A Survey on Working Postures among Malaysian Industrial Workers

Raemy Md. Zeina, Isa Halimb, Noorul Azreen Azisa, Adi Saptarib and Seri Rahayu Kamatb *

aErgonomics Excellence Centre, National Institute of Occupational Safety & Health (Southern Regional Office), No. 10, Persiaran Teknologi, Taman Teknologi Johor, 81400 Senai
bDepartment of Manufacturing Management, Universiti Teknikal Malaysia Melaka, Hang Tuah Jaya, 76100 Durian Tunggal, Melaka, Malaysia

Abstract

Industrial workers were frequently exposed to injury at work due to an incorrect working posture. Improper working posture such as bending, twisting, overreaching, repetitive task and uncomfortable posture contribute to musculoskeletal disorder (MSD). This paper deals with the survey of the posture practices by Malaysian industrial workers. The questionnaire was distributed among 282 industrial workers. The survey was concerned with demographic detail, job specialization, industrial sectors, work and rest duration and the physical and mental condition during working time. It was found that over 93.1% of the workers facing the physical fatigue and 94.2% experienced mental fatigue while working. For the working posture it was observed that shoulder at chest level (30.1%), back in moderately bent forward (90.8%) and lifting heavy load 1 to 5 kg (80.5%) are the major work postures practiced by most of industrial workers. Based on the statistical analysis there are significance correlation of the physical injury with the body injury among industrial workers. In conclusion, the specific working posture has yet to be determined for workers in industry. Therefore, this survey can provide a preliminary data for further research to ensure the correct working posture for worker.

* Corresponding author. Tel.: +607-599 1200; fax: +607-598 0746.
E-mail address: raemymdzein@gmail.com; eec.niosh@gmail.com

Keywords: Working Posture, Occupational Injuries, Questionnaire Survey, Ergonomics Solutions
1. Introduction

In today’s fast economic growth, occupational health plays an important role to boost competitiveness and productivity in Malaysian industries. Usually industrial workers perform their jobs in standing, sitting, and alternating sitting and standing. Standing position is the best choice when the jobs require frequent movements, large degree of freedom, and heavy objects. However, standing in a long period of time has lead to discomfort and fatigue among industrial workers.

The Social Security Organization (SOCSO) of Malaysia reported the severity of injuries that can contribute to poor occupational health. In the SOCSO annual reports, it was stated that industrial workers suffered from injuries in the head, neck, shoulder and lower limb, upper back and lower back. In 2012, numbers of injuries in fingers (9100), hand (5683), lower leg (4750), shoulder (2579) (SOCSO Annual report 2012). In addition to poor occupational health, unsafe working practices affect the psychology of workers. Workers who are out of work for too long may have lower self-esteem and morale due to loss of personal and professional relationship with peers or colleagues. In case the workers have exhausted their medical leave entitlement, they may need to take unpaid leave which will result in loss of income. Furthermore, the company will also be affected as employers need to take in temporary staff to replace the workers who have health problems. This could contribute to indirect costs which include expenses from lost days, production disruptions, increased premiums and cost to train new or replacement workers. Effective strategy to reduce the number of injuries should be developed to overcome this situation in the future.

In recognition the importance of safe working practices, this study was performed to investigate the orientations of posture practiced by the workers in Malaysian industries.

1.1. Working posture

Working posture can be defined as the orientation of body parts in a work area while a worker performing a task (Nico et al., 2004). Working posture is determined by the characteristics of the worker, the design of workstation and the process. Dimensions, spatial position, orientation and design of workstation must be suited with the physical of workers so that they can perform the task in safe working posture. In general, workers can perform the jobs either in standing or sitting, and combination in their workplaces.

