on.

Keywords: *Anthropometry, REBA, NBM, Fatigue.*

1. INTRODUCTION

Fatigue affects a person's physical capacity, mental, and emotional level, leading to a lack of alertness, which is characterized by a decreased reaction to something and reduced motor skills. Conor O'Neill and Kriengsak Panuwatwanich [1] found a significant relationship between fatigue and productivity, and productivity decreased with increasing fatigue levels. Khosro Sadeghniiat-Haghighi and Zohreh Yazdi [2] mention that fatigue is closely related to work performance and work accidents. Increased fatigue levels are at risk of triggering a decrease in work and an increase in work accidents. Kustono [3] describes that work attitudes affect a person's actions. Tired workers tend to have weak attitudes and motivation to work. This situation increases the risk of accidents at work.

In fact, it is often found that at the same load, one person can feel very tired, but other workers are not tired at all, meaning that fatigue can be individual. Individual characters that can be measured physically are the anthropometry of the body. Therefore, this study seeks to reveal the relationship between fatigue and body anthropometry. Meanwhile, according to Kustono and Muid [4], body anthropometry can be divided into static anthropometry, namely body size in a static state, and dynamic anthropometry, which is body measurement based on position when the body is working. Fatigue can be divided into mental fatigue and physical fatigue [5]. Mental fatigue can be measured using the Nordic Body Map and REBA, where the Nordic Body Map is taken at the time of the static anthropometric position and REBA at the dynamic anthropometric position. In contrast,

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physical fatigue can be observed through the physical condition of workers, namely blood pressure and pulse.

Blood pressure is the force (push) of blood against artery walls when blood is pumped out of the heart throughout the body [6]. When humans are active, there will be a metabolic process in the body to produce energy. The energy produced is in the form of mechanical energy, which is used to move. At the time of the activity, a person will occur physiological changes in the body. These changes can be used as indicators to determine the level of body fatigue. Physiological changes can be observed through indicators of change, one of which is blood pressure.

The pulse rate can be used to measure the fatigue a person feels. This approach can be done considering that the heavier a person's physical work is, the heavier the work of the heart. It can be assumed that the increase in heart rate is solely caused by an increase in the intensity of physical work [7].

REBA is used to assess repetitive movements and the most frequently performed movements from head to toe. REBA is used to calculate the level of risk that can occur in connection with work that can cause MSDs (musculoskeletal disorders) by displaying a series of tables to make an assessment based on body posture [8]. Nordic Body Map is used to assess the severity of skeletal muscle disorders of individuals or groups of workers. This questionnaire from the Nordic Body Map completely describes the body parts that workers may complain about, from the neck to the ankles, which includes 28 skeletal muscles on both the right and left sides of the body.

The importance of body anthropometry as the basis for fatigue and productivity research, for example, can be seen in the previous research by Iftikar et al. [9], revealing that in redesigning machines, machine tools, and the work environment, an anthropometric database is essential because it affects work productivity, (2)

Based on the discussion above, fatigue is unique because for the same load, the level of fatigue can be different, and anthropometry is also unique because every human individual has a different combination of body sizes. Thus, analyzing the relationship between two unique variables is interesting to carry out.

2. MATERIALS AND METHODS

2.1. Problem Statements

1. Is there any effect of body static anthropometry on workers' mental fatigue?
2. Is there any influence of body static anthropometry with physical fatigue of workers, if the fatigue is viewed from the worker's blood pressure?
3. Is there any influence of body static anthropometry with physical fatigue of workers, if the fatigue is viewed from the pulse of workers?
4. Is there any influence of body dynamic anthropometry on workers' mental fatigue?
5. Is there any effect of body dynamic anthropometry with physical fatigue of workers, if the fatigue is viewed from the workers' blood pressure?
6. Is there any influence of body dynamic anthropometry with the physical fatigue of workers, if the fatigue is viewed from the pulse of the workers?

The structural research model can be shown in Figure 1 below.

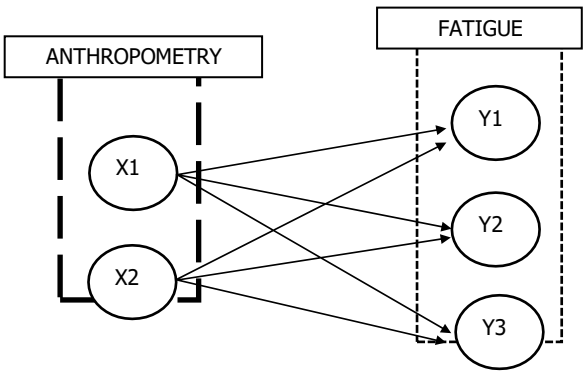

Figure 1 Structural Model of the Effect of Body Anthropometry on Fatigue Incidence.

