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Investigation of ergonomic risk factors in a car tyre service centre

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Abstract*- The purpose of this study was to investigate the ergonomic risk factors, the prevalence of body discomfort among workers and sources of injury/discomfort in a car tyre service centre. Questionnaire survey and interview session was used to identify the level of body discomfort areas and sources of injury or discomfort. Direct observation was performed by "walk through" inspection using digital camera to evaluate and identify ergonomic risk factors based on work activity. From questionnaire survey findings, the twelve (12) of respondents have body discomfort in the neck (8 each), shoulder (10 each), elbow/forearm (9 each), hand/wrist (11 each), knee (7 each), lower leg (7 each) ankle/foot (4 each) and lower back (9 each). The main sources of injury/discomfort in workplace were poor body posture (75%), bending the back (75%), highly repetitive motion (75%), lifting heavy object (83.3%), the long term standing (66.7%), long term squatting (58.3%), bending the neck (66.7%) and high hand force (58.3%). About 50% reported that poor workplace design also contributed to injury while 41.7% reported in use of hand tools. Eight (8) pictures were taken by using digital camera for the eight (8) different tasks to identified the ergonomic physical risk factors. Most of the physical risk factors identified were awkward posture from working with the hands above the shoulders, neck bending, bending the back forward, repeated bending, reaching, squatting and kneeling on the hard surface. Lifting heavy objects more than 10 kg, not wearing a hand gloves and exposed to high hand arm vibration when using high impact wrench (air gun) also contributed to the ergonomic physical risk factor. To address modifying the ergonomic hazards, engineering controls and administrative controls can be used. The study will be useful to ergonomists, researchers, consultants, workshop managers, maintenance workers and others concerned with identifying ergonomic risk factor on the workplace.

***Keywords*- Ergonomic, risk factor, body discomfort, source of injury, car tyre service centre**

I. INTRODUCTION

Too many people are injured while working in automotive workshops. Worksafe Victoria (2004) conducted the analysis of 'free text' fields in 589 claims in the 3 financial years 1999-2002. The injuries can occur from handling heavy or awkward objects, heavy lifting, and prolonged or sustained work in awkward postures. This injury trend occurs across all types of vehicle repair, maintenance or installation work, and on all types of vehicles. These body stressing injuries make up 47% of all reported injuries.The next most common category of injury is slips, trips and falls, usually from floors in substandard condition. (WorkSafe Victoria, 2004). Ergonomics studies work, as it relates to the human body and its limits. The most prevalent ergonomic related injuries are musculoskeletal, either from repetition, overload, awkward positions or some combination. Most probably injuries could be a reason affecting workers performance. (G E.R. Vieira et al., 2007)

Car tyre service centers are considered to be among the most hazardous in the automotive environment. Various car tyre activities involve handling heavy objects such as installation & replacing a tyre and rim. High force and awkward postures from lifting, lowering, and handling tire may cause Musculoskeletal Disorders (MSDs) due to improper work postures. Awkward postures typically include repeated or prolonged reaching, twisting, bending, working overhead, kneeling, squatting, and holding fixed positions or pinch grips. They may affect various areas of the body such as the hands, wrists, arms, shoulders, neck, back, and knees. The effects of awkward postures are worse if work tasks also involve repetitive motions or forceful exertions. (Ro-Ting Lin et al., 2007)

II. SUBJECTS AND METHOD

A case study was conducted at company A located in Selangor, Malaysia. There are twelve (12) workers in the car tyre service center area involved in this survey. Questionnaire survey were mainly focused on body part symptoms survey and the sources of injury or uncomfortable feelings. The purpose of the symptoms survey is to document whether there are trends in pain, discomfort and injuries among standing workstation employees due to standing at work. Obviously, if worsening trend in lower limbs were detected, this would indicate a risk. (OSH Guideline, DOSH, 2002)

The questionnaire will be distributed to the workers in workplace during site visit. Observation will be used in this research. By using digital camera to capture the work posture and Physical Risk Factor Ergonomic, it can be identified and evaluated ergonomic stressors in the workplace. Basically, a direct observation is performed by "walk through" inspection at the standing workstation areas. It is highly recommended that the person assigned to carry out the direct observation should have some knowledge in ergonomic risk factors related to standing work. The purpose of direct observation is to identify ergonomic risk factors due to improper design of standing workstation.

