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QC operator's nonneutral posture against musculoskeletal disorder's (MSDs) risks

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Abstract. Musculoskeletal disorders refer to a gamut of inflammatory and degenerative disorders aggravated largely by the performance of work. It is the major cause of pain, disability, absenteeism and reduced productivity among workers worldwide. Although it is not fatal, MSDs have the potential to develop into serious injuries in the musculoskeletal system if ignored. QC operators work in nonneutral body posture. This cross-sectional study was conducted in order to investigate correlation between risk assessment results of QEC and body posture calculation of mannequin pro. Statistical analysis was conducted using SPSS version 16.0. Validity test, Reliability test and Regression analysis were conducted to compare the risk assessment output of applied method and nonneutral body posture simulation. All of QEC's indicator classified as valid and reliable. The result of simple regression analysis are back ($0.326 < 4.32$), shoulder/arm ($8.489 > 4.32$), wrist/hand ($4.86 > 4.32$) and neck ($1.298 < 4.32$). Result of this study shows that there is an influence between nonneutral body posture of the QC operator during work with risk of musculoskeletal disorders. The potential risk of musculoskeletal disorders is in the shoulder/arm and wrist/hand of the QC operator, whereas the back and neck are not affected.

1. Introduction

Recently, the measurement of the Musculoskeletal disorders (MSDs) risk is generally not managed by the company, even MSDs are the most common complaints of labours, stated by [1]. The 2014 Labor Force Survey (LFS) Report published by [2] showed that there were 526,000 cases of MSDs in the UK, it almost three times higher than reported MSD's cases in 2013 (184,000 cases) MSDs are defined by [3] as the injuries or pain in the human musculoskeletal system when the muscles receive static loads and for a long periods. MSDs occur due to some risk factors, such as nonneutral working postures, static load of muscles, high workload, repetitive work, stated by **Error! Reference source not found..** Musculoskeletal disorders (MSDs) refer to a gamut of inflammatory and degenerative disorders initiated or aggravated largely by the performance of work or associated work settings **Error! Reference source not found..** It is the major cause of pain, disability, absenteeism and reduced productivity among workers worldwide **Error! Reference source not found..** Although not fatal, MSDs have the potential to develop into serious injuries in the musculoskeletal system if ignored **Error! Reference source not found..** Most MSDs are accumulative disorders resulting from protracted exposure to loads of varied intensity at work [6]. Risk factors often cited for musculoskeletal disorders in the workplace include rapid work pace and repetitive motion, forceful exertions, non-neutral body postures, and vibration [7]



Nonneutral body postures will increase the labour's workload that can be the potential causes of MSDs on certain body parts, stated by [8]. According to the results of MSD's research that has been conducted by **Error! Reference source not found.** back is body part with the highest risk of MSDs.

In this study QC operator's body posture at Widatra Bhakti ltd showed that the QC operators work in nonneutral body posture. It was supported by Mannequin pro simulation, the results are as follows : wrist = 0 Nm, elbow = 3 Nm and 2 Nm, shoulder = 4 Nm and 9 Nm, hip = 9 Nm and 10 Nm, Knee = 22 Nm and 21 Nm, Ankle = 23 Nm and 22 Nm, back = 26 Nm and 2 Nm Neck, these indicates there is an imbalance of labour torque



Figure 1. QC Operator when taking product at conveyor.

In this study, the researcher adopted a case study analysis method to confirm the influence of nonneutral working posture that is represented by torque load and MSDs risk. Case study analysis was conducted at Widatra Bhakti ltd. This study required collaboration Widatra Bhakti stakeholder to find the best solution for labour' safety and health.

2. Musculoskeletal Disorder

Musculoskeletal disorders (MSDs) can be defined as the injuries or pain in the human musculoskeletal system when the muscles receive static loads and for a long period. According to [3] musculoskeletal disorders usually affect the back, neck, shoulders and upper limbs, but lower limbs can also be affected. MSDs cover any damage or disorder of the joints or other tissues. Reference **Error! Reference source not found.** stated that the health problems range from minor aches and pains to more serious medical conditions requiring time off or medical treatment. In more chronic cases, MSDs can even lead to disability.