1.2. Occupational injuries related to working posture

Occupational injuries associated with working posture refer to conditions where the workers experienced discomfort in one or various body parts such as neck, shoulder, back, elbow, hand, hip and knee, pain in the joints, tingling, and swelling. Performing jobs in prolonged standing can be linked to lower back pain among industrial workers (Lafond et al., 2009). The cause of discomfort and whole body fatigue associated with prolonged standing is reduced blood circulation in the lower legs and localized muscle fatigue (Madeleine, 1998). Continuous standing for more than 4 hours in a day, potentially contribute to pain in the lower back and feet (William et al., 2000); (Messing and Kilbom, 2001).
1.3. Assessment of working posture

In advancement of research in occupational ergonomics, several methods and tools have been developed to identify, assess, and analyze occupational injuries related to working posture. The methods can be categorized into subjective, semi qualitative, and direct technical measurement methods. Both techniques can be applied at industrial workplaces and/or laboratories. Subjective method is used to obtain psychological feedbacks from the respondents (workers) through personal interview and questionnaire survey. The Borg Scale (or called Rating Perceived Exertion, RPE), and the Visual Analogue Scale (VAS) are commonly used. The Borg Scale is used to measure perceived exertion experienced by the respondents (Borg, 1982). The VAS is a psychometric response scale which can help respondents to specify level of agreements (e.g. comfort, moderate comfort, discomfort) by indicating a position along a continuous line between two end-points. The Borg Scale was applied to classify posture comforts on the basis of maximum holding time (MHT). Comfort posture can be obtained when workers perform jobs at moderate working height (50%, 75%, 100%, 125% from shoulder height) and small working distance (25%, 50% from arm reach). The moderate comfort posture could be obtained if the work is performed at moderate working height (50%, 75%, 100%, 125% from shoulder height) and large working distance (75%, 100% from arm reach).

On the other hand, discomfort posture is recognized when the working height is too low or too high than 25% and 150% of shoulder height respectively (Miedema et al., 1997). A study applied rate of intensity of unpleasantness (scale of 0 to 10) to examine the differences between subjective, physiological and biomechanical responses among individuals who exposed to prolonged standing. The study revealed that a reduced subjective effect of the soft surface on the intensity of unpleasantness accompanied by low postural activity and no swelling of the shank (Madeleine, 1998). Beside Borg Scale and VAS, a survey form was also established to investigate discomfort and subjective fatigue due to standing at workplaces. Surveys using the Body Part Symptom form revealed that all respondents who performed jobs in standing position experienced discomfort and pain, and the frequency and level of discomfort occurrence are greater at lower extremities (Ahmad et al., 2006); (Taha and Majid, 2008).

Through a semi qualitative method, working posture can be evaluated using Rapid Upper Limb Assessment (RULA) (McAtamney and Corlett, 1993). The RULA produces a score to demonstrate the risk level of posture. Low scores of 1 or 2 indicate that the working posture is acceptable. Further investigation and changes are required for grand scores 3 or 4; prompt investigation and changes for grand scores of 5 or 6 and immediate investigations and changes for a grand score of 7. Besides RULA, the Rapid Entire Body Assessment (REBA) is a useful tool to assess working postures and movements corresponding to the tasks and workstations (Sue and Lynn, 2000). A coding system is used to generate an action list that indicates the level of intervention or modification of workstation required to reduce the risks of occupational injuries due to physical loading on the worker. Another tool is Workplace Ergonomic Risk Assessment (WERA). It was established to screen the task for exposure to the physical risk factor that can contribute to occupational injuries (Abdol Rahman et al., 2012). This tool consists of six physical risk factors: posture, repetition, forceful, vibration, contact stress and task duration and its involve the five main body regions (shoulder, wrist, back, neck and leg).

The direct technical measurement method measures and analyzes physiological and biomechanical responses of subjects. This method requires scientific technical tools which can produce specific quantities such as pressure, voltage and frequency. The application of direct technical measurement method is always linked to direct contact between subjects and the instruments. The advantages of utilizing direct technical measurement method are reliable data that could be acquired from the subjects and it is able to represent the actual condition of subjects during the experiments. The tools that are commonly used for the assessment of working posture are surface electromyography (sEMG) and body pressure measurement system. The sEMG has been considered a reliable tool to assess localized muscle fatigue (Kumar et al., 2004); (Luttmann et al., 2000) due to awkward working posture. It refers to non-invasive (on the skin surface) recordings of electrical signals which are generated by muscle contraction. Muscle fatigue can be quantified by observing the changes in amplitude and frequency of electromyogram signals over time (Reenen et al., 2009). When the signal amplitude increases and power spectrum shifts to lower frequency, it
indicates the muscles are in fatigue condition (Luttmann et al., 2000); (Hostens and Ramon, 2005). Figure 1 shows the application of sEMG in measuring muscle activity of a worker while performing jobs in sitting position.