III. RESULTS AND DISCUSSIONS

A. *Questionnaire survey*

The results of body part symptoms survey on workers and the sources of injury or discomfort in the workplace is shown in Figure 1. The numbers of twelve (12) respondents having body discomfort at the neck, shoulder, elbow/forearm, hand/wrist, knee, lower leg, ankle/foot and lower back. The body part which experienced the most discomfort was the hand/wrist about eleven (11 each). This was followed by the shoulder (10 each), lower back (9 each) and elbow/forearm (9 each). Subjective complaints from the neck, lower leg and knee were reported in 8, 7 and 7 each respectively. And about 4 workers reported that ankle/foot was contributed to body discomfort area while 2 workers reported in chest and hip/thigh of body parts.

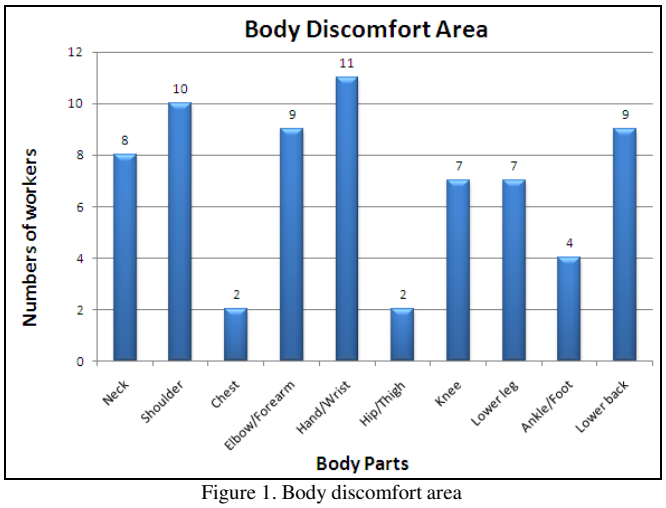


Figure 1. Body discomfort area

Figure 2 shows that the percentage of the sources of injury/discomfort in workplace are poor body posture, prolonged standing, squatting and kneeling, bending the back and neck, highly repetitive motion, lifting heavy object, use of hand tools and poor workstation design. The highest percentage of source of injury was in the lifting a heavy object about 83.3% reported major discomfort in workplace. Subjective complaints from the prolonged standing, prolonged squatting, bending the neck and high hand force were reported in 66.7%, 58.3%, 66.7% and 58.3% respectively.

And about 50% reported that poor workplace design was contributed to source of injury while 41.7% reported in use of hand tools. This was followed by body posture was 75%, bending the back was 75% and highly repetitive motion was 75%.

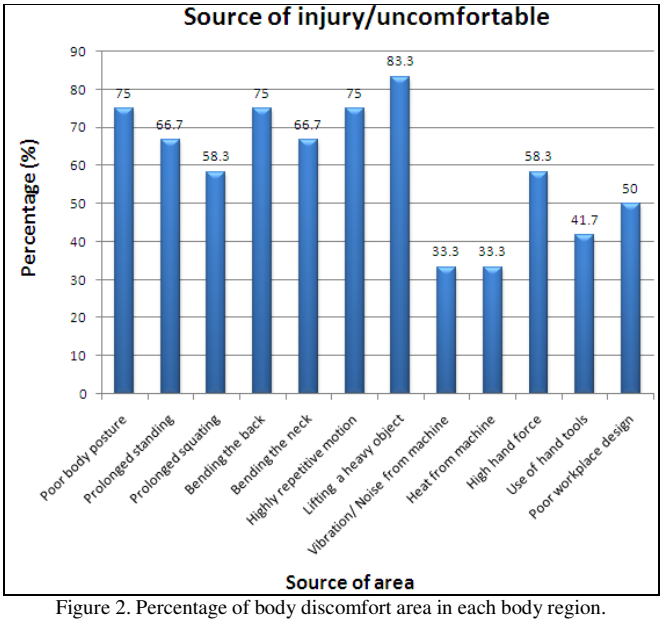


Figure 2. Percentage of body discomfort area in each body region.

