Ergonomics Awareness, Working Posture and Muscle Fatigue among Industry Workers and their Relationship with Musculoskeletal Disorders (MSDs) Symptoms: A Case Study

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ABSTRACT

Ergonomic awareness in the industry is deemed to be low and that the increasing trend involving musculoskeletal disorders (MSDs) has been reported. This can be attributed to several factors which include the lack of training which focuses on ergonomics and its weak implementation in the manufacturing industry. The objective of this study is to determine the relationship of ergonomic awareness, postures and muscle fatigue with MSDs symptoms. The results have shown that there is no significant relationship between ergonomic awareness and the MSDs symptoms. However, there is strong significance between MSDs symptoms and muscle fatigue. REBA analysis has shown that all the workers have worked in unhealthy postures especially in the lower extremities. As conclusion, it is vital to educate the workers with the correct postures and ergonomic training to reduce the chance of muscular fatigue and musculoskeletal disorders (MSDs) in the long run..

Keywords: Electromyography, Posture, Sustained load

1. INTRODUCTION

Musculoskeletal disorders (MSDs) cases at the workplace have skyrocketed for the past couple of years. According to the reports published by SOCSO for the years 2016 and 2017, the number of cases involving MSDs are 1006 and 1354 respectively [1, 2]. This situation is alarming as the number of accidents have increased by 34.5 percent in a span of just one year. By October 2018, the manufacturing industry has recorded to experience the highest occupational accidents which is at 50 percent out of the whole sector [3].

Referring to Figure 1, accidents involving musculoskeletal disorders are 56 percent for male and 59 percent for female out of the total number of occupational diseases for the year 2016. These figures have far surpassed the cases caused by other agents which include occupational respiratory diseases, skin diseases and cancer which in total is still lesser than that of MSDs cases [1].

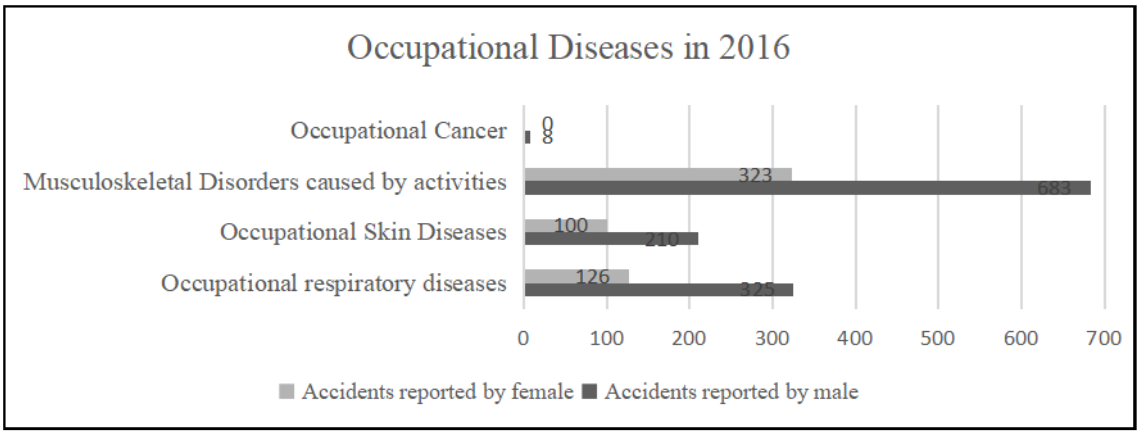

Figure 1: Number of Occupational Diseases in 2016

Musculoskeletal disorders are the main contributor to the day loss from work due to workplace accidents. MSDs is more prevalent in some industries compared to others which are transportation and warehousing, manufacturing, agriculture and services [5]. According to Rothmore et al. [4], the highest case involving accidents and workplace accidents received by The European Worker Union were those involving MSDs. In addition, Bureau of Labour Statistics of United States has reported that MSD had affected 32 percent of the occupational diseases in America, in which higher cases were reported among male workers compared to the female [5]. Similar situation has also been reported by the Social Security Organization (SOCSO) in Malaysia.

