Work-related Musculoskeletal Disorder (WRMD) among Production Operators: Studies of Differences in Age and Gender

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Abstract. Prevalence of musculoskeletal pain is a major concern among manufacturing-based companies as they are still very reliant on manual labour. A better understanding whether musculoskeletal pain differ between gender and would enable organizational intervention to improve employees’ health and safe working conditions. Therefore, the objective of this study is to determine the current prevalence of musculoskeletal pain among production workers and differences of musculoskeletal pain between gender and across age groups. A cross-sectional survey involving 324 shop-floor manufacturing workers was done using Cornell Musculoskeletal Discomfort Questionnaires (CMDQ). No significance differences were observed between female and male employees in terms of right hand, left hand, lower extremity, neck and lower back. However, there is a significance difference of pain at the upper extremity with female operators experienced more pain compared to their male counterparts. No significance differences were found among age categories for lower back, right hand, left hand, upper and lower extremity. However, neck pain and left hand was significantly different. The age effects indicate non linear association.

1. Introduction

Although manufacturing sector in Malaysia experienced moderate growth over the recent years [1], its contribution to Gross Domestic Product, external trade and job creation is still significant. To sustain this sector contribution to the economy, managing employees’ issues is paramount especially in terms of their health and well-being. However, work-related musculoskeletal disease (WRMD) cases are on the rise in Malaysia from only five cases in 1995 to more than 600 cases in 2014 [2][3][4]. WRMD is a costly health problems as it increases the labour cost and constitutes loss of work hours. WRMD include injuries and illnesses that affect the human body’s movement such as muscles, tendons, ligaments, nerves, discs, blood vessels, and other soft tissues. It is caused by excessive force, repetition of movement or simply poor posture while working, poor work practices, poor fitness and poor health. Tan Sri Lee Lam further added that industrialization, aging workforce and lack of safety standards and regulations at workplace are major contributors of this escalating statistics of WRMD [4].

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Production operators are usually required to perform work-related tasks that are categorized as manual labour such as handling machines, assembling parts or products, quality assurance activities such as testing and repairing and prepare simple reports of their activities. This implies the importance of production ergonomics for the safety and health of the production operators. Empirical evidence has shown that proper workplace ergonomics could improve motivation, satisfaction, performance and productivity [5][6]. Despite availability of production ergonomics guidelines and best practices, majority of companies have not fully implemented them since there is no legislative guideline governing ergonomics production in Malaysia [7].

Consequently, determining the effects of individual factors such as age and gender are vital to the development of effective and efficient ergonomics programs and interventions. The health of ageing employees and those of women has significant economic implication on the nation [8]. Though there has been numerous empirical works to understand the antecedents and consequences of musculoskeletal discomforts, the impact of gender and age remains inconclusive. Furthermore, majority of these studies have been focusing on Video Display Terminal (VDU) operator [9], [10] and healthcare community [11], [12]. Thus, the purpose of this study is to compare prevalence of Work-related Musculoskeletal Disorder (WRMD) between age and gender groups among production operators.

2. Age and Gender Effects

According to Armstrong’s model [13] age and gender potentially reduce an individual’s ability to cope with musculoskeletal stress especially female. Furthermore, Karlqvist [14], found that female employees tend to have different working posture compared to their male counterparts that perform similar tasks. Specifically, female employees had higher shoulder elevation and rotation when working with computer mouse. Prolonged exposure to musculoskeletal stress especially among older employees would increase WRMD prevalence.

Evidence on the effects of age and gender on Work-related Musculoskeletal Disorder (WRMD) has been inconsistent. Andersson et al. [15] surveyed two general Swedish populations primary healthcare and found that women experienced more pain at various body parts compared to men. Prevalence of pain increased by age up to 50-59 years for both genders and then slowly decreased. Similarly, Ribeiro [16] found that gender, age, BMI, consistent exercise regime and other types of illnesses were significantly associated with musculoskeletal disorders among nurses. Dianat et al [17] to certain extent replicated this study among Iranian sewing machine operators and confirms that gender, age, BMI, and consistent exercise regime are predictive of musculoskeletal symptoms. Neupane [18] revealed similar finding among healthcare personnel where older and female healthcare personnel were more likely to report pains a various places. Weaver et al. [19] sampled university employees who worked with computers and found that young respondents experienced more wrist pain while arm and shoulder pain are different between male and female. In two population studies using secondary data, [20], [21], gender differs significantly in terms of the musculoskeletal health especially in the form of carpal tunnel syndrome.