According to **Error! Reference source not found.** most work related MSDs develop over time. There is usually no single cause of MSDs; various factors often work in combination. Physical causes and organisational risk factors include: Handling loads, especially when bending and twisting, repetitive or forceful movements, awkward and static postures, vibration, poor lighting or cold working environments and prolonged sitting or standing in the same position. There is growing evidence linking MSDs with psychosocial risk factors (especially when combined with physical risks), including high demand of work or low autonomy and low job satisfaction

Quick Exposure Check is a tool developed by Li and Buckle [9] and enhanced by David et al. [10]. QEC is applied to assess level of exposure to ergonomic risks. One of the unique features of QEC is that the observed worker should rate the weights handled, time spent on observed task, level of hand force, visual demands, application of vibrating tools and difficulties to sustain with the work as well as the stressfulness of the work.

Observer's Assessment

Back

A When performing the task, is the back
(select worse case situation)

Almost neutral?
 Moderately flexed or twisted or side bent?
 Excessively flexed or twisted or side bent?

B Select ONLY ONE of the two following task options:

EITHER

For seated or standing stationary tasks. Does the back remain in a static position most of the time?

No
 Yes

OR

For lifting, pushing/pulling and carrying tasks (i.e. moving a load). Is the movement of the back

Infrequent? (Around 3 times per minute or less)
 Frequent? (Around 8 times per minute)
 Very frequent? (Around 12 times per minute or more)

Wrist / Hand

E Is the task performed with
(select worse case situation)

an almost straight wrist?
 a deviated or bent wrist?

F Are similar motion patterns repeated

10 times per minute or less?
 11 to 20 times per minute?
 More than 20 times per minute?

Shoulder / Arm

C When the task is performed, are the hands
(select worse case situation)

At or below waist height?
 At about chest height?
 At or above shoulder height?

D Is the shoulder/arm movement

Infrequent (Some intermittent arm movement)?
 Frequent (regular movement with some pauses)?
 Very frequent (almost continuous movement)?

Neck

G When performing the task, is the head/neck bent or twisted?

No
 Yes, occasionally
 Yes, continuously

QEC - Quick Exposure Check for Work-Related Musculoskeletal Risk. (2003 version)

Figure 2. Observer's Assessment of Quick Exposure Check .

3. Research Methodology

This study uses Quick Exposure Checklist (QEC). This study focused on MSDs risk on four indicator of 24 QC operators body as study's object that included back, shoulder/arm, wrist/ hand and neck. This cross-sectional study was conducted in order to investigate correlation between risk assessment results of QEC (Dependent variable) and body posture calculation of mannequin pro (Independent variable) at a single point in time. Observer asked the workers about their tasks while completing the observer portion of the tool after that observer asked the workers to answer the worker assessment and observer scored the assessment.

QC operator's body postures were simulated by Mannequin pro. The simulation results measured its contribution to the variable work posture to determine which factor or torque load in which body part most dominant influence the operator work posture

Statistical analysis was conducted using SPSS 16.0 student version [11]. Validity test, reliability test and regression analysis were done to compare the risk assessment output of applied method and nonneutral body posture simulation.

4. Result and Analysis

a. Validity and Reliability test of Quick Exposure Check

The results of validity and reliability test are presented in Table 1. According to this table, all of QEC's indicator classified as valid (The Corrected item total correlation (R) is higher than 0.05) and reliable (The Cronbach's Alpha is higher than 0.60)

Table 1 . Validity and Reliability of Quick Exposure Check.

Exposure	R		Result
Back			
When performing the task, is the back	0.612	> 0.05	Valid
For manual handling tasks only, is the movement of the back	0.484	> 0.05	Valid
Other tasks : are the tasks performed in static posture most of the time?	0.187	> 0.05	Valid
Shoulder/arm			
Is the task performed	0.207	> 0.05	Valid
Is the arm movement repeated	0.546	> 0.05	Valid
Wrist/hand			
Is the task performed	0.401	> 0.05	Valid
Is the task performed with similar repeated motion patterns	0.595	> 0.05	Valid
Neck			
When performing the task, is the head/ neck bent or twisted excessively	0.506	> 0.05	Valid
<i>Cronbach's Alpha</i>	0.705	> 0.06	Reliable

b. Regression Analysis

- Back postures with MSD's risk at Back

The result of simple regression analysis is presented in Table 2. According to this table, the F – Theory is higher than F-Empiric. It can be concluded that there is no correlation between nonneutral back posture and MSD's risk at the back of the QC operators (H_0 accepted)

Table 2. Regression Analysis result.

