

Association between Awkward Posture and Musculoskeletal Disorders (MSD) among Assembly Line Workers in an Automotive Industry

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ABSTRACT

Automotive industry in Malaysia is one of the booming industries which encompass the design, development and manufacturing of motor vehicles. However, it has its own setback as the interaction between complex tools, machines, and instruments, coupled with humans as workers pose several health hazards. A cross-sectional study was conducted to determine the prevalence of musculoskeletal disorders (MSD) and the association with awkward posture among automotive assembly line workers. A simple random sampling method was adopted and data were collected based on Standardized Nordic Questionnaire (SNQ) and Rapid Upper Limb Assessment (RULA) method for analysing awkward posture. With a response rate of 83%, a total of 232 assembly line workers with at least one year job tenure participated in this study. The findings revealed that 78.4% of workers reported MSD while the highest percentage of complaints concerned the lower back (50.9%). Three factors were found to be significantly associated with MSD: age ($\chi^2=5.61, p=0.018$), job tenure ($\chi^2= 8.26, p=0.004$) and awkward posture ($\chi^2= 65.37, p < 0.001$). Logistic regression analysis indicated that significant risk factors for MSD symptoms were workers aged ≥ 25 years old (OR= 2.25, 95%CI 1.14-4.46) and those workers with equal and more than three years job tenure (OR= 2.44, 95%CI 1.04-5.63). In addition, workers in the very high and high RULA action level who were 69 times (OR = 69.38, 95%CI 14.51-331.73) and 12 times (OR = 12.42, 95%CI 5.21-29.58), respectively, also had higher odds of complaints of MSD. The high prevalence of MSD shows that MSD symptoms is a significant problem among automotive assembly line workers while age, job tenure and awkward posture based on RULA action level are the significant factors for MSD. In particular, this study proves that the prevalence of MSD increases as the RULA action level and job tenure increases. Thus, this problem could be reduced by decreasing RULA action level through appropriate ergonomic workstation design and ergonomic training for workers.

Keywords: MSD, Awkward Posture, RULA, Automotive

INTRODUCTION

Musculoskeletal disorders (MSD) represent one of the leading causes of occupational injury and disability in the developed and industrially developing countries. At present time, MSD is one of the major problems encountered by ergonomists in various workplaces around the world. The economic loss due to such disorders affects not only the individual but also the organisation and the society as a whole. MSD is defined as injuries and disorders of the soft tissues (muscles, tendons, ligaments, joints and cartilage) and nervous system. According to the Occupational Safety and Health Administration (OSHA) of the US, some physical factors at the workplace that were associated with the occurrence of MSD were awkward posture, repetitive movement, force of movements, vibration and temperature.^[1]

Awkward posture is defined as the deviation of a body part from its natural or 'neutral' position while job tasks are being performed (NIOSH, US). These postures typically include reaching behind, twisting, working ahead, wrist-bending, kneeling, stooping and squatting. Such postures are usually related to injuries incurred during tasks that are static in nature and relatively long lasting and during tasks that demand exertion of force. Awkward

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posture has been found to be associated with decreased efficiency of performance and increased complaints of MSD among workers.^[2]

Automotive assembly is one of the important industries in certain countries and due to the nature of the tasks, workers in this particular industry are exposed to various working postures that could give rise to MSD. Previous studies have also found that poor working posture is a major cause of back pain, workplace stress, resulting in lost time, reduced productivity, poor employee health and low morale. In Malaysia, a study conducted among workers in an automotive industry found that MSD was a major problem and needed to be controlled.^[3] Research by other countries also showed similar findings. Iran, for example, reported that the prevalence of MSD was found to be high among automotive assembly line workers^[4] and another study conducted among truck assembly workers found that as high as 79% of the workers had MSD in the last 12 months of work and the commonest musculoskeletal symptom (65%) was low back pain.^[5]

Even though a number of studies has explored the relation between automotive assembly line work and musculoskeletal symptoms and has consistently shown significant findings between them, the association between awkward posture and MSD has not been extensively explored. With this rationale, a study was conducted among assembly line workers in an automotive industry aimed at 1) determining the prevalence of musculoskeletal symptoms among the workers, and 2) to ascertain their association with awkward posture.