However, Taib et al [22] surveyed 85 dentists in Malaysia and found that both age and gender are not significant predictors of musculoskeletal disorder. Rocha et al [23] study concurred as no significant differences of gender and age were observed among system analysts in Sao Paolo. This study used mixed methods of data collection which include work ergonomics assessment, individual and group semi-structured interviews and self-applied questionnaires.

Maakip et al [24] found age as significant predictor of musculoskeletal discomfort among Malaysian officer workers but not age. Likewise, in terms of mixed findings, Seppala [25] and Demure et al [26] found only gender explained variance in musculoskeletal discomforts but not age.
3. Methods
Four hundred twenty productions operators working in eleven medium-sized manufacturing companies in Johor were surveyed. Participation was voluntary and no personal data was recorded to maintain confidentiality and privacy. Those who refused certain questions were excluded from the analysis to yield a return rate of 92% (Three hundred and Twenty Four). The data were collected cross sectionally in November 2016.

3.1. Participants
Male respondents were slightly higher at 56.2% compared to female (43.8%) with the majority of respondents aged between 23 to 27 years old (31.2%) followed by those aged 28-32 years old (21.9%), 33-37 years old (14.2%), 18-22 years old (13%), above 42 years old (10.5%) and 38-42 years old (9.3%). It could be concluded that more than 90% of the respondents aged below 42 years old. Majority of respondents (79.6%) had worked more than 2 years. In terms of types of production tasks, 45.4% worked in packaging, 28.4% worked in quality assurance while 13% handled machines. Majority of employees were Malaysian (67.9%) while 32.1% were Non Malaysian. In terms of years of service, majority (37.6%) had worked more than four years, followed by 24.4% had worked 2 years, 17.6% had worked 3 years, 12% had worked less than a year while 8.3% reported to had worked for 1 year.

3.2. Measures
Cornell Musculoskeletal Discomfort Questionnaires [27] was used to measure the musculoskeletal pain. The questionnaires include hand assessment and total body assessment. There were a total of 54 questions were asked regarding prevalence of musculoskeletal pain, ache or discomforts in 20 body parts during the previous week. The version of female/male standing CMDQ was used in this study, where all three indicators (frequency, discomfort and interference) were averaged to yield the cumulative scores of WRMD.

3.3. Analysis
Descriptive and non-parametric tests were used to analyse the data via the use of IBM SPSS Version 22. Descriptive analysis includes the tabulation of frequency, mean and SD. Hypotheses about equality between averages of two/more quantitative variables were examined using Mann-Whitney and Kruskal-Wallis tests. Values of \( p \) less than 0.05 were considered as statistically significant.

4. Results
Figure 1 shows the mean and standard deviation (SD) of musculoskeletal pain in terms of the frequency in the last work week. As evident from the Figure 1, neck had the highest frequency and mean of discomfort, followed by lower back, lower extremity, and upper extremity. Right hand was observed to have higher frequency of discomforts compared to left hand which may imply that majority of respondent are right-handed. The prevalence areas of discomforts are consistent with previous studies such as [28]–[30].
Table 1 shows the cross tabulation table between WRMD reported at various body parts between male and female. Male employees reported more pains in both hands (55.7% and 54.3% respectively), lower back (54.5%) and neck (53.2%). More female employees reported pains at upper extremity and and lower extremity (54.3% and 56.6%) respectively.

Table 2 shows the cross tabulation of WRMD across age groups. It is evident that across the groups, the age category of 23-27 years old consistently had higher percentages of reported pains compared to other age categories. This indicates that pains reported is not directly related with increased age, contrary to the present understanding.

In order to test whether the descriptive differences observed from the cross tabulation tables were statistically significant, Man Whitney test were performed to find the differences between male and female while Kruskal Wallis Test was used to compare differences among age categories. Table 3 shows that only upper extremity differed between male and female operators with female reported WRMD. Table 4 shows the comparison across age categories. Only WRMD at neck and left hand were statistically different among age categories. Specifically, age groups of 38-42 years old reported higher neck pain compared to 33-37 years old; more than 42 years old; and 18-22 years old. However, 23 to 27 years old reported higher neck pain compared to 38-42 years old. This is interesting finding since the results show non-linear association between age and WRMD. In terms of left hand, age group 23-27 years old differed significantly from age group more than 42 years old.
**Table 1: Cross Tabulation of WRDS and Gender**