As for the body pressure measurement system, it is used to measure the distribution of pressure or force between human body and contact surface such as seat pan, back rest, shoe insole, and gloves. Figure 2 shows an example of body pressure measurement system in measuring pressure of back and buttock for sitting position (a) and pressure under the feet during the standing position (b).

Figure 1: Muscle activity measurement using sEMG

Figure 2: Body pressure measurement system for buttock and back (a), and feet (b)
1.4. Ergonomics solutions for working posture

In occupational ergonomics, engineering controls and administrative controls are methods to reduce the risk of occupational injuries due to unsafe working posture. Engineering controls refer to the use of engineering techniques to minimize the risk of occupational injuries. It includes application of floor mats and shoe insoles to release muscle fatigue in the feet due to floor condition at the workplace. Many researches revealed that floor mats and shoe insole are effective solutions to improve body comfort for standing jobs. King (2002) found that the floor mat, shoe insoles and combined conditions were more comfortable than standing on hard floor (King, 2002). However, floor mat and shoe insoles may have little effect on controlling leg oedema for industrial workers exposed to standing for more than 8 hour shifts (Zander et al., 2004). Muscle fatigue in the leg may not be relieved by using floor mats, but benefited the back (Kim et. al., 1994). Sitting can be much less strenuous than standing because it requires fewer muscles to be contracted to stabilize the body. Furthermore the loading on upper limbs will be uniformly distributed through the seat pan (Kroemer et al., 1994), thus reduce the loading on the lower limbs. However, sitting in long periods of time is also not good for health. Alternate the standing and sitting positions using a sit-stand stool enables workers to perform the jobs in sitting and/or standing. In addition, the sit-stand stool is equipped with foot rest that can provide comfort on workers’ legs. Also, it can be rotated at 360 degrees so that the workers can reach the materials without twisting their body and enlarge the degree of freedom to do the jobs.

Administrative controls using work-rest scheduling is an alternative in the case where engineering controls are impossible to be implemented due to various constraints. Jaap and Huub (1998) proved that providing longer breaks would be more effective to minimize risk of leg swelling (Dieen and Vrielink, 1998). Konz (2006) proposed to have some sitting, some standing and some walking for a job and process in the manufacturing environment. If a job requires continuous standing throughout the working hours, job rotation within the shift is recommended (Konz, 1996).

2. Methodology

The study was carried out in which a questionnaire was designed in which personal factors, occupational factors and postural factors were investigated. Personal factors investigated were age, gender, ethnicity, citizenship, height, weight, marital status, and academic status. Occupational factors investigated included occupation and tasks, duration of work and rest, type of industries, frequency of physical and mental fatigue and work posture adopted. Types of industries were based on classification under schedule 1 of Occupational Safety & Health Act (1994).

Postural factors investigated were segmental posture adopted during work (neck, hand & shoulder, wrist, back and leg); manual handling activities. Each subject was asked to provide frequency of segmental posture adopted by them during work. Postural factors were based from WERA workposture classification (Nasrull, 2012) whereas the frequency of posture adoption was based from Dictionary of Occupational Titles, 1991. 300 survey questionnaires were distributed amongst Malaysian Adult industrial workers attending National Conference of Occupational Safety & Health (COSH) organised by National Institute of Occupational Safety & Health (NIOSH), Malaysia on 25th to 27th August 2014. Out of these, 282 responded and filled the questionnaire (94%). All 282 respondents completed the questionnaire.
3. Result

The data were collected among various industrial workers in Malaysia. Table 1 shows the background information of the respondent during this study. The mean age of the industrial workers was $43.55 \pm 1.053$ years with the body height and body weights were $166.9 \pm 10.425$ cm and $73.33 \pm 14.02$ kg, respectively. Average time for the worker to work is $9.24 \pm 1.304$ hours. Based on survey 95% of the workers change their working position during working time with 78% of the respondents working in standing and sitting position. Mini break gives workers time to rest and relieve them from job monotony. Analysis of physical and mental fatigue shows that 77.1 % of employees experience physical fatigue and 62.1 % experienced mental fatigue while performing duties. Analysis of posture shows that most of the industrial workers used highly risk working posture when performing their work duties. Table 2 shows the distribution of body posture for neck, hands, back, wrist, leg and load for lifting among the industrial workers in Malaysia.