In addition, ergonomic awareness level is not just an issue faced in Malaysia but also globally. This is a concern because the ergonomic awareness drives the ergonomic application, ensures a safe workplace and improves human wellbeing. Studies related to ergonomic awareness in various industries for instance the health sectors, call centres and telemarketers have been conducted throughout the world such as in Nigeria, Sweden and United States [6-8]. All the studies concluded that ergonomic awareness level ranged from low to moderate. Hence, some control measures should be introduced to increase the level of ergonomic awareness among the industrial workers.

There are a few factors that may contribute to the shortfall of ergonomic awareness among the industry workers such as lack of health and safety training culture and working environment [6, 9, 10]. Ergonomics training is found as having significant relationship with ergonomics awareness [10, 11]. Some of the examples suggested to increase ergonomic awareness are orientations, training, assessment and inspections that can be organized by the top management of the company.

An extensive study was conducted by Shikdar and Sawaqed [12]. It was found that many companies' managements failed to do regular assessments concerning health and work environment on the shop floor. In the case study done by Shikdar and Sawaqed [12], the company has no systematic plan to organize targeted training with the sole focus on ergonomic awareness and the application of ergonomic awareness in the work place. This is critical especially among the small and medium industries in developing countries all around the globe. The management of companies were also unsupportive as they do not provide proper instructions nor encourage safe environment in their premises. Thus, the management attitude towards ergonomics practices is low due to lack of ergonomic awareness in the workplace [12].

2.0 METHODOLOGY

Figure 2 shows the overall methodology that has been implemented throughout this experiment. Prior to the selection of the targeted respondents, the survey has been distributed to 45 workers to identify the

ergonomic awareness level of the workers. The respondents consist of those who work at the production floor. The nature of their job may include but not limited to standing for a long period, bending and lifting loads. The surveys were divided into four parts namely Part A, B, C and D (i.e A: Demographic Profile, B: Ergonomic Awareness and Good Practices, C: Job Aspect, D: Musculoskeletal Symptoms). Questionnaire survey was utilized as the data gathering method. It is used to assess workers' perceptions on the subject matter. It was distributed personally and randomly onsite at the equipment manufacturer company. This method was chosen because the response time is faster compared to the mailing method. Besides that, any doubt or questions from the respondents can be clarified by the assessor, subsequently encouraging them to answer in the more truthful way [13].

