Investigation of work-related musculoskeletal disorders in wall plastering jobs within the construction industry

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Abstract. Objective: The aim of this study was to investigate the work-related musculoskeletal disorders (WMSDs) among workers in wall plastering jobs within the construction industry.
Participants: A total of 43 workers within three workplaces participated in the study.
Methods: Subjects were interviewed using self-report charts. During the task duration, observation of the workplace was carried out using a Workplace Ergonomic Risk Assessment (WERA) method.
Results: An analysis of WERA assessment, the wrist score for WERA body part was >4 in 86% of workers, while wrist pain or discomfort was reported by 86%, yielding a significant association between WERA body part score and self-reported pain ($\chi^2 = 16.12; p = 0.000$). The WERA body part score for the shoulder regions during wall plastering job yielded a score >4 in 93% and caused shoulder pain or discomfort in 91%, the association being significant ($\chi^2 = 12.58; p = 0.000$). The back regions for WERA body part score was >4 in 91% of workers, with 98% reporting pain or back discomfort, with a significant association ($\chi^2 = 9.98; p = 0.002$).
Conclusions: These results showed that statistically significance for the wrist, shoulder and back regions of the individual WERA body part score were affecting the worker and lead to the development of pain or discomfort among workers in wall plastering jobs.

Keywords: Ergonomic risk assessment, observation method, physical risk factors, workplace, WERA tool

1. Introduction

Wall plastering is one of the major work tasks/jobs in the home building construction industry. According to the Department of Occupational Safety and Health, Malaysia (DOSH) report on occupational accidents for the category of death until August 2010, 51% of victims were reported by the construction industry. Manufacturing industry was the second highest where 45% of victims were reported behind agriculture (26% victims) and transportation (10% of victims) [1]. For the Occupational Accidents By State in Category Of Death Until August 2010, 28% of the victims were reported in Selangor state followed by Perak state (21% of the victims), Pahang state (9% of the victims), Johor state (8% of the victims), Kelantan state (4% of the victims) and Melaka state (4% of the victims) [2].

According to Social Security Organization in 2007, there were 2900 accidents reported in the construction industry [3]. For the number of occupational diseases by causing agent reported by SOCSO, 26 cases were re-
ported in occupational musculoskeletal disorders. Recent studies and statistics have shown that the rates of musculoskeletal injuries and disorders among workers in the construction [trades are much higher when compared to those working in other industries [1–4].

In general, construction workers are at a high risk of developing work-related musculoskeletal disorders (WRMDSs) that are associated with exposure factors in this work environment [5]. Despite the high prevalence of ergonomic risk factors in construction work [4,6], the aims of this study was to investigate the work-related musculoskeletal disorders (WMSDs) among workers in wall plastering jobs within the construction industry using a newly developed ergonomic risk assessment tool called Workplace Ergonomic Risk Assessment (WERA).

2. Methods

2.1. Subjects and task duration

Home building industry in three workplaces were randomly selected as a field study in this research. This field study was conducted at Pahang, Johor and Selangor, May to September 2010 (5 month). From the three workplaces of home building industry, 43 workers were randomly selected as a subjects in this study. In the construction site of home building located in Pahang state, all the workers reported at 08:00a.m. in the field. The work details were generally decided by the supervisor of contractor between 08:00a.m. and 08:15a.m. These workers began their work at 08:15a.m. to 10:00a.m. and received a short break from the 10:00a.m. to 10:30a.m. Then, continued their work from 10:30a.m. to 01:00p.m. The lunch hour was from 01:00p.m. to 2:00p.m. At the evening shift, these workers continued work at 02:00p.m. and ended their shift at to 05:00p.m. on that particular day. The schedule of the wall plastering job, bricklaying job and floor concreting activity were determined based on the some preparatory processes like mixing the sand with cement, staging preparation, and availability of raw materials. Therefore, the total time of these tasks was 8 hours per day and the total work week was 5–6 days per week. In the construction site of home building located in Selangor state, there were different times and tasks durations. They began work at 8:30a.m. to 12:00p.m. The lunch time was 1 hours from 1:00p.m. to 2:00p.m. and they continued and finished their work from 2:00pm to 6:00pm. Therefore, the total time for these tasks was 9 hours per day and total days of work was 6–7 days per week. The total time was reported in other construction site of home building located in Johor. Instead that, the total time for these tasks in both Selangor and Johor state were highest compared to the other workplace in Pahang state. Table 1 shows the total of the task duration in three workplaces.

2.2. Wall plastering job

In Pahang state, 16 workers performed a wall plastering job in the home building site. The job was based upon the procedure of work. Firstly, these workers need to climb the scaffolding in the work area. In a standing position on top of the scaffolding, these workers need to determine the areas of wall to be plastered. Before that, the other workers must carry and lift the plaster by using timber and place it on the top surface of scaffolding that has been cover by wood timbers/planks. After determining the areas of wall to be plastered, these workers need to bend their back while twisting to the left side when loading plaster from the ground by using the hawk and float tool. The hawk was a flat board, about nine inches square, that has a hard shape of the handle. Then, these workers applied a layer of plaster on the interior wall by covering a wall, using a hawk in his left hand and float in his right hand with reaching over the head in standing position. And again, these workers were repeated the same step/procedure during their works completed. The same step/procedure of work was performed by the other workers in Johor (n = 14) and Selangor state (n = 13). All 43 workers performed the wall plastering job from the three workplaces. But, there were significant differences from the three workplaces in terms of task duration, material preparing, workplace condition and use of hand tool. Figure 1 shows cycle of the wall plastering job.