Figure description:
Independent Variable:
X1 = Static body anthropometry
X2 = Anthropometry of dynamic bodies Dependent Variable:
Y1 = Mental fatigue
Y2 = Physical fatigue based on blood pressure measurement values
Y3 = Physical exhaustion based on pulse rate Measurement

2.2. Methods

This study employed an experimental study. The sample is 40 (forty workers) with relatively the same age and education level. The independent variable is body anthropometry, and the dependent variable is fatigue. Control variables are age, education level, workload, and time to complete the workload.

The research steps are presented as follows: (1) samples were taken from 40 workers with relatively the same age and the same level of education, (2) samples were measured by static and dynamic anthropometry, measured blood pressure and pulse, asked to answer REBA and NBM questionnaires, (3) the sample is asked to do welding work (with the same job sheet) and in the same time (4 hours) (4) after doing the same job then the sample is asked to answer the REBA and NBM

questionnaires, heart rate and blood pressure are measured and (5) the data is processed by comparing before and after loading. In more detail can be seen in Figure 2.

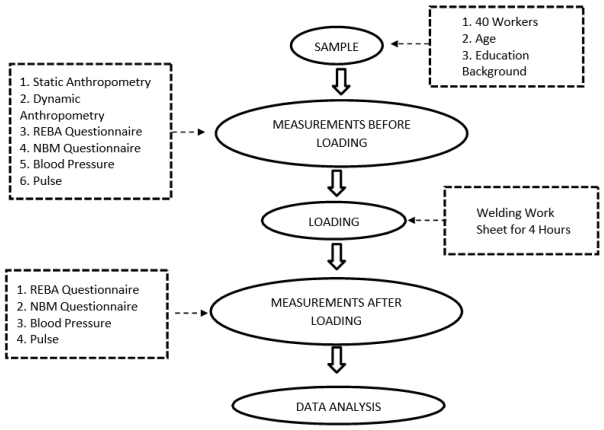

Figure 2 Research Steps.

3. RESULTS AND DISCUSSION

Data were analyzed using The LISREL 8.80 program produces a structural model as shown in Figure 3.

Body static anthropometry has a significant effect on workers' mental fatigue ($p<0.05$). An increase in body anthropometry by one unit will increase the degree of mental fatigue by 1,093 parts. Taken together, body anthropometry (both static and dynamic) contributes 91.5% to workers' mental fatigue. The effect that occurs when the anthropometric value of the practitioner is higher, the degree of fatigue complaints increases, because the higher the anthropometric size of a person's body when receiving a load continuously, the tendency to feel tired. In line with that, this research is supported by the results of research conducted by Dianastiti [10] that body anthropometry affects the physical ergonomics of female workers in the cigarette industry, and this is due to the lack of movement carried out while working by female workers in the cigarette industry.

Body static anthropometry has no significant effect on physical fatigue in terms of workers' blood pressure ($p=0.375$). Dianastiti's [10] study revealed that body anthropometry has no effect on the ergonomic fatigue syndrome of female workers in the cigarette industry because ergonomic fatigue syndrome will occur if a person experiences stress that arises from his mind not because of his physical condition.

Body static anthropometry has a significant effect on physical fatigue in terms of the worker's pulse. An increase in body anthropometry by one unit will increase the degree of fatigue seen from the pulse rate by 2.03 parts. Taken together, body anthropometry (both static and dynamic) contributes 71.8% to fatigue based on the size of the worker's pulse. The effect that occurs when the anthropometric value of workers is higher, the degree of fatigue complaints increases because the larger the anthropometric size of a person's body when receiving a load continuously, the tendency to feel tired.

Body dynamic anthropometry has a significant effect ($p<0.05$) on workers' mental fatigue. Each dynamic anthropometric variable of the body increases by 1. The level of mental fatigue will increase by 0.738 and together with static anthropometry and dynamic anthropometry, it can explain the mental fatigue variable by 91.5%. The remaining 8.5% is influenced by other factors not explained in the study. The results of this study indicate that body dynamic anthropometry has a significant effect on workers' mental fatigue. The effect