B. *Observation on ergonomic physical risk factor*

Eight (8) tasks were observed and pictures taken using digital camera to identify the ergonomic physical risk factors. The tasks were:-

- Lifting the tyre from the top basement.
- Lifting the rim tyree from the top racking.
- Loosing rim nuts by using air gun (low pressure).
- Removing the tyre from changer machine.
- Inspection of the tyre leakage.
- Lifting up the car by using jack tools.
- Loosing rim nuts by using air gun (high pressure).
- Installation of the alignment device (sensor) on the rim tyre.

Summary of the result for ergonomic physical risk factor for eight (8) different tasks as shown in Table 1. In this paper, the most critical task that contribute to ergonomic physical risk factor were task 1 for lifting the tyre from the top basement, task 2 for lifting the rim tyre from the top racking, task 4 for removing the tyre from changer machine, task 5 for inspection of the tyre leakage and task 7 for loosing rim nuts by using air gun (high pressure). Most of the physical risk factor were identified are awkward posture from working with the hands above the shoulders, neck bending, bending the back forward, repeated bending, reaching, squatting and kneeling on the hard surface.

It also includes the lifting a heavy object more than 10 kg, not wearing a hand gloves and exposed to high hand arm vibration when using high impact wrench (air gun) were contributed to the ergonomic physical risk factor.

TABLE 1
RESULT OF ERGONOMIC PHYSICAL RISK FACTOR FOR EACH TASK

No of task	Task Descriptions	Ergonomic Risk Factor
1.	Lifting the tyre from the top basement.	Awkward posture from working with the hand(s) above the shoulders. Forceful exertions, lifting a heavy object more than 10kg & does not wearing a hand gloves, grip force, contact stress. Workers standing on the wood chair. (Unstable support for legs that could be slip and falls)
2.	Lifting the rim tyre from the top racking.	Awkward posture from working with the elbow(s) above the shoulders. Repeated reaching, forceful exertions, lifting a heavy object more than 10kg & does not wearing a hand gloves, grip force, contact stress. Workers standing on the wood chair. (Unstable support for legs that could be slip and falls)
3.	Loosing rim nuts by using air gun (low pressure)	Awkward posture from working with the neck bent & repeated squatting. Exposed to high hand arm vibration when using high impact wrench (air gun) & does not wearing a hand gloves, grip force. Workers exposed to the risk on his back that near to another car.
4.	Removing the tyre from changer machine	Awkward posture from working with the back bent forward Repeated bending, forceful exertions, lifting a heavy object more than 10kg & does not wearing a hand gloves, grip force, contact stress. Workers exposed to the risk on his legs and foots such as improper arrangement of tire and rim
5.	Inspection of the tyre leakage	Awkward posture from working with the back bent forward. Repeated bending, forceful exertions lifting a heavy object more than 10kg & contact stress.
6.	Lifting up the car by using jack tools	Awkward posture from working with the neck bent & repeated kneeling on the hard surface, contact stress.
7.	Loosing rim nuts by using air gun (high pressure)	Awkward posture from working with the back & neck bent. Repeated bending. Exposed to high hand arm vibration when using high impact wrench (air gun) & does not wearing a hand gloves, grip force.
8.	Installation of the alignment device (sensor) on the rim tyre.	Awkward posture from working with the back forward and neck bent. Repeated bending, forceful exertions, lifting a heavy object more than 10kg & does not wearing a hand gloves, grip force, contact stress

Task 1: Lifting the tire from the top basement.

Figure 3 shows that the worker needs to raise his hand above the shoulder when lifting a tyre that weighted more than 10kg from top basement in awkward posture includes repeated reaching. This worker were standing on the wood chairs that can cause falling down if unbalanced lifting, handling sharp and hardness objects that are difficult to hold for comfortable grip and he does not wearing a hand glove to protect his hand when doing a task.

