**ORIGINAL ARTICLE**

# WORK-RELATED MUSCULOSKELETAL DISORDERS (WMSDs) AMONG INDUSTRIAL PACKAGING WORKERS IN MALAYSIA

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**ABSTRACT**

Work-related musculoskeletal disorders (WMSDs) is an occupational health issues that being actively discussed over the world. In Malaysia, there is trend of increasing over the years, particularly in the manufacturing sectors. **OBJECTIVES**: This study aims to investigate work-related musculoskeletal disorder (WMSDs) among manual material handling workers. **METHODS**: Task analysis was used to determine work process and identify generic risk factors contributes to the WMSDs. Meanwhile, Work Movement Task Analysis (WMTA) was applied to evaluate specific work-related ergonomic risk factors. Further, trend of discomfort and pain among workers was identified using body discomfort survey. Relationship between WMTA's risk score and symptoms of discomfort was determined using chi square analysis. **RESULTS**: It showed most of the workers (94%) were considered in the range of moderate risk according to WMTA's risk categories, meanwhile two cases each for low and high-risk category. While body discomfort survey for neck, back, shoulder and arm and knee and legs respectively revealed 42%, 74%, 89% and 29% workers had symptoms of discomfort or pain. However, there was no significant relationship between WMTA risk score with discomfort. There were other factors influenced WMSDs rather than working postures. This study suggests body mass index (BMI), smoking habit, psychosocial hazards and general health status possibly seems predispose to the discomfort symptoms. **CONCLUSIONS**: The activities were generally in the moderate risk level, which requires further investigation, and need to change when required. Shoulder discomforts substantially among workers mainly affected from pulling, pushing and lifting tasks. Effective control measures and prevention should employ according to the principles of OSH risk management inclusive hierarchy of risk controls. **INDUSTRY RELEVANCE**: Systematic ergonomic risk assessment consists of task analysis, onsite evaluation and body discomfort survey. Control measures lead by intervention steps on major risks followed by residual risks. This study introduce new observational instrument called Work Movement Task Analysis (WMTA) as an alternative approach to evaluate WMSDs.

***Keywords:*** *Work-related musculoskeletal disoders, ergonomic risk assessment, task analysis, observational approach*

## INTRODUCTION

In the past 30 years work-related musculoskeletal disorders (WMSDs) have become a growing concern in industrialized countries (Buckle & Devereux, 2002). WMSDs include a wide range of inflammatory and degenerative conditions affecting the muscle, tendons, ligaments, joints, peripheral nerves, and supporting blood vessels. These include clinical syndromes such as tendon inflammations and related conditions (tenosynovitis, epicondylitis, bursitis), nerve compression disorders (carpal tunnel syndrome, sciatica), and osteoarthritis, as well as less well standardized conditions such as myalgia, low back pain and other regional pain syndromes not attributable to known pathology (Punnett & Wegman, 2004).

Musculoskeletal disorders are reported to occur in certain industries and occupations with rates up to three or four times higher that the average rate across all industries (Punnett & Wegman, 2004). In Malaysian industries, manual task using human labor such as lifting, loading and unloading are still widely used in production process due highly flexible and cheap labors. However, most of the industrial workers are exposed to repetitive task, prolonged work and pain because of awkward postures that often lead to muscle fatigue and musculoskeletal discomfort among those workers (Baba Md.

Deros, Dian Darina Indah Daruis, Ahmad Rasdan Ismail, Nurfarhana Abdul Sawal, & Jaharah A. Ghani, 2010; Chandrasakaran, Chee, Rampal, & Tan, 2003). Manual material handling (MMH) is one of the main factor causing WMSDs among workers in the industrial developing country (IDC) (Parida & Ray, 2015) such as Malaysia. Thus, it is necessary to study the effect of work-related musculoskeletal disorder among respective task involves with manual material handling workers.

## METHODOLOGY

Cross sectional study was conducted among 33 males workers in the industrial packaging company located at Selangor, Malaysia. The study includes field risk assessment, task analysis and body discomfort survey among respondent.