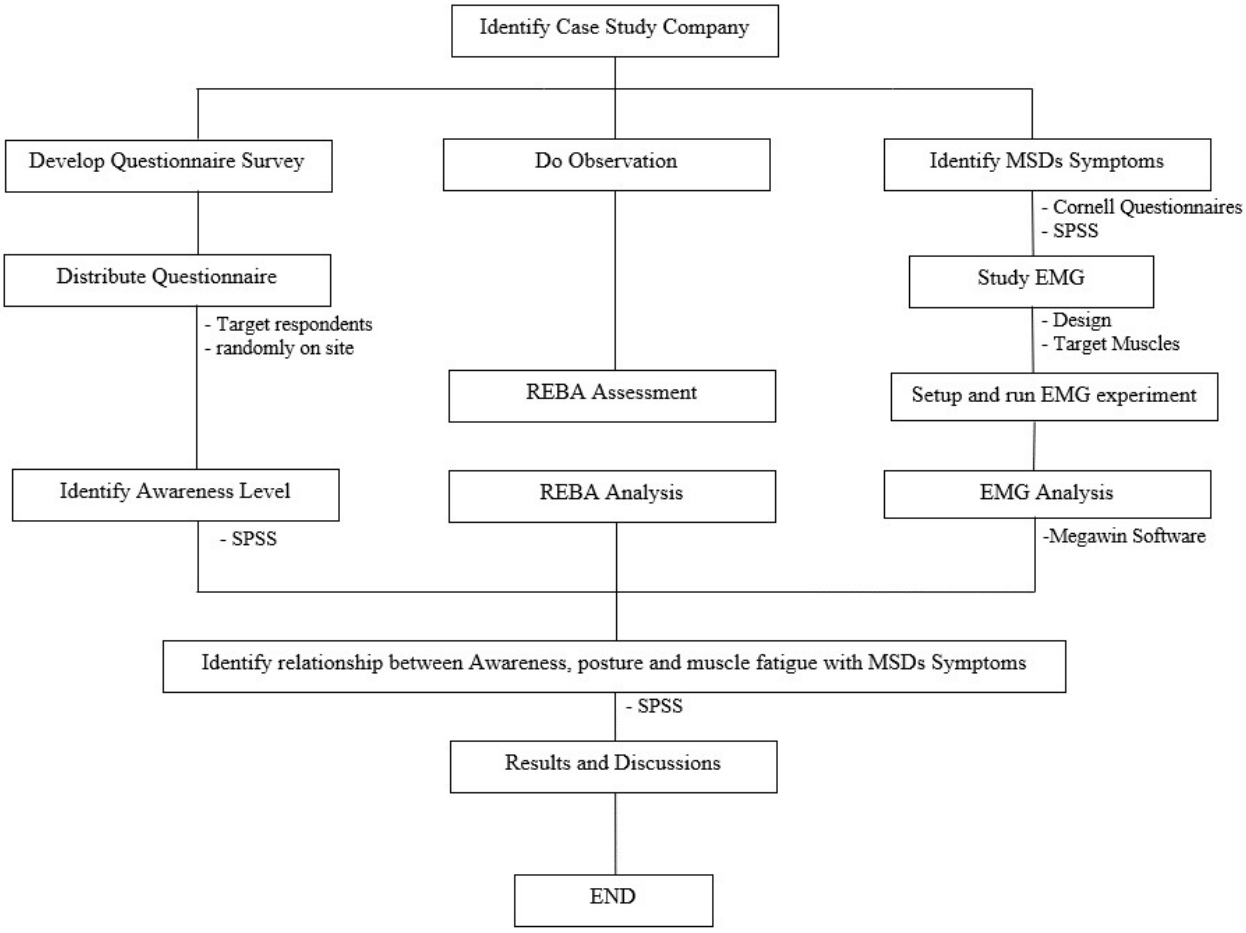

Figure 2 Methodology of study

The objectives of the questionnaire surveys are to study the level of ergonomic awareness, existing ergonomic implementations and MSDs symptoms that the workers might have suffered from. Dual languages were used (English and Malay) as the targeted respondents were more comfortable to answer the survey in their native language. This improvement has been made based on the feedback from the pilot study. Following the completion and analysis of the survey, eight (8) respondents have been chosen to be tested for REBA and EMG. All the respondents were chosen based on the results of the surveys that they have answered earlier. This is entirely based on the results of the Part B of the surveys which revolve around the topic of ergonomic awareness and good practices.

Two analyses were done, namely Rapid Entire Body Assessment (REBA) and Electromyography (EMG). Rapid Entire Body Assessment (REBA) was used to assess the postures of the workers. Pictures

of the workers' postures during working have been captured and assessed. Electromyography has been chosen to assess the local muscle fatigue of the workers. This method has been very popular for the past 30 years, hence is said to be very reliable [14]. Several muscle areas were chosen to be measured. It was based on the literature review [15-17] and consultation from the representatives of National Institute of Safety and Health (NIOSH). Surveys from the target respondents (Part D) based on the MSD symptoms were also used to determine the selected muscle area based on the posture highlighted in the REBA form. Based on the considerations of all the three sources, muscles that have been opted were trapezius, erector spinae, tibialis and soleus for both left and right sides of the body as shown in Figure 3.