F – Empiric	F – Theory	Result
0.326	4.32	0.326 < 4.32

- Shoulder/arm postures with MSD's risk at Shoulder/arm

The result of simple regression analysis is presented in Table 3. According to this table, the F – Theory is lower than F-Empiric. It can be concluded that there is correlation between nonneutral shoulder/arm body posture and MSD's risk at the shoulder/arm of the QC operators (H_0 rejected)

Table 3. Regression Analysis result.

F – Empiric	F – Theory	Result
8.489	4.32	8.489 > 4.32

- Wrist/hand postures with MSD's risk at Wrist/hand

The result of simple regression analysis is presented in Table 4. According to this table, the F – Theory is lower than F-Empiric. It can be concluded that there is correlation between nonneutral wrist/hand body posture and MSD's risk at the wrist/hand of the QC operators (H_0 rejected).

Table 4. Regression Analysis result.

F – Empiric	F – Theory	Result
4.86	4.32	4.86 > 4.32

- Neck postures with MSD's risk at Neck

The result of simple regression analysis is presented in Table 5. According to this table, the F – Theory is lower than F-Empiric. It can be concluded that there is no correlation between nonneutral wrist/hand body posture and MSD's risk at the wrist/hand of the QC operators (H_0 accepted)

Table 5. Regression Analysis result.

F – Empiric	F – Theory	Result
1.298	4.32	1.298 < 4.32

5. Analysis

Based on the empirical data obtained by the results of this study, there is an influence between non-neutral body posture of the QC operator during work with risk of musculoskeletal disorders. The potential risk of musculoskeletal disorders is in the shoulder/arm and wrist/hand of the QC operator, whereas the back and neck are not affected by the body posture.

The operator's movement of shoulder and wrist illustrate the high risk of MSDs by their moving shoulders and repetitive hands flexing during work. This condition occurs because the shoulder of the operator keep moving and the wrist always bent every time they picking up the product from conveyor.

On the other hand, the QEC's statement of moving/bending/twisting back and neck does not occur to the QC operators. This happens because the back of the operator does not bend and does not in a static condition and neither does the neck. Since the neck of the operator does not often bend or twisted and does not cause fatigue while working, in which the height of the work bench can be adjusted to the posture of each operator thus minimize potential risk of musculoskeletal disorders.

The dimensions of musculoskeletal disorders (MSDs) based on the concept of Quick Exposure Check (QEC) that explained by **Error! Reference source not found.** consist of 4 potential risk dimensions (back, shoulder/arm, wrist/hand and neck). It was found that most of the research's objects had the potential risk of MSDs on high scales in all four dimensions of potential risk with the order from the largest to the smallest was the back, neck, shoulders and wrist.

The results in this study indicated that the posture of the QC operator during work significantly influence the potential risk of MSDs, especially on the shoulder and wrist operator. The results of shoulders and wrists suggest that these dimensions potentially lead to MSDs in QC operators supported by observations where the constantly moving shoulders and wrists are always bent due to unsuitable conveyor location. This result is in accordance with the statement results of the study by [13] and **Error! Reference source not found.** This indicates that working with nonneutral / awkward posture will increase the risk of MSDs on shoulder and wrist.

6. Discussions

Case study analysis is the method that allows us to accommodate users need in a research. This will be helpful on research because the opinions revealed are based on the real case in the field. In order to find the representative case study, the case must be chosen carefully and, it is quite challenging sometimes. The future research could be developed not only medication product company, but can be expanded to the other company type so that the research will produce a more general result. The number of objects

can be added that the criteria of the study and the resulting robust criteria. In a subsequent study, it is expected that the management in safety and health in the company be considered, so the result becomes more representative when it is used in real life event.

7. Conclusions

By using the integration of mannequin pro and QEC analysis, this research developed MSDs risk indicator that can be used by company to assess their worker's safety and health. Refer to **Error! Reference source not found.** four parts of the body (i.e. back, shoulder/arm, wrist/hand and neck) that can be affected by MSDs. This study concluded that there is a significant effect of non-neutral body posture on the risk of MSDs especially at shoulder/arm and wrist/hand. It can occur because their shoulder/arm is constantly moving and their wrist/hand are flexed repeatedly during work. On the other hand, back and neck are constantly in a neutral position.

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