### Task Analysis

Task analysis provides some structure for the description of task or activities, which then makes it easier to describe how activities fit together, and to explore what the implications of this may be for the design of products. This can be particularly useful when considering the design of interfaces to works or products, and how users interact with them (Gómez-Bull, Hernández-Arellano, & Ibarra-Mejía, 2015).

### Work Movement Task Analysis (WMTA)

Work Movement Task Analysis (WMTA) was developed on the basis of the existing observational tools e.g. Quick Exposure Check, Rapid Upper Limb Assessment and Rapid Entire Body Assessment (Graves, Way, Riley, Lawton, & Morris, 2004; Hignett & Mcatamney, 2000; Mcatamney & Corlett, 1993). WMTA tool have undergone validity and reliability testing and demonstrated good result (Shamsudin et al., 2016; Shamsudin & Daud, 2014). This tool is appropriate for evaluating tasks where postures are dynamic, static or where gross changes in position take place. WMTA provided a method to calculate the rating of musculoskeletal loads task which breakdown the specific risk for neck, back, shoulder & arms, and knee & legs loading. In addition, this tool provides a score as a "snapshot" of the task, which is the rating of posture and movement is required. The risk is calculated into a score of 9, which is low and score 46, which is considered high (table 1). These score are grouped into three action levels that provide an indication of the time frame in which it is reasonable to expect risk control to be initiated.

### Body Discomfort Survey

The survey demonstrates human figure and respondent is requested to mark at specific body region where the most experience discomfort or pain. This case study applied Corlett and Bishop (1974) body discomfort chart, which demonstrates the entire body including the neck, back, shoulder and arms and knees and legs. Upon field observations, discomfort survey collected from the respondents. Respondents will be interviewed and express their sense of discomfort and pain in their body.

## RESULTS

Table 1 shows task analysis outcomes various types of work contribute towards WMSDs. A total of 27 main activities observed in this premise. These activities were vital and dominance processes, which includes preparation and maintenance of machine components, raw materials and products handling.

### Ergonomic risk assessment using WMTA tool

The findings of WMTA risk category are shown in figure 1. The distribution of the risk scores demonstrated most of the tasks in the moderate risk condition, which were 31 (94%). Only two cases each in the categories of low risk and high scores (6%).

The findings according to the limbs are shown in table 2. For neck region, 31 (94%) in the moderate risk category and balance (6%) in the low risk category. Meanwhile, for back region, a total of 18 (56%) of respondents assessed in the high-risk category, 9 (26%) in the medium risk category, and the remaining 7 (21%) were in the low risk category. Furthermore, shoulder and arms represented 12 (37%) respondents in the high-risk category. Meanwhile, 18 (55%) respondents assessed in the moderate risk. Remaining 3 (8%) respondents in the low risk category. Knees and legs region demonstrated a total 21 (63%) respondent in the moderate risk category. The remaining 11 (34%) in the low risk and one person 3% were reached high-risk category.

**Discomfort survey**

Figure 2 shows the distribution of the body discomfort survey according to the specific body region. The distribution pattern of the respondents who have experienced symptoms of discomfort at neck, back, shoulder and arms and knees and legs, respectively 42%, 74%, 89% and 29%.