Of all 282 survey sample, it was identified that most frequent working posture for neck, shoulder, wrist and leg is in neutral position (40.8%, 33.3%, 40.4% and 42.2%) respectively. The most working posture performed by industrial workers usually focusing on back of the body and object lifting. Based on survey, the frequent working postures for back is where the workers moderately bent forward around $20^o$ (33.3%) with load lifting under 5 kg (19.1%) and only 8.2% of workers lifting the load more than 10 kg frequently (Table 2). Working in awkward condition while lifting heavy load may inducing musculoskeletal disorder diseases such as lower back pain. From the survey it was identified that 33% of the working time to perform their task in awkward position with the body slightly bent forward.

Table 1: Background information of respondent

|               | Frequency | Percent (%) |
|---------------|-----------|-------------|
| Gender:       |           |             |
| Male          | 212       | 75.2        |
| Female        | 70        | 24.8        |
| Age:          |           |             |
| 20 - 29 olds  | 49        | 17.4        |
| 30 – 39 olds  | 90        | 31.9        |
| 40 – 49 olds  | 93        | 33.0        |
| 50 – 59 olds  | 39        | 13.8        |
| 60 – 69 olds  | 11        | 3.9         |
| Industry:     |           |             |
| Manufacturing | 78        | 27.7        |
| Mining and quarrying | 9    | 3.2        |
| Construction  | 97        | 34.4        |
| Agriculture, forestry and fisheries | 11    | 3.9        |
| Utility       | 26        | 9.2         |
| Transportation, storage and communication | 20    | 7.1        |
| Wholesale and retail trade       | 1        | 0.4        |
| Hotel and restaurant            | 8        | 2.8         |
| Finance, insurance, real estate and services | 15 | 5.3 |
| Public service and statutory     | 15       | 5.3         |
Figure 3 shows finding from survey of working posture among the industrial workers. Based on Figure 3, most of industrial workers are moderately bent forward body posture during working time. Shoulder, back and load lifting shows higher opportunity for musculoskeletal disorder to occurs.

Table 2: Distribution of Frequent Work Posture among Industrial Workers

| Body part       | Force/posture                        | Frequency (%) |
|-----------------|--------------------------------------|---------------|
| Neck            | Neutral position                      | 40.8          |
|                 | Moderately bent forward               | 36.9          |
|                 | Extremely bent forward                | 16.0          |
| Hands/shoulder  | Waist level                           | 33.3          |
|                 | At the chest level                    | 30.1          |
|                 | Above chest level                     | 15.6          |
| Back            | Neutral position                      | 38.7          |
|                 | Bent forward                          | 33.3          |
|                 | Extremely bent forward                | 18.1          |
| Wrist           | Neutral position                      | 40.4          |
|                 | Moderately bent up or bent down       | 40.1          |
|                 | Bent up or bent down with twisting    | 28.4          |
| Leg             | Feet are flat on floor/floor rest     | 42.2          |
|                 | Feet are bent forward on the floor    | 34.0          |
|                 | Feet do not touch the floor           | 25.2          |
| Manual handling | Load 0 – 5 kg                         | 19.1          |
|                 | Load 5 – 10 kg                        | 13.1          |
|                 | > 10 kg                               | 8.2           |

Figure 3: Frequency of Working Posture Based on Different Body Part
The frequency of extreme working posture for every body part is below than 30% (Figure 3) except for neck and back position. 47.2% of respondent used to extremely bend the neck forward and backward when performing job task and 51.1% of respondents was reported to moderately bend forward their back position.

