

ORIGINAL ARTICLE

RISK FACTORS FOR MUSCULOSKELETAL DISORDERS IN LIQUEFIED PETROLEUM GAS BOTTLING PLANT - A CASE STUDY

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ABSTRACT

This study aims to investigate the risk factors of musculoskeletal disorders (MSDs) for operators at a Liquefied Petroleum Gas (LPG) bottling plant in Malaysia. The operators are involved in manual material handling such as lifting LPG cylinders from conveyer, rolling LPG cylinders onto platform, lifting and stacking the cylinders. Adapted Nordic Questionnaire were distributed to six subjects to determine the affected body part as perceived by them. They were also observed and assessed using pen and paper tool for entire body, REBA. The findings show that the majority of the subjects perceived that they experienced discomfort if not pain at almost every part of their body. The discomforts and pains have led them to be absent from work at any time during the past 12 month. From REBA it was found out that the loading and stacking activity gave the highest risk factor to MSDs (score 11) as compared to the rolling activity (score 7). The risk factors identified were awkward posture, repetitive movement and prolonged static posture.

Keywords: LPG Bottling Plant; Musculoskeletal Disorders; LPG cylinder; Nordic Questionnaire; Rapid Entire Body Assessment (REBA)

INTRODUCTION

The definition of Musculoskeletal Disorders (MSDs) is pains or injuries that affect the human body's movement or musculoskeletal system like muscle, tendons, ligaments, nerves, disc and blood vessel. Main risk factors that can contribute to MSDs are high task repetition, forceful exertion and sustained awkward posture (Jun et al., 2015). MSDs can cause low productivity, increased absenteeism and operators' turnover.

MSDs can also be resulted from manual handling activities when workers perform their task. The manual handling activities include lifting, forceful exertion such as pushing, pulling and carrying. According to Nimbarte (2014), lower back disorders are traditionally have been associated with the forceful arm exertion and lifting. Unfortunately, the effects of the forceful exertion and lifting on neck and cervical spine are not generally understood even though it is clearly indicated by the epidemiological evidences. An empirical evidence has been provided by Nimbarte (2014) which proved the causative relationships between the forceful arm exertion and the neck and cervical spine disorders.

One of the ergonomics pen-and-paper assessment tools that is usually used in

determining the risk factor of MSDs is Rapid Entire Body Assessment (REBA). According to Moussavi-Narjakola & Mirzaei (2012), REBA is very useful as it can assess the risk factors for the entire body whilst the validity and reliability of it have been reported in many studies of various jobs and tasks. REBA considers the exposure factor of posture, load, force, movement and frequency that related to the MSDs (David G.C, 2005; Pascual S.A et al, 2008).

A Liquefied Petroleum Gas (LPG) bottling plant in Malaysia operating dimension is 16 hours for 6 days operation. It consists of two work shifts; Work shift A from 6 am to 2 pm and Work Shift B from 2 pm to 10 pm. The average loadings per shift were 15 packed trucks that approximately has 10,000 LPG cylinders. Each cylinder weighs about 30 kg inclusive of the weight of the cylinder and the LPG fill. The recommended weight limit (RWL) can be calculated by applying the revised NIOSH lifting equation (Waters et al. 1994). However the recommended weight for lifting/carrying at elbow height for male as according to the latest Guidelines of Ergonomics Risk Assessment at Workplace (DOSH, 2017) is 25 kg and lighter for other levels or for female operators. The manual handling activities at the plant start with the counting incoming empty cylinders, unloading empty cylinders, sorting out cylinders, inspecting the quality visually, filling

the domestic cylinders (in carousel), checking the weight, testing for any valve leak, washing the cylinders, loading filled cylinders and finally counting outgoing cylinders. These details are sufficient to hint the potential ergonomics risk factors at the LPG bottling plant.

The objective of this study is to investigate the prevalence of risk factors for LPG bottling operators by using REBA pen and paper tool.