METHODOLOGY

This cross sectional study was carried out from April 2008 to August 2008 among assembly line workers. Respondents were selected based on simple random sampling method from the list of assembly workers. Data were collected through a general questionnaire that covered the socio-demographic factors (age, right/left-handedness, education background and marital status) and job tenure. In addition, a reliable (Cronbach alpha = 0.87) Standardised Nordic Questionnaire (SNQ) was used to examine the musculoskeletal symptoms (neck and shoulder pain, upper back pain, low back pain, arm pain, knee and leg pain, ankle and foot pain) among the respondent population. Reported MSDs were limited to those in the past 12 months.^[6]

For the analysis of awkward posture, the Rapid Upper Limb Assessment (RULA) technique, which is known as a pen-paper observational method, was applied to provide a score of a snapshot of activity as part of a rapid screening tool. It basically evaluates individuals' exposures to postures, forces and muscle activities that have been shown to contribute to MSD.^[7] The scores were calculated for the posture of each body part. Score 1 indicates the most neutral posture and score 4 shows the worst position. The combined individual scores for shoulder, elbow, and wrist gave score A and those of the neck, trunk and legs gave score B. Muscle use and force exerted attributed a score of 0 or 1. These scores were added to scores A and B to obtain scores C and D, respectively. Combination of scores C and D, called the Grand Score (ranging from 1 to 7), shows the musculoskeletal loading associated with the workers posture. The results of assessment were summarised according to Table 1.

Table 1. RULA Grand Score analysis

Grand Score	Risk Level	Action
1 or 2	Low	Acceptable working posture
3 or 4	Intermediate	Further investigation is needed and change maybe required
5 or 6	High	Prompt investigation and changes are required soon
7	Very High	immediate investigation and changes are required

This study was approved by the Medical Research Ethics Committee, Faculty of Medicine and Health Sciences, University Putra Malaysia as well as the respective automotive industry. A written, informed consent was obtained voluntarily from each respondent and confidentiality of the collected data was maintained throughout the study period. Statistical Package of Social Science (SPSS for Windows, Version 16.0) was used to analyse the data.

RESULTS

Out of 255 calculated sample sizes, 232 participants responded to the questionnaire, giving a response rate of 83%, whereas 23 workers did not give their consent. Based on socio-demographic characteristics, a majority of the respondents (57.3%), were in the younger age group (< 25 years), single (78.0%), right-handed (86.2%) and held an STPM or Diploma education level (96.1%). The median age was 24 years (IQR = 5) with the minimum and maximum age of 20 and 52 years old respectively. As for job tenure, approximately 50% of the respondents were still at an early stage of their working life/career (< 3 years).

The prevalence of MSD among the automotive assembly line workers was 78.2% and when the prevalence of MSD at different body regions was analysed, the most commonly affected regions among the workers were lower back, 118 (50.9%), followed by shoulder, 88 (37.9%), wrist/ hand 79 (34.1%), neck 77 (32.2%), upper back 72 (31%), knee 59 (25.4%), ankle/feet 56 (24.1%), hip/thigh 38 (16.4%) and elbow 21 (9.1%).