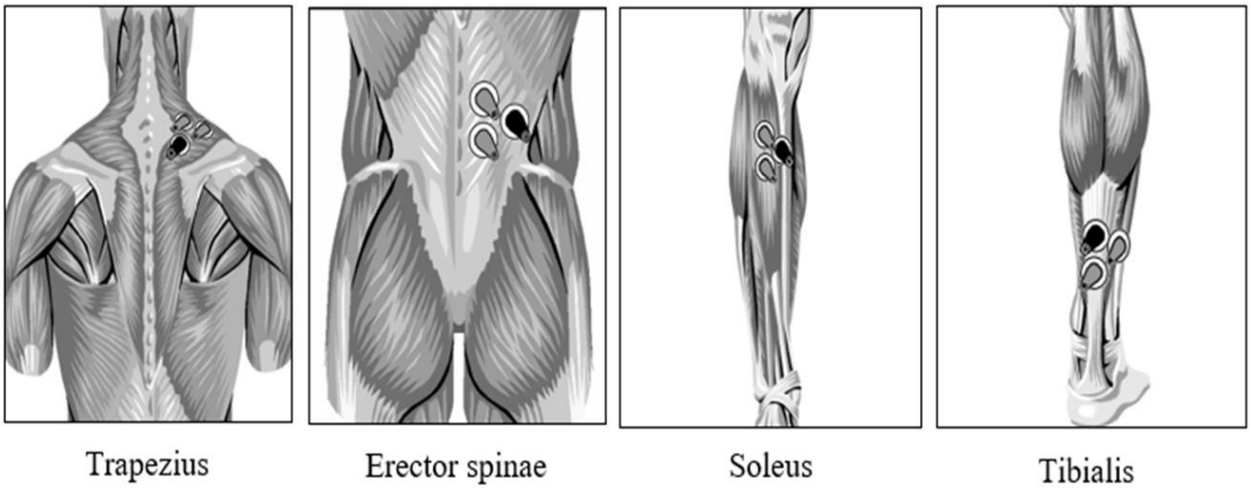

Figure 3 EMG Sensors location

Before placing the electrodes at the target muscle, selected skin area was swabbed with alcohol for preparation. Electrodes were placed at the skin area. Procedure of the electrodes installation on the skin area is according to Konrad [18]. Placements between the electrodes are recommended to be 20 mm and the samples of the frequencies will be set at 1000 Hz. Maximum voluntary contractions (MVC) of the muscles must be recorded first before the actual readings. Three cycles of MVC with 10 seconds in between and the activities that will be done will be based on those suggested by Konrad [18]. Then, MVC readings are compared with actual reading of EMG and if the actual reading is 20 percent of MVC, it is regarded as muscle fatigue. The actual test has been carried out for a 20 minutes period.

3.0 RESULTS

3.1 Ergonomics Awareness and MSDs Symptoms

The relationship between ergonomic Awareness and MSDs symptoms was established using Mann – Whitney Test. MSDs symptoms (Part D) final score has been computed by referring to Hedge et al. [19]. However, before type of test to run is chosen, normality test will be ran first using Skewness and Kurtis values. Data are categorised as normal if the kurtosis and skewness values are ±2.00 [20] . The normality test has shown that the data concerning MSDs symptoms are not normal as the kurtosis value is not within the range stated (Skewness = -.177; kurtosis = -.288). Furthermore, Mann – Whitney test shows that the relationship between ergonomic awareness and MSDs symptoms experienced by the workers is not significant. Significant level is set at $p < 05$ while the Mann Whitney test has yielded $p = .149$ ($p > .05$).

3.2 REBA Analysis

REBA analysis is limited to include only the neck area, trunk and leg. Each body part is given penalty score from 1 to 4. Penalty score 1 represents the workers in a neutral position and 4 is the highest score in which the workers are in a very poor posture. The penalty score will also reflect the risk level that the workers are susceptible to in terms of MSDs symptoms (i.e. 1 = low risk; 2 = medium, 3 = high risk and 4 = very high risk).

Based on the analysis, all the workers have low penalty score (1 and 2) in the neck area. However, this is not the case for trunk and legs. 63 percent of the workers scored 4 while the rest scored 3 for the trunk area. Plus, 100 percent of the workers have obtained penalty scores of 3 and 4. This shows that most of the workers are exercising unhealthy postures in the lower extremities.

3.3 Fatigue Analysis

Fatigue analysis was done by evaluating the relationship between maximum voluntary contraction (MVC) and MSDs Symptoms from Part D of the survey. The muscle parts that have been chosen to be tested correspond to the selected REBA analysis as shown in Table 1.

Table 1: Corresponding Body parts for REBA and EMG

REBA	EMG
Neck	Trapezius (Left and Right)
Trunk	Erector Spinae (Left and Right)
Leg (Left and Right)	Soleus (Left and Right) Tibialis (Left and Right)

The relationship is analysed using Spearman' rho based on the strength of correlation(r) and the significance level of $p < .05$. Spearman's rho is chosen as the data is non parametric and monotonic [20, 21]. Error! Reference source not found. reflects the analysis that have been carried out with regards to the relationship. Based on Error! Reference source not found., all the muscle areas that have been chosen have significant correlations with MSDs symptoms except for the neck area. According to Chua [20], value of r between ±.71 and ±.90 shows that a strong relationship exists. Regarding the neck area, the correlations fail to be computed as the values are constant (i.e. belong in one group).