MATERIALS AND METHODS

The study was conducted in one of LPG bottling plant in Malaysia. The specific process selected for this study is the loading the LPG cylinders. This study focuses on the prevalence of musculoskeletal disorders among the LPG plant operators, those who are involved with the manual cylinders handling.

The subjects for this study is six operators from a single shift. The low number of the operators involved has also lead to the selection of the REBA tool.

2.1 Questionnaire

Nordic Musculoskeletal Questionnaires were also distributed to the six operators. The operators were briefed by the researchers before they fill up the questionnaires. The body parts survey were illustrated separately in one page to allow better visualization and determination of body parts that are inflicted by musculoskeletal disorders due to their work.

2.2. Observation & REBA

In order to determine the ergonomics risk associated with the work, observation was done on the workers while they are performing their tasks. Photos were taken to allow for closer analysis and REBA process after the walk-through observation. The operators' tasks were separated into 3 activities namely:

- 1) Lifting of LPG cylinders from the chain conveyer to the platform.
- 2) Rolling the LPG cylinders onto the platform.
- 3) Lifting and stacking the LPG cylinders.

RESULTS AND DISCUSSION

3.1 Nordic Questionnaire Results

For question 1: Have you at any time during the last 12 months had trouble (ache, pain, discomfort, and numbness), the majority (five to six subjects) experienced pain or discomfort at their neck, shoulders, elbows, wrists/hands, upper back and lower back. Almost half from the six subjects had trouble at hips/thighs, knees and feet. More than half of the subjects experienced pain or discomfort at shoulder, elbow and wrist/hand of their right part and

the rest experienced it at both right and left parts.

Out of those pains and discomforts, the majority of them at any time during the past twelve months have been absent from work as depicted in Figure 1. Although Motamedzade et al. (2013) could not prove that there was a significant relationship between physical factors and absenteeism, Figure 1 shows an alarming data. However, this finding does not occurred during the last seven days of the study except for one to two subjects for their hip/thigh, lower back, upper back, hands, elbows, shoulders and necks discomfort or pain.

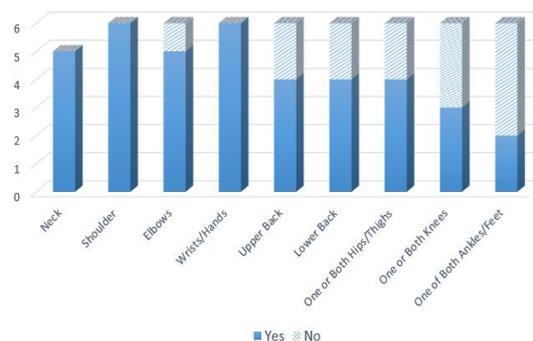


Fig. 1 Findings for Question 2: Have you at any time during the last 12 months been prevented from doing your normal work (at home or away from home) because of the trouble?

The questionnaire which was adapted from Kourinka et al. (1987) is important in order to identify which workers body facing the critical problem regarding manual handling issue. It was obvious that the operators who handle the LPG cylinder experienced discomfort if not pain during their work. Their job demand of handling 30 kg loads repetitively throughout the day manually without any mechanical aids pose a high risk factor for MSDs. Employees work with manual handling of heavy tools considerable risk to health (Bust et al. 2004). Based on the survey result, it is important to confirm the operators' perception with REBA.

3.2 Rapid Entire Body Assessment (REBA)

Table 1.0-3.0 show the findings of REBA for the three activities; lifting, rolling and stacking with score 11 (high), score 7 (medium) and score 11 (high) respectively. Step 1 to step 11 which is totalled as step 12 in REBA form is summarised and represented as awkward posture, whilst repetitive movement and prolonged are from step 13 in REBA.