**Table 1** Task analysis outcomes for 27 different types of work

| Tasks | Description of the tasks | Risk factors |
|---|---|---|
| 1. Lifting, pulling and pushing paper reel shaft | Every time when paper reels being emptied, worker needs to replace with new paper reel. When reload they need to lift and push the shaft inside the paper reel and bolted with nut to be fit. | Back bending<br>Back twisting<br>Forceful exertion<br>Forceful gripping |
| 2. Lifting and pulling printing cylinder shaft | The job is done when printing cylinder change over takes part. Worker change the printing cylinder according to the company's brand according to production scheduled. Worker needs to pull shaft from printing cylinder and lifted the shaft, then he replace with other printing cylinder for the changeover. | Back bending<br>Back twisting<br>Repetitive motion<br>Gripping (contact stress)<br>Forceful exertion |
| 3. Lifting bottom patch reel | Work is done when the changeover of the empty bottom patch reel with new reel (39kg) happens. The worker needs to lift and fix the bottom patch reel at particular space. | Forceful exertion & gripping<br>Back bending & twisting<br>Kneeling (contact stress) |
| 4. Lifting and lowering pallet | SEEMI is the palletize section. It is robotic palletizing process. Two workers need to refill the pallets when necessary. | Back bending & twisting<br>Forceful exertion<br>Forceful gripping |
| 5. Manual feeding tubes | Workers feed the tubes manually if a problem occurs with rotary feeder. | Back bending & twisting<br>Forceful exertion<br>Forceful gripping |
| 6. Stacking paper waste inside press machine | Worker stacked waste papers from the production plant inside the press machine manually. Then he arranged the paper fit to the machine. | Extreme neck flexion (prolonged)<br>Moderate back bending<br>Gripping (contact stress) |
| 7. Manual stacking bags after Quality Check (QC) inspection | Normally the palletizing done by robotic process. But first pallet bags for each brand of companies will go through Quality Control inspection before further palletizing process. QC inspector manually checked the quality of the bags and other workers stacked the paper on pallet. | Back twisting<br>Hand above shoulder (repetitive)<br>Gripping (contact stress) |
| 8. Pouring chemical into cylindrical tank | Worker poured the chemical from the container (25kg) into the cylindrical tank for reservation at wastewater treatment plant. | Moderate neck flexion (prolonged)<br>Hand above shoulder (repetitive)<br>Arms movement (repetitive) |
| 9. Lifting glue bags and pour inside tank | Worker lifted glue bags (25kg) from the specific place (unused conveyer) and poured the powder inside tank for glue mixing process. | Shoulder abduction (repetitive & prolonged)<br>Extreme back bending during lifting the chemical bottles |

| | | | |
|---|---|---|---|
| | | | Back twisting during pouring<br>Forceful exertion<br>Forceful gripping (contact stress) |
| 10. | Installing / Dismantling the strapping rope | This job took place when the strapping rope finish on strapping machine (strapped the finished goods). It was non-routine work. | Hand above shoulder (repetitive)<br>Gripping (contact stress) |
| 11. | Lifting the ink pail / glue waste pail | Worker lifted the ink pail and put on trolley when the ink mixture is ready to deliver for printing process. The glue waste also collected into pail, the worker manually lifted the pail and put on the trolley to transfer to glue waste storage. | Shoulder abduction (repetitive & prolonged)<br>Extreme back bending during lifting the chemical bottles<br>Back twisting during pouring<br>Forceful exertion<br>Forceful gripping (contact stress) |
| 12. | Installing / Dismantling wrapping film | This job took place when the wrapping film finished. It was non-routine work. | Back bending & twisting<br>Forceful exertion<br>Forceful gripping<br>Kneeling (contact stress) |
| 13. | Pulling and pushing hand pallet truck to scheduled waste area | Worker pulled and pushes the hand pallet truck after packed scheduled waste in the bag for measurement purpose. Approximate load was >60kg. | Pressure on the back & shoulder |
| 14. | Installing and dismantling bottom patch printing cylinder | Bottom patch was the part, which attached at bottom of the tube. So, the bottom patch printer was located in the middle of bottomer. The operator installed or dismantled printing cylinder according to the production schedule. | Back bending & twisting<br>Neck flexion and side bending (prolonged)<br>Forceful exertion<br>Forceful gripping (contact stress)<br>Kneeling (contact stress) |
| 15. | Transferring office file to storage area | Worker lifted the box, which was filled by the office file approximately (10kg) and walked from office to the store. | Awkward body posture<br>Forceful exertion<br>Forceful gripping<br>Contact stress |
| 16. | Transferring printing cylinder using trolley and hand pallet truck | Worker transferred printing cylinder using trolley or hand pallet truck from the vertical carousel to printer for changeover process. | Awkward body posture<br>Forceful exertion<br>Forceful gripping<br>Contact stress |
| 17. | Transferring pallet using the hand pallet truck | Transferred pallets for palletizing purpose area to SEEMI using hand pallet truck. | Forceful gripping<br>Contact stress |
| 18. | Transferring bottom patch reel | Transferred bundle of bottom patch reels using pallet from the storage areas to bottomer. | Back bending & twisting<br>Forceful on the shoulder during stabilize the load<br>Forceful gripping (contact stress) |
| 19. | Lifting and pushing trolley (Transfer ink / glue waste from dispenser to printer | Worker pushed trolley with pails, which is filled with ink from ink dispenser to all printers, and retrieve the pails filled with glue waste from the bottomer to glue waste storage. | Pressure on the back during pushing<br>Back bending & twisting during lifting the pails<br>Forceful gripping (contact stress) |
| 20. | Pushing material pallet at transporting conveyer | Worker pushed the finished good on conveyor to the strapping area. | Forceful gripping<br>Contact stress |
| 21. | Pushing paper reel | Tuber worker pushed paper reels from | Pressure on the back |