Exerting large amounts of force can result in fatigue and physical damage to the body. Contact stress result from the body pressing against hard or sharp surfaces. It may affect discomfort various areas of the body such as the hands, wrists, arms, shoulders, neck, back, and knees.

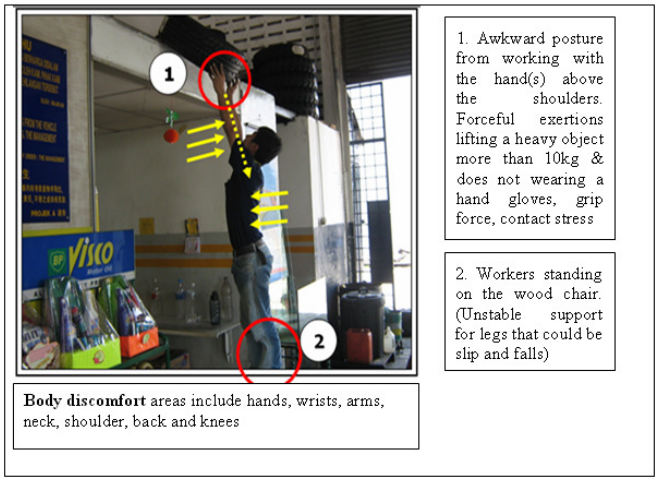


Figure 3. Physical risk factor for Task 1

Task 2: Lifting the rim tire from the top racking.

Figure 4 shows that the worker needs to raise his elbows above the shoulders when lifting a rim tyre that weighted more than 10kg from top racking in awkward posture includes repeated reaching. The worker were standing on the wood chairs that can cause falling down if unbalanced lifting, handling sharp and hardness objects that are difficult to hold for comfortable grip and he does not wearing a hand glove to protect his hand when performing a task. Exerting large amounts of force can result in fatigue and physical damage to the body. Contact stress result from the body pressing against hard or sharp surfaces. It may affect discomfort various areas of the body such as the neck, shoulder, elbows, wrists, lower legs, back and knees.

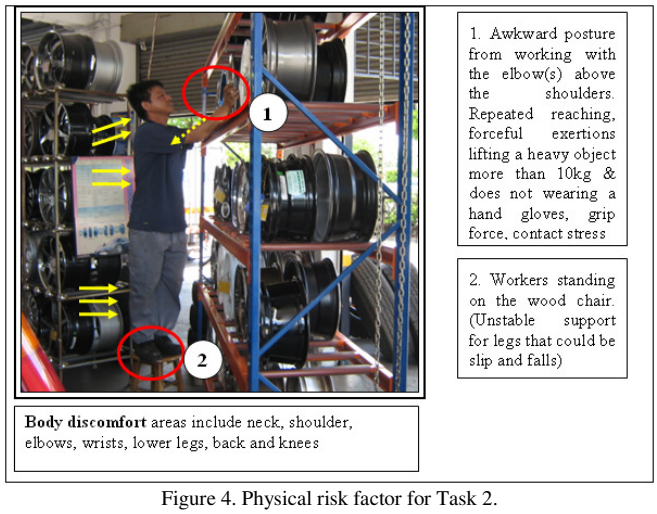
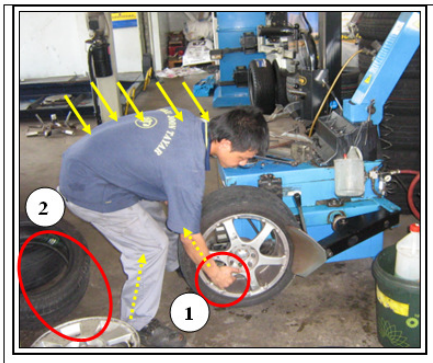


Figure 4. Physical risk factor for Task 2.

Task 4: Removing the tire from changer machine

Figure 5 shows that the worker needs to bend forward his back when removing the tyre from changer machine in awkward posture includes repeated bending. The worker also exposed to the risk on his legs and foots such as improper arrangement of tire and rim, handling sharp and hardness objects that are difficult to hold for comfortable grip and he does not wearing a hand glove to protect his hand when doing a task. Exerting large amounts of force can result in fatigue and physical damage to the body. Contact stress result from the body pressing against hard or sharp surfaces. It may affect discomfort various areas of the body such as the neck, back, shoulder, elbows, wrists, hips, lower legs and knees.