Table 1.0 REBA results for activity 1

No	Risk Factor	Description	Health Effect
1	Awkward Posture	<ul style="list-style-type: none"> ➤ Lifting load >10kg ➤ Twisted body movement 	Low back pain Neck constrain Muscular fatigue
2	Repetitive Movement	<ul style="list-style-type: none"> ➤ Bend posture ➤ Flexion wrist ➤ Shoulder movement with twisting 	Low back pain Traumatized joint Shoulder bursitis
3	Prolonged	<ul style="list-style-type: none"> ➤ Standing ➤ Movement 	Muscle fatigue Leg pain



Fig.1 Activity 1: Lifting LPG cylinder from chain conveyor

Table 2.0. REBA results for activity 2

No	Risk Factor	Description	Health Effect
1	Awkward Posture	<ul style="list-style-type: none"> ➤ Hand reach LPG cylinder height ➤ Trunk bending ➤ Neck bending 	Low back pain Neck constrain Muscular fatigue
2	Repetitive Movement	<ul style="list-style-type: none"> ➤ Bend posture ➤ Twisting/flexion wrist ➤ Lateral feet movement 	Low back pain Traumatized joint Carpal tunnel syndrome
3	Prolonged	<ul style="list-style-type: none"> ➤ Standing ➤ Movement 	Muscle fatigue Leg pain



Fig. 2 Activity 2: Rolling LPG cylinder onto the platform

Table 2.0. REBA results for activity 3

No	Risk Factor	Description	Health Effect
1	Awkward Posture	<ul style="list-style-type: none"> ➤ Lifting load >10kg ➤ Twisted body movement 	Low back pain Neck constrain Muscular fatigue
2	Repetitive Movement	<ul style="list-style-type: none"> ➤ Bend posture ➤ Flexion wrist ➤ Shoulder movement with twisting 	Low back pain Traumatized joint Shoulder bursitis
3	Prolonged	<ul style="list-style-type: none"> ➤ Standing ➤ Movement 	Muscle fatigue Leg pain



Figure 3.0 Activity 3: Lifting and stacking the LPG cylinder

Figure 1 to Figure 3 depict the operators performing the activities that were assessed. Job demand involving repetitive trunk bending and heavy load pose risk factor for low back pain (Eungpinichpong et al., 2013). Besides that, as according to Schaefer et al., (2007) many studies had shown that lifting and pulling activities are associated to the risk of MSD.

No further statistical analysis could be presented as the number of subjects are low in this case study. As a recommendation, in accordance with DOSH (2017), preventive actions should be taken.

The ideal solution for this problem can be solved by eliminating the manual transferring of the LPG cylinders by introducing palletizer system (automation mechanism). In this system, the LPG Cylinder can be automatically transferred onto the chain conveyor and then into a stacking rack. The stacking process in this manner will be safer not just to the operators but also to the products, i.e. the LPG cylinders.

Otherwise, the substitution control can be introduced, that is by using mechanical device for example a cylinder trolley. The cylinder will be transferred from the conveyer onto the trolley and moved to stacking area. This control can reduce the pain that cause by twisting and lifting load repetitively during the transferring activities.

Apart from that, administrative control must be introduced. A buddy system could be implemented where each cylinder must be carried or lifted by minimum of two operators. The operators should also be given more short but frequent rest periods so that they can regain their energy and less prone to injuries. Most importantly the operators need to be educated with the correct technique in lifting and carrying loads.

CONCLUSION

Although the case study is not supported by any statistical analyses as the number of subjects or the operators at the plant is low, it was shown that the operators confessed that they experienced if not pain but discomfort at most of their body parts. These discomforts and pains had resulted them to be absent from work.

From REBA, it is suggested that the ergonomic risk for loading filled LPG cylinder activity is high for lifting LPG cylinder from chain conveyer and lifting and stacking on second layer. Whereas, medium risk for rolling LPG cylinder onto platform. The LPG plant need to be installed with mechanical device or some automation system to ease the risk factors that pose MSDs to the operators, if not immediately, in the long run.

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