4. Discussion

Industrial workers are exposed to various physical and ergonomics hazards at the workplace. The main objective of this survey is to identify working posture among the industrial worker. This study observed various experienced industrial workers in various different industries as a respondent. From the analysis of the working posture, most of the workers use inappropriate working posture while performing tasks. Working in awkward position leads to the development of musculoskeletal disorder. From the survey, it was identified that working with the shoulder at chest level, back bent forward and lifting loads more than 0 - 5 kg were the most critical posture will induce musculoskeletal disorder disease. From the survey, it can be conclude that the shoulder and back region are the common region for musculoskeletal among industrial workers. Workers must understand the principal of working at the neutral position. Working in awkward position will increase the possibility for body to get injury. The most critical job that leads to poor working posture should be eliminated or reduced to reduce risk of musculoskeletal disorder or back injury. Engineering control or redesign employee job task (Lee and Han, 2013) is example to reduce the risk from injury.

Shoulder and back position give the higher frequency to be performed by the workers due to forward and backward movement. Task requirement and workspace design is the contributing factors that lead to working posture. Some of industrial workplace is poorly design, workers need to adapt with the workspace design to complete the task given. Many studies have been performed to identify the working posture for specific job task (Lee and Han, 2013; Gangopadhyay et al., 2010). However most of the study is focusing on the production area and certain industry only. This survey is one of the approaches to gather information of working posture practices among industrial workers. Good working posture can minimize the injury and increase the work performance (Rahman, 2012), lack of awareness on ergonomics risk factor such as working contribute to developing of the workplace accidents. Good work posture will avoid strain and damage to body such as muscle, lower back and tendons. Most of the workers have a tendency to accept the work without realize the stress that will accept by the body, some of worker may not realize their body under strain until the feel real pain without understanding the causes of pain. This study recommended the industrial workers to aware about working posture during work. Training is required for employee to be aware of the important of ergonomics risk factor at the workplace and its association with health.

5. Conclusion

Industrial workers give higher contribution in the development of industry in Malaysia. Industrial work is dynamic and more complicated that regular job. Different type of industries involve in different type of working posture based on job tasks. This survey identifies that working with shoulder and hand at chest level and back region moderately bent forward is the main working posture practice by worker. Workers also reported lifting load below than 5 kg at the workstation. This survey recommended for industrial workers to aware with the working posture to avoid injury. Musculoskeletal disease will affect the daily life of the worker and some of the cases prevent workers from working due to back injury. Further study is necessary to identify job tasks that have higher opportunity to impact on working posture. The study should be focusing on the employee at the production area and management level to reduce the error during data collection. Management teams shall provide training for employees to working in safe posture and implement safe work practices in workplace to prevent musculoskeletal disorder disease and injury.
6. Acknowledgement

The authors would like to acknowledge the National Institute of Safety and Health of Malaysia for funding this research (project no.: 06-01-01-SF0258), and the Universiti Teknikal Malaysia Melaka (UTeM) for providing facilities and assistance to prepare this paper.

7. References

1. D. Lafond, A. Champagne, M. Descarreaux, J.-D. Dubois, J. M. Prado, and M. Duarte (2009), Postural control during prolonged standing in persons with chronic low back pain. Gait & Posture, vol. 29, pp. 421-427.
2. P. Madeleine, M. Voigt, and L. Arendt-Nielsen (1998), "Subjective, physiological and biomechanical responses to prolonged manual work performed standing on hard and soft surfaces," European Journal of Applied Physiology and Occupational Physiology, vol. 77, pp. 1-9.
3. J. K. William, S. V. Jeff, A. B. Jill, A. G. Lincoln, R. W. Paul, L. G. Ana, M. Z. Vladimir, D. Marcos, and A. R. Nicholas (2000). Influence of compression hosiery on physiological responses to standing fatigue in women. Medicine & Science in Sports & Exercise, pp. 1849-1858.
4. K. Messing and A. Kilbom (2001), Standing and very slow walking: foot pain-pressure threshold, subjective pain experience and work activity. Applied Ergonomics, vol. 32, pp. 81-90.
5. G. Borg (1982), Psychophysical bases of perceived exertion. Medicine & Science in Sports & Exercise, vol. 14, pp. 377-381.
6. M. C. Miedema, M. Douwes, and J. Dul (1997), Recommended maximum holding times for prevention of discomfort of static standing postures. International Journal of Industrial Ergonomics, vol. 19, pp. 9-18.
7. N. Ahmad, Z. Taha, and P. L. Eu (2006), "Energetic requirement, muscle fatigue, and musculoskeletal risk of prolonged standing on female Malaysian operators in the electronic industries: influence of age," Engineering e-Transaction, vol. 1, pp. 47-58.
8. Z. Taha and S. A. Majid (2008), "Frequency and level of discomfort of male operators in standing work posture," in The 9th Asia Pasific Industrial Engineering & Management Systems Conference, Bali, Indonesia.
9. S. Kumar, T. Amell, Y. Narayan, and N. Prasad (2004). Measurement of localized muscle fatigue in biceps brachii using objective and subjective measures in Muscle Strength, S. Kumar, Ed., ed New York: CRC Press, pp. 105-121.
10. A. Luttmann, M. Jager, and W. Laurig (2000). Electromyographical indication of muscular fatigue in occupational field studies. International Journal of Industrial Ergonomics, vol. 25, pp. 645-660.
11. H. H. H.-v. Reenen, B. Visser, A. J. v. d. Beek, B. M. Blatter, J. H. v. Dieen, and W. v. Mechelen (2009). The effect of a resistance-training program on muscle strength, physical workload, muscle fatigue and musculoskeletal discomfort: An experiment. Applied Ergonomics, vol. 40, pp. 1-8.
12. I. Hostens and H. Ramon (2005) Assessment of muscle fatigue in low level monotonous task performance during car driving. Journal of Electromyography and Kinesiology, vol. 15, pp. 266-274.
P. M. King (2002). A comparison of the effects of floor mats and shoe in-soles on standing fatigue, *Applied Ergonomics*, vol. 33, pp. 477-484.