| Body Parts | Gender | Male | Female | Total | Mean | SD |
|------------|--------|------|--------|-------|------|----|
| **Right Hand** | <= 1.44 | 61 | 46 | 107 | 1.712 | 0.569 |
|            | 1.45 - 1.78 | 62 | 49 | 111 | 55.9% | 44.1% | 100.0% |
|            | 1.79+ | 59 | 47 | 106 | 55.7% | 44.3% | 100.0% |
| **Left Hand** | <= 1.33 | 58 | 37 | 95 | 61.1% | 38.9% | 100.0% |
|            | 1.34 - 1.78 | 69 | 58 | 127 | 54.3% | 45.7% | 100.0% |
|            | 1.79+ | 55 | 47 | 102 | 53.9% | 46.1% | 100.0% |
| **Upper Extremity** | <= 1.59 | 60 | 41 | 101 | 59.4% | 40.6% | 100.0% |
|            | 1.60 - 2.04 | 76 | 41 | 117 | 65.0% | 35.0% | 100.0% |
|            | 2.05+ | 46 | 60 | 106 | 43.4% | 56.6% | 100.0% |
| **Lower Extremity** | <= 1.67 | 69 | 45 | 114 | 60.5% | 39.5% | 100.0% |
|            | 1.68 - 2.19 | 57 | 38 | 95 | 60.0% | 40.0% | 100.0% |
|            | 2.20+ | 56 | 59 | 115 | 48.7% | 51.3% | 100.0% |
| **Lower Back** | <= 1.67 | 67 | 45 | 112 | 59.8% | 40.2% | 100.0% |
|            | 1.68 - 2.33 | 36 | 31 | 67 | 53.7% | 46.3% | 100.0% |
|            | 2.34+ | 79 | 66 | 145 | 54.5% | 45.5% | 100.0% |
| **Neck** | <= 2.00 | 99 | 69 | 168 | 58.9% | 41.1% | 100.0% |
|            | 2.34+ | 83 | 73 | 156 | 53.2% | 46.8% | 100.0% |
### Table 2: Cross Tabulation of WRDS and Age Categories

| Age       | 18-22 years old | 23-27 years old | 28-32 years old | 33-37 years old | 38-42 years old | Above 42 years old |
|-----------|-----------------|-----------------|-----------------|-----------------|-----------------|-------------------|
| **Right Hand** |                 |                 |                 |                 |                 |                   |
| <= 1.44   | 12              | 24              | 24              | 20              | 9               | 18                |
|           | 11.2%           | 22.4%           | 22.4%           | 18.7%           | 8.4%            | 16.8%             |
| 1.45 - 1.78 | 13             | 41              | 20              | 13              | 13              | 11                |
|           | 11.7%           | 36.9%           | 18.0%           | 11.7%           | 11.7%           | 9.9%              |
| 1.79+     | 17              | 36              | 27              | 13              | 8               | 5                 |
|           | 16.0%           | 34.0%           | 25.5%           | 12.3%           | 7.5%            | 4.7%              |
| **Left Hand** |                |                 |                 |                 |                 |                   |
| <= 1.33   | 13              | 19              | 23              | 20              | 7               | 13                |
|           | 13.0%           | 31.2%           | 21.9%           | 14.2%           | 9.3%            | 10.5%             |
| 1.34 - 1.78 | 19             | 45              | 21              | 13              | 14              | 15                |
|           | 13.7%           | 20.0%           | 24.2%           | 21.1%           | 7.4%            | 13.7%             |
| 1.79+     | 10              | 37              | 27              | 13              | 9               | 6                 |
|           | 9.8%            | 36.3%           | 26.5%           | 12.7%           | 8.8%            | 5.9%              |
| **Upper Extremity** |             |                 |                 |                 |                 |                   |
| <= 1.59   | 12              | 30              | 19              | 17              | 7               | 16                |
|           | 11.9%           | 29.7%           | 18.8%           | 16.8%           | 6.9%            | 15.8%             |
| 1.60 - 2.04 | 16             | 41              | 28              | 13              | 8               | 11                |
|           | 13.7%           | 35.4%           | 16.5%           | 10.2%           | 11.0%           | 11.8%             |
| 2.05+     | 14              | 30              | 24              | 16              | 15              | 7                 |
|           | 13.2%           | 28.3%           | 22.6%           | 15.1%           | 14.2%           | 6.6%              |
| **Lower Extremity** |            |                 |                 |                 |                 |                   |
| <= 1.67   | 13              | 30              | 20              | 19              | 14              | 18                |
|           | 11.4%           | 26.3%           | 17.5%           | 16.7%           | 12.3%           | 15.8%             |
| 1.68 - 2.19 | 9              | 33              | 23              | 13              | 10              | 7                 |
|           | 9.5%            | 34.7%           | 24.2%           | 13.7%           | 10.5%           | 7.4%              |
| 2.20+     | 20              | 38              | 28              | 14              | 6               | 9                 |
|           | 17.4%           | 33.0%           | 24.3%           | 12.2%           | 5.2%            | 7.8%              |
| **Lower Back** |              |                 |                 |                 |                 |                   |
| <= 1.67   | 19              | 36              | 26              | 14              | 7               | 10                |
|           | 17.0%           | 32.1%           | 23.2%           | 12.5%           | 6.3%            | 8.9%              |
| 1.68 - 2.33 | 5              | 22              | 10              | 9               | 8               | 13                |
|           | 7.5%            | 32.8%           | 14.9%           | 13.4%           | 11.9%           | 19.4%             |
| 2.34+     | 18              | 43              | 35              | 23              | 15              | 11                |
|           | 12.4%           | 29.7%           | 24.1%           | 15.9%           | 10.3%           | 7.6%              |
| **Neck**  |                |                 |                 |                 |                 |                   |
| <= 2.00   | 26              | 55              | 31              | 26              | 8               | 22                |
|           | 15.5%           | 32.7%           | 18.5%           | 15.5%           | 4.8%            | 13.1%             |
| 2.34+     | 16              | 46              | 40              | 20              | 22              | 12                |
|           | 10.3%           | 29.5%           | 25.6%           | 12.8%           | 14.1%           | 7.7%              |
| **Total** | 42              | 101             | 71              | 46              | 30              | 34                |
|           | 13.0%           | 31.2%           | 21.9%           | 14.2%           | 9.3%            | 10.5%             |
Table 3: Mann Whitney Results