1. Awkward posture from working with the back bent forward Repeated bending, forceful exertions lifting a heavy object more than 10kg & does not wearing a hand gloves, grip force, contact stress

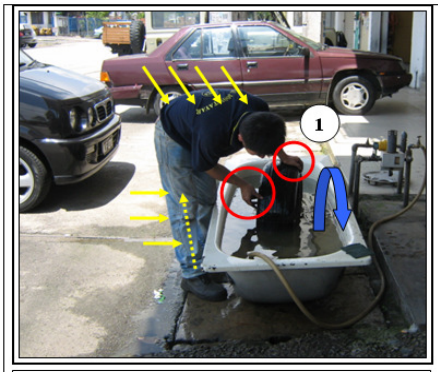
2. Workers exposed to the risk on his legs and foots such as improper arrangement of tire and rim

Body discomfort areas include neck, back, shoulder, elbows, wrists, hips, lower legs and knees

Figure 5. Physical risk factor for Task 4.

Task 5: Inspection of the tire leakage

Figure 6 shows that the worker needs to bend forward his back when inspection of the tyre leakage in awkward posture includes repeated bending. The worker also lifting and rotate the tyres that weighted more than 10 kg and handling sharp and hardness objects that are difficult to hold for comfortable grip. It may affect discomfort various areas of the body such as the neck, back, shoulder, elbows, wrists, lower legs and knees.



1. Awkward posture from working with the back bent forward. Repeated bending, forceful exertions lifting a heavy object more than 10kg & contact stress

Body discomfort areas include neck, back, shoulder, elbows, wrists, lower legs and knees

Figure 6. Physical risk factor for Task 5

Task 7: Loosing rim nuts by using air gun (high pressure)

Figure 7 shows that the worker needs to bend forward his back and neck when loosing rim nuts by using air gun (high pressure) that weighted more than 10 kg in awkward posture includes repeated bending. The worker also exposed to high hand arm vibration that handled using a pinch grip instead of a power grip when using high impact wrench (air gun) and he does not wearing a hand glove to protect his hand when doing a task. It may affect discomfort various areas of the body such as the neck, back, shoulder, elbows, wrists, hips, lower legs and knees.

1. Awkward posture from working with the back & neck bent. Repeated bending. Exposed to high hand arm vibration when using high impact wrench (air gun) & does not wearing a hand gloves, grip force

Body discomfort areas include neck, back, shoulder, elbows, wrists, hips, lower legs and knees

Figure 7. Physical risk factor for Task 7

IV. CONCLUSION

Controls should be put in workplace to minimize or eliminate the risks of work-related entire body disorders. There are a two hierarchy of controls that widely accepted for modifying ergonomic hazards in which are engineering controls and administrative controls. Engineering controls involve changing the workstation layout, selection and use of tools, position of process materials, or work methods used to complete a task. Administrative controls are policies or practices directed by management that can reduce or prevent exposure to ergonomics risk factors. Some organizations combine work practices with administrative controls. Since administrative controls do not eliminate hazards but merely reduce the duration of exposure, management must ensure the practices are being followed.

Daily management involvement is needed. The recommended of administrative controls may include:-

- Provide frequent (every 30 minutes) task/job rotation or longer rest (30 minutes) breaks to allow the body time to recover from fatigue.
- Rotate workers through several jobs with different physical demands (referred to as task/job expansion).
- Train workers in recognizing risk factors and methods to ease the task demands.

- Perform stretching exercises to relieve stress and limber muscles.
- Provide wellness programs to improve the overall health of the employees.
- Reduce shift length or curtail overtime to prevent fatigue.
- Utilize team lifting for heavy or awkward lifts.

This study will be useful to ergonomists, researchers, consultants, workshop managers, maintenance workers and others concerned to identify ergonomic risk factor on the workplace.

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