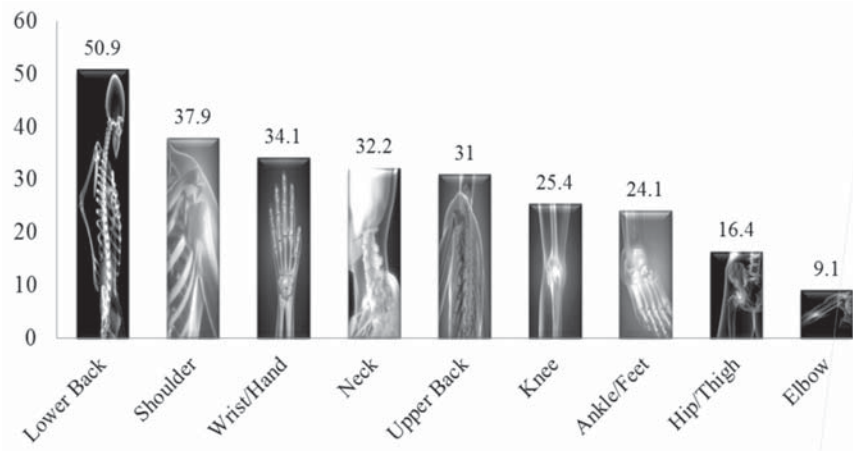


Figure 1. Prevalence of MSD according to the body regions.

Upon observing the association between socio-demographic factors and MSD, only the age factor showed significant findings, whereby those with the age equal or more than 25 years complained more of MSD ($\chi^2 = 5.61$, $df = 1$, $p = 0.018$).

As for the RULA risk assessment for awkward posture, Table 3 shows that approximately 42.6% of respondents who were in the low and intermediate RULA risk level had MSD, while 87.0% of the workers were in the high RULA risk level and about 97.2% of respondents who were in the very high RULA risk level also reported MSD. The result demonstrates an increasing trend where the prevalence of MSD increases as the RULA risk level increases. In addition, the statistical analysis revealed that there was a significant association between RULA risk level and

Table 2. The association between socio-demographic characteristics and MSD (n = 232)

Factors	MSD		χ^2	df	p-value
	Yes n(%)	No n(%)			
Age			5.61	1	0.018*
< 25	97 (72.9%)	36 (27.1%)			
≥ 25	85 (77.7%)	14 (21.3%)			
Marital status			1.35	1	0.246
Single	145 (80.1%)	36 (19.9%)			
Married	37 (72.5%)	14 (27.5%)			
Left/Right Handedness			0.26	1	0.609
Right handed	158 (79.0%)	42 (21.0%)			
Left handed	24 (68.8%)	8 (31.2%)			
Education Level			0.96	1	1.00b
SRP	7 (77.8%)	2 (22.2%)			
STPM, Diploma	175 (78.5%)	48 (21.5%)			
Job tenure			8.26	1	0.004*
< 3	82 (70.7)	34 (29.3)			
≥ 3	100 (86.2)	16 (13.8)			

*: Significant at $p < 0.05$

b: Fisher χ^2 Exact Test

Table 3. The association between RULA risk level and MSD

Variable	MSD symptom		χ^2	df	p-value
	Yes n (%)	No n (%)			
RULA risk level			65.37	2	< 0.001*
Low & Intermediate	26 (42.6)	35 (57.3)			
High	87 (87.0)	13 (13.0)			
Very high	69 (97.2)	2 (2.8)			

* Significant at $p < 0.05$

MSD ($\chi^2 = 65.37$, $df = 2$, $p < 0.001$). With regard to this, the Cramer's value obtained ($V = 0.531$) indicated that the strength or the magnitude in the relationship between RULA action level and MSD was high.

Table 4 demonstrates the logistic regression analysis performed for the predictor variables of MSD among automotive assembly line workers. It has been found that MSD is closely associated with some factors such as age, job tenure and awkward posture. Workers who were more than 25 years old had higher odds to complain about MSD (OR = 2.25, 95%CI 1.14-4.46) as compared to those less than 25 years old. Workers with equal or more than 3 years job tenure were two times more likely to complain about MSD (OR = 2.44, 95%CI 1.04-5.63) as compared to those with less than 3 years job tenure. Workers in the very high RULA risk level were 69 times (OR = 69.38, 95%CI 14.51-331.73) more likely to complain of MSD symptom as compared to those workers in the low and intermediate RULA risk level. Similarly, workers in the high RULA risk level were 12 times (OR = 12.42, 95%CI 5.21-29.58) more likely to complain of MSD symptom as compared to those workers in the low and intermediate RULA risk level.