| | | |
|---|---|---|
| | the maintenance area to the specific places at the tubers. | (forceful exertion)<br>Forceful gripping (contact stress) |
| 22. Pushing Mobile Elevating Working Platform (MEWP) for work at height (WAH) activity | Maintenance worker pushed the MEWP from maintenance workshop if have any WAH activity. | Pressure on the back (forceful exertion)<br>Forceful gripping (contact stress) |
| 23. Lifting and transferring spare parts using hands pallet truck | Maintenance worker transferred spare parts from the workshop to machines area. | Back bending & twisting<br>Forceful exertion<br>Forceful gripping (contact stress) |
| 24. Pulling strapped paper waste from press machine | Worker pulled strapped paper waste from press machine and transferred to paper waste bin. | Pressure on the back (forceful exertion)<br>Back bending & twisting during lifting<br>Forceful gripping (contact stress) |
| 25. Pushing waste trolley | Worker pushed trolley filled with waste papers after the quality check to the international zone. | Pressure on the back (forceful exertion) |
| 26. Pushing drum hand jack to ink drum area. | Worker used drum hand jack to move the ink drum to the ink dispenser. | Pressure on the back (forceful exertion) |
| 27. Pushing toolbox trolley | Maintenance worker pushed the toolbox trolley when maintenance activity carried out. | Pressure on the back (forceful exertion) |