J. E. Zander, P. M. King, and B. N. Ezenwa (2004). Influence of flooring conditions on lower leg volume following prolonged standing. *International Journal of Industrial Ergonomics*, vol. 34, pp. 279-288.

J. Y. Kim, C. S. Buttle, and W. S. Marras (1994). The effects of mats on back and leg fatigue, *Applied Ergonomics*, vol. 25, pp. 29-34.

K. Kroemer, H. Kroemer, and K. Kroemer-Elbert (1994). *Ergonomics - How to Design for Ease and Efficiency*. New Jersey: Prentice Hall International Inc.

J. H. V. Dieen and H. H. E. O. Vrielink (1998). Evaluation of work-rest schedules with respect to the effects of postural workload in standing work, *Ergonomics*, vol. 41, pp. 1832-1844.

S. Konz (2006) Standing work," in *International Encyclopedia of Ergonomics and Human Factors* vol. 1, W. Karwowski, Ed., Second Edition ed. New York: Taylor & Francis, pp. 929-932.

Nico J. Delleman, Christine M. Haslegrave, Don B. Chaffin (2004). Working postures and movements: tools for evaluation and engineering, CRC Press, Boca Raton, Florida.

McAtamney, L. and Corlett, E. N. (1993). RULA: a survey method for the investigation of work-related upper limb disorders. *Applied Ergonomics* 24 (2), p. 91-99.

Hignett, S. and McAtamney, L. (2000), Rapid entire body assessment (REBA). *Applied Ergonomics*, 31, p. 201-205.

Mohd Nasrull Abdol Rahman, Mat Rebi Abdul Rani and Jafri Mohd Rohani. Proceedings of the 2012 International Conference on Industrial Engineering and Operations Management Istanbul, Turkey, July 3–6, 2012.

Social Security Organization Annual Report 2012, The Ministry of Human Resource of Malaysia.

Chowdury M.L. Rahman (2014). Study and Analysis of Work Postures of Workers Working in a Ceramic Industry Through Rapid Upper Limb Assessment (RULA). *International Journal of Engineering and Applied Sciences*. Vol. 5. No. 3.

Gongapadhyay S., Ghosh T., Ghosal G. and Das B. (2010). Effect of Working Posture on Occurrence of Musculoskeletal Disorders among the Sand Core Making Workers of West Bengal. *Cent Eur J Public Health*; Vol.: 18 (1) Page: 38–42.

Tzu-Hsien Lee and Chia-Shan Han (2013). Analysis of Working Postures at a Construction Site Using the OWAS Method. *International Journal of Occupational Safety and Ergonomics (JOSE)*, Vol. 19, No. 2, Page: 245–250.