Table 4. Logistic regression analysis showing factors associated to MSD symptom

Factors B	S.E	Sig.	OR	95% CI		
				Lower	Upper	
Age group						
< 25#	0.812	0.348	0.019*	2.25	1.14	4.46
≥ 25						
Job tenure						
< 3#						
≥ 3	0.885	0.430	0.040*	2.44	1.04	5.63
RULA risk level						
Low & Intermediate#	2.519	0.443	< 0.001*	12.42	5.21	29.58
High	4.240	0.798	< 0.001*	69.38	14.51	331.73
Very high						

* Significant at $p < 0.05$

Reference group

DISCUSSION

This study showed that the prevalence of MSD among assembly line workers was high (78.4%) and these findings are consistent with other studies elsewhere in similar business-oriented industries.^{[3],[4],[5],[8],[10]} It was noted that age had a significant association with MSD and this is in agreement with other researchers who reported a significant association between age and lower back pain among Iranian car manufacture workers with a strong correlation ($r = 0.9$).^{[5],[8],[14]} In addition, the prevalence of MSD was slightly higher in the older age group (77.7%) when compared to the younger age group (72.2%). Thus, it shows that older workers (≥ 25 years old) were more likely to report MSD. Apart from age, workers with equal or more than 3 years job tenure reported more prevalence rate of MSD (86.2%). Based on these two important findings among the workers who were still in the infancy of their careers, and the fact that prevalence of MSD was high among them, there is a need for this problem to be tackled seriously.

Despite there being no association between marital status and MSD, a majority of respondents were single and the prevalence of MSD was higher among this group when compared to married respondents (80.1% vs 72.5%, respectively). Studies elsewhere showed workers who were young and single complained more about MSD than those who were older and married. Possible explanations are that being young and single workers, they are still fit and healthy and this allows them to spend more time and concentrate more at work (for example, more overtime). However, one must remember that occupational diseases such as MSD are chronic problems which usually appear after prolonged exposure.^[9]

Based on the questionnaire (SNQ), workers complained of pain more commonly in the regions of lower back, shoulder, neck and wrist/hand. This can be explained by the nature of tasks in an automotive industry that requires workers to bend, work ahead and twist at these body regions in order to assemble the motor components. Findings of studies carried out elsewhere also showed similar results with minor variations and this could be due to different populations with different occupational risk factors, such as different physical work tasks that were performed and the level of technology used in the companies.^[10]

As mention earlier, RULA allows a rapid evaluation of work-related loads of workers' musculoskeletal systems to posture, muscle use and the force exerted in performing their tasks.^[7] It shows that based on the risk assessment by RULA, 73.7% of workers studied were categorised in the 'high' and 'very high' levels of exposure to musculoskeletal risk and it also shows a significant association between RULA risk level and MSD ($p < 0.001$). This shows that workers are exposed to extreme bending and twisting in different parts of their bodies (awkward posture), besides using force and requiring muscle strength while performing their job-related tasks. All these ergonomic factors are known contributing factors for MSD.

Significant independent variables such as age, job tenure and awkward posture were found to be the predictors of MSD symptoms among automotive assembly line workers. This result is similar to those of Ferreira *et al.*, where they reported job tenure as a predictor of MSD symptoms among engaged workers in computer–telephone interactive tasks in Brazil.^[12]

This study found that workers in the 'very high' and 'high' RULA risk levels were 69 times and 12 times respectively more at risk to complain of MSD symptoms than the workers with 'low' and 'intermediate' RULA risk levels. This shows that the higher the RULA action level, the more use of awkward posture, therefore increasing the risk to MSD. Thus, the study demonstrates that awkward posture contributed strongly to MSD risk factors. This study is also in line with the study conducted by Choobineh *et al.* among assembly line workers in the communication industry that showed a significant association between RULA risk levels and MSD with increasing trend.^[13] Despite the significant findings, these significant predictors were only able to explain approximately 45% of the variation in MSD (Nagelkerke $R^2 = 0.45$), which means that there are other factors which were not studied that may also contribute to MSD. Therefore, it is suggested that any future study should include the other factors mentioned earlier.