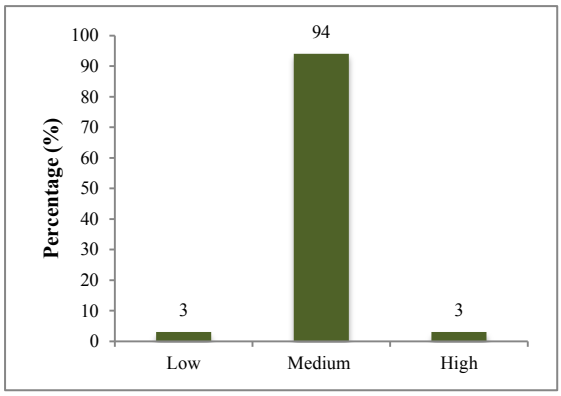


**Figure 1** WMTA score categories

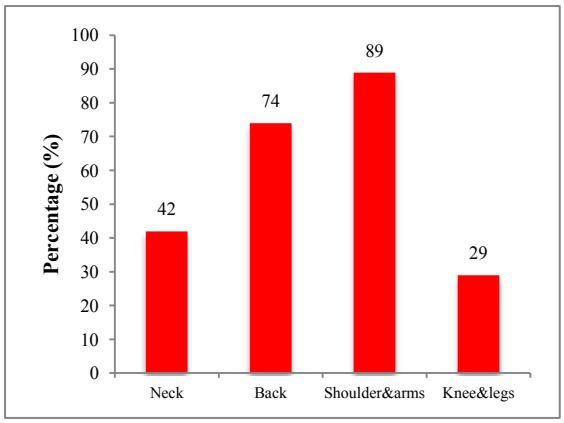


**Figure 2** Discomfort survey description by body regions

**Table 2** WMTA score categories for each body region.

| | Low | Medium | High |
|---|---|---|---|
| N | 2 (6%) | 31 (94%) | 0 (0%) |
| B | 7 (21%) | 9 (26%) | 18 (56%) |
| S&A | 3 (8%) | 18 (55%) | 12 (37%) |
| K&L | 11 (34%) | 21 (63%) | 1 (3%) |

N = Neck, B = Back, S&A = Shoulder & Arms, K&L = Knee & Legs

**Relationship between WMTA risks scores and body discomfort**

Table 3 shows the relationship of the WMTA risk score and body discomfort analysis. However, there were no significant relationships between WMTA risk score and body discomfort for neck, back, shoulder and arms and knees and legs.

## DISCUSSION

This study was carried out at the industrial packaging premise to observe trends of WMSDs among workers. The result revealed most of the workers were in the moderate risk condition according to the WMTA instrument action level. For moderate risk, WMTA suggests the risk requires advanced

investigation and practicable intervention is strongly encouraged. Although the findings demonstrated WMTA's risk were moderate, but as a safety and health practitioner, these cases shall be concerned. Intervention steps implements before the situation getting worse are proactive approach.

**Table 3** Relationship between WMTA scores and body discomfort.

| Body part | BDS | *Low& Moderate | **High | $X^2$ | P-value |
|---|---|---|---|---|---|
| N | Yes | 12 | 0 | 2.54 | 0.28 |
| | No | 21 | 0 | | |
| B | Yes | 12 | 15 | 10.82 | 0.21 |
| | No | 1 | 5 | | |
| S&A | Yes | 17 | 14 | 4.21 | 0.90 |
| | No | 2 | 0 | | |
| K&L | Yes | 9 | 0 | 6.14 | 0.41 |
| | No | 23 | 1 | | |

N = Neck, B = Back, S&A = Shoulder & Arms K&L = Knee & Legs, * *Combination of low & moderate WMTA risk scores; ** WMTA high risk score; BDS = body discomfort survey*

Proactive intervention is more effective than reactive intervention (Rozlina, Awaluddin, Hassan, Abdul, & Norhayati, 2012). Rapid actions avoiding serious injury from happen. However, it is necessary to take into account premise internal factors such as budgeting and other related factors in practicable manner as stated in the Malaysian Occupational Safety and Health Act 1994.

Most of the research outcomes highlighted in researcher perspectives but not for industrial practitioners. Considers that these issues are influenced by limited of research seemly applicable for the safety and practitioners. Until now, there are limited evidences demonstrates on the implement systematic practitioner-friendly ergonomic intervention. In other words specific golden standard does not yet exist so far. However in industrial reality, most of the safety and health practitioners and ergonomist unanimously expressed that ergonomic intervention should have at least three basic steps of control. The more effective and important; 1) engineering control involves pre-designed and re-designed phases and 2) administrative management involves proper arrangement on workforces and systematic work process coordination. For example, setup of shift-works and workflows are necessary in the aforementioned intervention phases. The least important; 3) Personal protective equipment's (PPE's) ensures workers are equipped with suitable PPE in order to counter residual risks. These three phases of intervention are not an option but should be implemented in accordance with the level of risk outcomes. Manage the major risks with relevant engineering control; subsequently followed with appropriate PPE's to encounter the balance of risks. Based on the above discussion, it can be concluded, although the risks were in the medium category, appropriate control measures should be given attention by the premise stakeholders e.g. manager and safety representative.