2.3. WERA method

The Workplace Ergonomic Risk Assessment (WERA), which is an observational tool [7] was developed to provide a method of screening the working task quickly for exposure physical risk factor
associated with Work-related Musculoskeletal Disorders (WMSDs). The WERA assessment consists of six physical risk factors including posture, repetition, forceful, vibration, contact stress, and task duration, and its involve the five main body regions (shoulder, wrist, back, neck and leg). It has a scoring system and action levels which provide a guide to the level of risk and need for action to conduct more detailed assessments. As the WERA tool is a pen and paper technique that can be used without any special equipment, it also can be done in any space of workplaces without disruption to the workforce. This tool has been tested on its reliability and validity during the development process [7].

2.4. Data collection

During the resting time and launch time, a structured interview was conducted by using self-report charts (Body Discomfort Chart— which have been shown to provide a valid measure of body discomfort) [Corlett and Bishop, 1976] which was given to all subjects for each task. The body discomfort chart consisted of a question about the level of pain or discomfort in terms of pain or no pain in the six body part including the shoulder, elbow, wrist, back, neck and leg regions. The rationale for using the body discomfort chart is to establish the pattern of body discomfort while at work. The body discomfort chart also provides the demographic items such as the age, working experience and type of task. During the task duration, observation of the workplace was carried out by recording the job with using WERA method [7]. Eight tasks were observed and videotaped during the task duration in one day work in order to gather the data for job analysis including frequency of the activity such as standing, seating, reaching, bending, twisting, kneeling and squatting. From the videotape the angle of the some body segments relative to the vertical was then estimated to include back, shoulder, elbow and head. The most frequent postures of task adopted by the workers were taken into consideration for WERA assessment. In addition, measurements were made on the weight of the load and distances of walking by using the weight scale and measurement tape in the workplaces.

2.5. Data analysis

To establish whether WERA assessment have a relationship with the work related musculoskeletal disorders which might be reported as pain, ache or discomfort in the relevant body region, chi square test ($\chi^2$-test) was used to determine the association between the physical risk factor score defined by WERA tool and anybody reported pain, ache or discomfort from body part region that based on the number of task. Statistical analysis was performed using SPSS for Windows (version 16.0).

3. Result and discussion

3.1. Description of the sample

From the wall plastering job, out of the 43 workers the age range was from 20 to 44 years (mean 32.67 ± 5.85) while the working experience ranges were from 2 to 12 years (mean 6.28 ± 2.33). It shows that the workers were all young adults and all had a minimum of at least more than 5 years working experience. Table 2 shows the demographics of the workers in wall plastering job.

3.2. Task analysis

Eight tasks were analyze in the wall plastering job. Firstly, the worker needed to determine the areas of wall to be plastered in typically while in a standing position. Then, the worker need to bend his back and twisting the
left side when loading plaster from the ground by using the hawk and float tool. After that, this worker applied a layer of plaster on the interior wall by covering a wall, using a hawk in his left hand and float in his right hand with reaching over the head in standing position. And then, the worker repeated the same task in which bending his back and twisting the left side when take it a plaster from the ground and layering plaster on the interior wall until the wall section work was completed. From the job analysis and work parameter, frequency of this job was 5 times in standing position, 3 times in reaching the overhead, 3 times in bending posture and 3 times in lifting the load less than 5 kg. The height for reaching over the head was 1.52 m from the foot level. Therefore, 2400 times per days in standing position while 1440 times for reaching the overhead, bending posture and lifting the load less than 5 kg (taking 8 hours per day for task duration = 480 minutes). Table 3 shows the work parameter and task analysis for wall plastering job.

3.3. Body discomfort survey

An analysis of the self-report charts (Body Discomfort Charts) from the wall plastering jobs have found that 97.6% of workers were reported discomfort in the back regions. Shoulder regions was the second most highest reported discomfort by the workers in 90.7%. This was followed by wrist/hand, elbow, leg and neck regions, where the percentage of workers reported to discomfort were 86%, 81.4%, 70% and 70% while doing a work. Figure 2 shows the number of workers reported to body discomfort in wall plastering job.