CONCLUSION

This study concluded that MSD was prevalent among the workers and the highest prevalence according to body region was found in the lower back region and shoulders. Among the factors studied, age, job tenure and awkward working posture had statistically significant associations with MSD. In addition, RULA method showed that a majority of workers were exposed to a working posture that was highly at risk for MSD symptoms. Meanwhile, regression analysis indicated that factors which could influence the prevalence of MSD were age, job tenure and awkward posture. Given the association between awkward posture and the prevalence of MSD symptoms, reducing RULA action level by designing ergonomic workstations and ergonomic training for workers may be beneficial in reducing the prevalence of MSD symptoms among the automotive assembly line workers.

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REFERENCES

- [1] OSHA. *Ergonomics: The study of work*. Retrieved November 10, from http://www.washingtonpost.com/wpsrv/business/legacy/pdf/ergonomic_study_of_work.pdf
- [2] NIOSH. (1997). *Musculoskeletal disorders (MSD) and workplace factors. A critical review of epidemiologic evidence for work-related musculoskeletal disorders of the neck, upper extremity, and low back*. Cincinnati: US Department of Health and Human Services.
- [3] Nur Aiza Z. & Rampal, K.G. (1999). Musculoskeletal problems and its influencing factors among automobile factory workers. *Community Health Journal*, 12(1). ISSN 1675-1663.
- [4] Ghasemkhani, M., Aten, S., & Azam, K. (2006). Musculoskeletal symptom among automobile assembly line workers. *Journal of Applied Science*, 6(1), 35-39.
- [5] Hussain, T. (2004). Musculoskeletal symptom among truck assembly line workers. *Journal of Occupational Medicine*, 48, 506-512.
- [6] Kuorinka, I., Jonsson, B., & Kilbom, A. (1978). Standardized Nordic Questionnaires for the analysis of musculoskeletal symptoms. *Appl. Ergon.*, 18(3), 233-237.
- [7] McAtamney, L., & Nigel C.E. (1993). RULA: a survey method for investigation of work-related upper limb disorders. *Appl Ergon.*, 24, 91-99.
- [8] Ghaffari, M., Alipour, A., & Jensen, I. Low back pain among Iranian industrial workers. *Journal of Occupational Medicine*, 56, 455-460.
- [9] G.Stendig-Lindberg. (1998). Prevalence of musculoskeletal pain and its socio-demographic correlates in an urban Israeli population sample. *European Journal of Physiology Medicine and Rehabilitation*, 8(3), 77-80.
- [10] Punnett, L., Fine, L.J., & Monroe Keyserling W. (2000). Shoulder disorders and postural stress in automobile assembly work. *Scand J. Work Environ Health*, 26, 283-291.
- [11] Engstrom, T., Hanse, J.J., & Kadefors, R. (1999). Musculoskeletal symptom due to technical in long cycle time work in automobile assembly plant: A study of prevalence and relation to psychosocial factors and physical exposure. *Applied Ergonomics*, 30(5), 443-453.
- [12] Ferreira, M., & Saldvia, P.H.N. (2002). Computer–telephone interactive tasks: predictors of musculoskeletal disorders according to work analysis and workers' perception. *Applied Ergonomics*, 13(2), 147-153.
- [13] Choobineh, A., Tabatabaei, S.H., & Ghadami, F. (2007). Musculoskeletal problems among workers of an Iranian communication company. *Indian Journal of Occupational and Environmental Medicine*, 11(1), 32-36.
- [14] Guo, H.R., Chang, Y.C., & Yeh, W.Y. (2004). Prevalence of musculoskeletal disorder among workers in Taiwan: a national study. *Journal of Occupational Health*, 46(1), 26-36.