In term of body discomfort, the result shows shoulder and arms region indicated highest prevalence rate (more than 80%). These phenomenon's demonstrate that, most of work activities dominated by these parts of the body. The findings were supported by task analyses, which conducted before workers evaluation. It clearly indicated the activities e.g. pulling, pushing and lifting were significant dominated the premise work activity. Aforesaid activities mainly involve shoulder and hands muscles. Muscles physiological research conducted by Antony and Keir (2010) on the shoulder and hands manipulation focused on gripping, demonstrated that increasing the specific muscles (trapezius and infraspinatus) activity which lead to prevalence of discomfort. Moreover, repetitive movements strengthening the effects of muscle fatigue which lead to WMSDs (Fuller, Lomond, Fung, & Cote, 2009). Severe shoulder flexion and abduction, which lead to chronic muscle disorders when extensively uses as a routine job, especially more than 10% work cycle occurs (Punnett, Fine, Keyserling, Herrin, & Chaffin, 2000). In a recent review by Linaker & Walker-bone (2015) suggested, despite of heavy lifting, pulling and pushing, other factor contributed to the pathophysiological of shoulder disorder was psychosocial factor. This is interesting risk factor to debate, which has been discussed a few years back and continues as noteworthy part of the ergonomic research. It is thought that, aside of physiological and work environment factors, psychosocial factors should be emphasized as a potential risk factor generates shoulder disorders.

Meanwhile, back discomfort demonstrated second highest after shoulder and arms. The uses of back body region for pulling, pushing and lifting develop symptoms of discomfort. Additionally, back twisting and lateral

bending increased the spine muscles (erector spinaes) and disc injury according to the biomechanical characteristics (Shamsudin et al., 2016; Waters, Putz-Anderson, Garg, & Fine, 1993). Water et al., (1993) strongly emphasized compressive force more than 3.4kN boosted incidence rate more than 10%. Furthermore, extreme awkward bending adversely affected the back (Bernard, 1997). This phenomenon indicates the job involves frequent bending and twisting posture affects the biomechanical mechanism of the back. From the point of epidemiological study, Anuar, Nurulakhmar, Mazrura, & Azhar (2010) were investigated component assembly works at automotive premise. Their findings showed activity involves a lot of back bending and twisting posture had significant correlated with symptoms of back discomfort. In example, drilling automotive components involves awkward bending and back twisting in prolonged period. However for packaging industry, so far as researchers' knowledge, there has been no similar study carried out especially in Malaysian context. Although from the task analysis outcomes, it clearly indicated lifting and lowering were dominant at the premise. This may explain that, manual material handling activity related with lifting, carrying and lowering predominance as back risk factors. In fact, several relevance literatures previously have discussed this issue thoroughly.

Relationships between WMTA risk score and discomfort survey did not show any significant findings for all body regions (neck, back, shoulder and arms and knees and legs). It should note that, there are other factors that contribute to the symptoms such as body mass index (BMI), psychosocial factors, smoking habit and general health status. These are possibly seems predisposed to the discomfort and even worse will cause injury. Moreover, number of samples obtained also influences statistical power in term of analysis. Constrained to get more respondents encountered since the premise did not have many employees and the absentee's trends also to be considered. Nevertheless, from the point of individual worker, it was showed symptoms and effects. 18 workers were found high WMTA's score for back region, 15 of them showed symptoms of back discomfort. This may suggests that the risk more merely individual rather than entire employees investigated. Based on the concept of occupational safety and health (OSH) control and prevention, any findings obtained from OSH risk assessment should be given nessessary attention even without significant relationship of cause and effect. Concern regarding workers safety and health should exist in the industrial forefront; even a worker, he/she is an asset to the company.

## CONCLUSION

Although the study found evidence manual material handling activity mainly dominant in the study area, however cause and effect analysis failed to determine significant relationship between the risk factors and body discomfort. But from the point of individual workers, the result was the opposite. Effective control measures and prevention should employ according to the principles of OSH risk management inclusive hierarchy of risk controls. In the context of WMTA instrument, it has been designed to carry out a critical assessment on the various aspects of work and further suggests the reasonable measures to employers. Specific musculoskeletal disorders analysis should integrate with other methods to enhance the outcome of the assessment.

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