| Group  | Right Hand | Left Hand | Upper Extremity | Lower Extremity | Lower Back | Neck |
|--------|------------|-----------|----------------|-----------------|------------|------|
| Male   | 182        | 159.912   | 159.115        | 153.074         | 154.552    | 156.904 | 156.904 |
| Female | 142        | 165.817   | 166.838        | 174.581         | 172.687    | 169.673 | 169.673 |
|        | U          | -.564     | -.738          | -2.051          | -1.730     | -1.490 | -1.231 |
|        | p-value    | .573      | .461           | 0.04*           | .084       | .136  | .218  |

*p<0.05

Table 4: Kruskal Wallis Results

| Age Categories | n   | Right Hand | Left Hand | Upper Extremity | Lower Extremity | Lower Back | Neck |
|----------------|-----|------------|-----------|----------------|-----------------|------------|------|
| 18-22 years old| 42  | 175.77     | 151.90    | 166.02         | 179.65          | 150.94     | 146.21 |
| 23-27 years old| 101 | 175.77     | 180.06    | 160.74         | 170.47          | 159.23     | 158.28 |
| 28-32 years old| 71  | 167.42     | 166.58    | 168.52         | 173.97          | 165.48     | 175.77 |
| 33-37 years old| 46  | 146.27     | 143.10    | 158.50         | 150.79          | 171.76     | 154.93 |
| 38-42 years old| 30  | 159.23     | 167.45    | 190.32         | 134.23          | 178.12     | 203.30 |
| Above 42 years old| 34 | 121.25     | 136.76    | 131.66         | 134.47          | 153.97     | 141.68 |
| H             |     | 12.463     | 10.014    | 7.664          | 10.939          | 2.790      | 14.112 |
| p-value       |     | 0.029*     | .075      | .176           | .053            | .732       | 0.014* |

*p<0.05

It could be concluded that the age and gender effects differed based on localization of pains at various parts of the body.

5. Discussion and conclusions
The results clearly indicate neck had higher prevalence compared to other parts of the body. Right hand had higher prevalence than left hand. The prevalence of MSDs at these areas might indicate common work postures assumed by these operators. Production operators experienced musculoskeletal discomforts at neck, lower back and upper extremity which is consistent with the nature of the production activities which are still largely manual and repetitive. This results are consistent with findings of Raemy [31] who found that 90.8% of the industrial workers had their back being bent forward and 80.5% lifted heavy load ranging from 1 to 5 kg. Similar phenomenon was observed by Widia [32] where manual material handling were found to be significantly associated with musculoskeletal discomforts. Da Costa and Vieira [33] claimed that heavy physical work, awkward postures, lifting and whole body vibration lower legs discomforts might imply excessive standing of prolonged hours. Interestingly, neck pain is also a common discomfort in this study as being reported in studies of other types of occupations [36].

In conclusions, the effects of gender and age on WRMD were mixed based on localization of the pains. Further exploration is required to understand the nature of these linkages. However, it is worth to highlight that the effect of age is non linear which need to be scrutinized further.
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