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.

![QC Operator when taking product at conveyor.](image)

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.
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 |
| Cronbach’s Alpha                                                        | 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 (H₀ accepted)

| 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 (H₀ rejected)

| 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 (H₀ 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 (H₀ 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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