3.4. WERA assessment

From the WERA assessment for 8 tasks in wall plastering job, the shoulder score was 4.63 ± 1.68 scores (range from 2–6). The highest for the shoulder score was in task 3, 5 and 7 where these tasks were extreme bent up for the shoulder posture or hands at above the chest level and have heavy movement with no rest. For the wrist score was 4.13 ± 0.83 scores (range from 3–5) and the highest score was in task 3, 5 and 7 where wrists are extreme bent up and down with twisting and have 12 times per minute for wrist repetition. In back score, the total mean age was 2.75 ± 1.03 scores (range from 2–4) where task 2, 4 and 6 have a highest score of 4 in which back posture was extreme bent forward with 3 times per minute for the repetition. The neck score was 5.50 ± 0.93 scores (range from 4–6) where task 2, 3, 4, 5, 6 and 7 have a highest score in which neck was extreme bent forward and bent back for more than 20 degrees. And the leg score was 4.75 ± 0.46 scores (range from 4–5) where all tasks have a highest score in which legs were moderate bent forward except task 1 and 8 in neutral position. Forceful score was 2.75 ± 1.03 scores (range from 2–4) where lifting the load less than 5 kg for all tasks. The score for vibration and contact stress were 3.75 ± 0.46 scores (range from 3–4) and 3.75 ± 0.46 scores (range from 3–4) where the worker never used of vibration tool and using a hand glove when doing a wall plastering job. The score for the task duration was 4 score where more than 4 hours per day (taking 8 hours per day for task duration). Task 1 and 2 (standing posture) have a final score in 27 in which indicated the low risk level while task 2.4 and 6 (bending posture) were final score in 40, which indicated the medium risk level and task 3, 5 and 7 (reaching the overhead position) were final score in 38, which indicated for medium risk in action level. Therefore, the total final score for 8 tasks in wall plastering job was 36 ± 5.63 scores (range from 27–40) in medium risk level. These result shows that the task was still accepted but need further investigate and require to change. Table 4 shows the final score and action level for eight tasks in wall plastering job.

3.5. WERA validation

In wall plastering job (n = 43), the relationship of the individual WERA body part scores to the development of pain or discomfort is statistically significant for the wrist, shoulder and back regions. The wrist score for WERA body part was >4 in 86% of workers, while wrist pain or discomfort was reported by 86%, yielding a significant association between WERA body part score and self-reported pain ($\chi^2 = 16.12, p = 0.000$). The WERA body part score for the shoulder regions during wall plastering job yielded a score >4 in 93%
Table 3
Work parameter and task analysis for wall plastering job

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Distance (walking) = None
Load (weight) = None

Distance (walking) = None
Load (weight) = Less than 5kg

Height (reaching) = 1.52 m
Load (weight) = Less than 5kg

Height (reaching) = None
Load (weight) = Less than 5kg

Height (reaching) = 1.52 m
Load (weight) = Less than 5kg
### Table 3, continued

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* Activity items - Stand for standing, Seat for seating, Knee for kneeling, Squat for squatting, Reach for reaching overhead, Lift for lifting and Bend for bending

### Body Discomfort Survey in Wall Plastering Job (n=43)

![Bar Chart](image)

Fig. 2. Number of workers reported to body discomfort in wall plastering job.
and caused shoulder pain or discomfort in 91%, the association being significant ($\chi^2 = 12.58; p = 0.000$). The back regions for WERA body part score was $>4$ in 91% of workers, with 98% reporting pain or discomfort in the back regions, with a significant association ($\chi^2 = 9.98; p = 0.002$).

The neck score for WERA body part was 1–3 in 86% of workers, this score corresponds to the most neutral posture (standing position with hand below the waist). As neck pain or discomfort was reported by 70%, there was no association between WERA score and neck pain ($\chi^2 = 0.032; p = 0.858$). Similarly, no association was found in leg score for WERA tool and reported pain or discomfort in those regions. Table 5 shows the chi square statistical analysis ($\chi^2$-test) of WERA body part score and number of workers reporting pain, ache or discomfort in wall plastering job.

### 4. Conclusion

These results showed that workers in wall plastering job were reported discomfort in their back, shoulder, wrist and elbow with higher repetitive work in awkward posture. The relationship of the individual WERA body part scores to the development of pain or discomfort is statistically significant for the wrist, shoulder and back regions. According to the number of accident by location of injury conducted by SOCSO, 6927 cases reported in wrist/hand regions, 2086 cases reported in shoulder region and 1111 cases reported in back region. This fact was also established by Gregory and Callaghan [8] who examined the prolonged standing as a precursor for the development of low back discomfort. They reported that low back discomfort has been associated with prolonged periods of standing and not linked with alterations in standing over time, but rather associated with how an individual initially stands [8–12]. Furthermore, Lipscomb et al. [11] who study injuries from slips and trips in construction industry, have found that slips contributed to the vast majority (85%) of same-level falls and over 30% of falls from height, as well as a significant number of musculoskeletal injuries sustained after slipping or tripping but without falling. This was also highlighted by [12] who study on the evaluation of scaffold safety at construction sites, have found that thirty-six scaffolds were either in danger of collapse or missing planking, guardrails, or adequate access. These results showed that statistically significant for the wrist, shoulder and back regions of the individual WERA body part scores to the development of pain or discomfort among workers and contribute to the high risk of developing work-related musculoskeletal disorders (WRMSDs) in wall plastering job.
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References