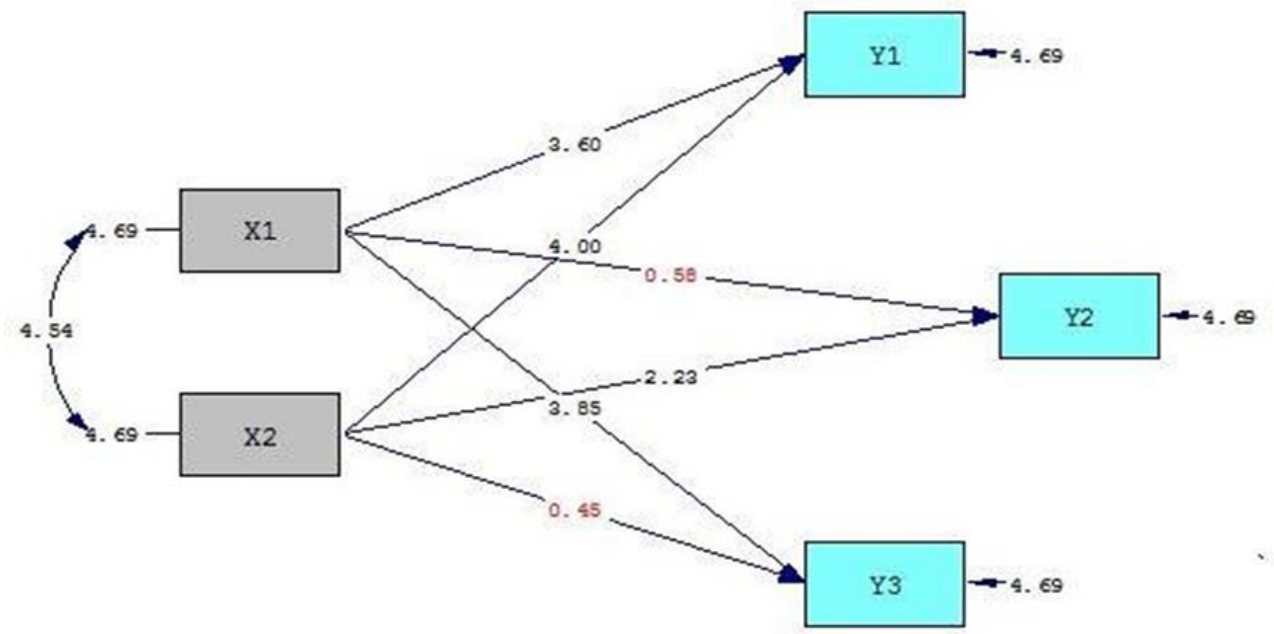

Figure 3 Model Analysis Results.

that occurs when the practitioner's dynamic anthropometric value is higher, the degree of fatigue complaints increases, because the more often someone does a lot of movements with high frequency, the person will be prone to experiencing physical fatigue complaints. In line with that, this study is supported by Shah's study [11] where repeated positions at work result in a 92-95% risk of MSDs in handicraft workers. It corresponds to the research conducted by Hendra [12] that the REBA risk score for loading palm oil into trucks is 8-10/high risk, and 83.7% of 117 workers feel MSDs complaints on the neck and back. It is also supported by the results of a study conducted by the European Campaign on MSDs (2008) which states that 235 million workers in Europe as many as 62% have been exposed to MSDs on the hands due to repetitive motion and 46% experience complaints of fatigue due to body position at work. It is in line with the previous research by Jalajuwita [13] that non-ergonomic posture at work is one of the causes of musculoskeletal fatigue. Restupuri [14] also explained that based on the results of his research, the causes of MSDs (Musculoskeletal Disorders) complaints in CV production workers. Wijaya Kusuma is the work posture of the workers throughout the production process.

Dynamic anthropometry has a significant effect on physical fatigue in terms of workers' blood pressure ($p<0.05$). If the dynamic anthropometry of the body is increased by 1, the level of physical fatigue in terms of blood pressure will increase by 0.876 and together with static anthropometry and dynamic anthropometry, it is able to explain the variable of physical fatigue in terms of blood pressure of 59.8%. This finding corresponds to

Muharmi's study [15], which found that the higher the activity carried out by a person, the more physiological the body will increase. The physiological increase in the body is marked by increasing blood pressure. It is in line with the previous research by Manembu [16] revealing that the measurement of blood pressure (systolic and diastolic) in the sitting position and standing position experienced differences, where there was an increase in systolic and diastolic blood pressure from a sitting position to a standing position.

In this study, dynamic anthropometry had no significant effect on physical fatigue regarding the welding practitioner's pulse ($p>0.05$). This finding echoes May's (2010) research that pulse rate was affected by workload only for workers with a load weight of more than 40 kg. Meanwhile, for workers with a bodyweight below 40 kg, there was no increase in fatigue as seen from the pulse rate.

4. CONCLUSIONS

1. In general, body anthropometry has a significant effect on both physical and mental fatigue.
2. Body static anthropometry has a significant effect on the physical and mental fatigue of workers.
3. Body static anthropometry has no significant effect on physical fatigue in terms of workers' blood pressure.
4. Body static anthropometry has a significant effect on physical fatigue in terms of the pulse of welding practitioners.
5. Anthropometry of body dynamics significantly affects physical fatigue in terms of the feelings of welding workers.
6. Body dynamic anthropometry has a significant effect on physical fatigue in welding practitioners' blood pressure.
7. Anthropometry of body dynamics has no significant effect on physical fatigue in terms of the pulse of the welding practitioner.

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