Table 2: Fatigue Analysis

Correlations between MSDs Symptoms and MVC	P	r	Findings
Lower Leg – Tibialis (Left)	.028*	.760	Strong correlation
Lower Leg – Soleus (Left)	.037*	.737	Strong correlation
Lower Leg – Tibialis (Right)	.122	.592	Not significant
Lower Leg – Soleus (Right)	.024*	.775	Strong correlation
Neck – Trapezius	Cannot be computed		Constant
Trunk / Lower Back – Erector Spinae	.028*	.760	Strong Correlation

4.0 DISCUSSION

This study aims to identify ergonomic awareness, postures and muscle fatigue with MSDs symptoms. Based on the obtained results, it can be concluded that ergonomic awareness possessed by the workers is not significantly correlated with MSDs. In contrary, MSDs symptoms have a strong relationship with muscle fatigue as depicted in Table 2. This result may be affected by the year of experience of the respondents. Most of them have 5 to 10 year experience and the nature of working is not in long period (more than 2 hours working continuously or cumulatively in 8 hours working day).Anwar et al. [22], Fazi et al. [23] and Ansari and Sheikh [24] have attributed the prevalence of MSDs to the work nature during manual material handling. According to a study conducted by Hellig et al. [25], muscle activities can be highly associated with working postures. Similar situations have also been observed in the studied company as shown in Figure 4.

Figure 4 Working postures

Moreover, the relationship between MSDs symptoms and fatigue analysis has shown a strong correlation especially at the lower extremities area. However, r cannot be computed between the neck and trapezius. This is because all the values belong in one group and all the workers were working with the correct postures in the neck area. This data is also supported by the results of EMG analysis which show that MVC is less

than 20 percent (not fatigue). There are also possibilities of external factors that alter the accuracy of the results in the area. As mentioned, the skin must be prepared properly to ensure correct reading. Nevertheless, due to the high temperatures in the environment of which the workers are working in, the increase in perspiration in the shoulder area may cause the electrodes to detach.

According to Daneshmandi et al. [26], the workers who experienced fatigue during working hours have reported muscle discomfort and pain. This research is able to replicate the results of the strong correlation at the lower extremities area with the most musculoskeletal symptoms being recorded by the survey. Similar results have also been highlighted by Chavalitsakulchai and Shahnavaz [27]. REBA and EMG analysis have clearly shown that most of the problems arise at the lower extremities area (lower back and leg). This result can be attributed to the prolonged standing and bearing of static load throughout the shift [28, 29]. This has become a common issue in manufacturing industry [28]. This study is aligned with similar studies that have been conducted around the world such as in Iran, Arab Saudi and Dutch [30-32]. Standing position are preferred by most of the workers as it allows the workers to move freely at any leg angle [28]. Furthermore, it was found that the result is not significant between right lower leg and tibialis muscle as depicted by Table 2. On the other hand, there is a strong correlation between right lower leg and soleus. This is because there is an imbalance posture as where most our weight is been supported by the left leg. Soleus muscle is put under strain or known as sustained loading, resulting in muscle fatigue in that area [33].

Incorrect technique may also become one of the reasons that contribute to the MSDs symptoms [30]. Based on the questionnaire survey, 100 percent of the workers believed that they are working with the correct techniques. However, the results of the experiments and direct observations at the company do not support the claim. This may worsen the conditions of fatigue and MSDs as the workers are working under false pretences.

Limitations

This study was conducted at an equipment manufacturer company with 8 participants. This is mainly due to time constraint. Although the sample size is very small, we are able to provide statistical evidence based on the methodology that has been adopted throughout this study. Consequently, this study may not be a representative of all the workers who work in the same industry. Hence, this study may provide the cornerstone for future research concerning manual material handling.

5.0 CONCLUSION

As a conclusion, the relationship between MSDs symptoms and fatigue analysis have been identified. It is vital to practice the correct postures when carrying out a task. MSDs may be reduced with the use of the correct technique during working hours. In return, muscular fatigue may also be lessened. Therefore, it is important for the workers to be exposed to ergonomic training.

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