

ORIGINAL ARTICLE

Prevalence of Work-related Musculoskeletal Disorders (WMSDs) Among Aviation Maintenance Personnel in Malaysia

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ABSTRACT

Introduction: Work-related Musculoskeletal Disorders (WMSDs) are a typical health problem and a significant cause of disability among workers from various fields across the industrialized world. Although aircraft mechanics and maintenance technicians experience high rates of workplace injuries, there is scarce evaluation of injury risk exposures from the various jobs/tasks in this industry. This study was conducted to investigate the prevalence of work-related musculoskeletal Discomfort/pain among maintenance personnel at RMAF in Malaysia and association between risk factors and MSD. **Materials and methods:** A total of 40 aviation maintenance personnel (Engineering department) from the Royal Malaysian Air Force (RMAF) were randomly selected via the simple random sampling. Relevant data were collected using ergonomics assessment tools comprising Cornell Musculoskeletal Discomfort Questionnaire (CMDQ). Data analysis was performed using Statistical Package for the Social Sciences (SPSS) version 25.0. **Results:** Based on the 12-month prevalence of WMSDs, the lower back region recorded the highest percentage of body discomfort and pain (77.5%) (CI 95%: 64.0–91.0), followed by the neck region (70%) (CI 95%: 55.0–85.0). Chi square analysis for the one-week prevalence shows that there is association between age ($p=0.012$) and duration of services in Royal Malaysian Air Forces ($p=0.008$) with prevalence of musculoskeletal symptoms. Age and duration of services in Royal Malaysian Air Forces is directly associated. Workers in the aviation maintenance industry, particularly those working in the engine bay, were exposed to a high risk of back, shoulder, and wrist region injury, which affected their well-being and productivity. Hence, aviation maintenance workers were recommended to perform routine physical exercises as an alternative ergonomic intervention. **Conclusion:** In conclusion, WMSD massively impacts workers' well-being in the aviation maintenance industry. Thus, an appropriate and effective ergonomic intervention, such as routine physical exercises, should be designed to protect workers from the severe impact of WMSDs.

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Keywords: Work-related musculoskeletal disorders(WMSDs), Ergonomic risk factors, Aviation maintenance personnel, Cornell musculoskeletal discomfort questionnaire (CMDQ), Prevalence

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INTRODUCTION

Human factors/ergonomics contribute in unison to the economic health and sustainability of organizations by enhancing workers' well-being, capability, job satisfaction, and maximizing performance, as well as reducing the direct and indirect costs of productivity losses, quality deficiencies, and employee turnover (1). Musculoskeletal Disorders (MSDs) are one the potential health issues among workers, which typically involve

strains and sprains mainly to the lower back region, shoulders, and upper limbs. They can result in prolonged pain, disability, and heavy medical treatment bills, which could expose those afflicted to tremendous financial stress. In particular, Work-related Musculoskeletal Disorders (WMSDs) are the major cause of disability that inflict terrible suffering and financial burden on individuals, their family, industry or employer, the healthcare system, and society in general (2). Often, employers find themselves paying exorbitant medical bills, either directly or through employee compensation insurance. Concurrently, they must cope with the loss of the full capacity of their employees (3).

Musculoskeletal injuries and disorders are the leading

cause of morbidity and temporary disability among military personnel. As such, the increased ergonomic risks and handling hazards faced by aircraft technicians of the Royal Malaysian Air Force (RMAF) have raised considerable concern over the potential impact of workplace injuries on workers' well-being. Aircraft maintenance has also been identified as a critical work task within the various high-risk areas in aviation; and is still categorized as a casual/contributory factor in several serious incidents in the commercial air transport industry (4). Nevertheless, systematic evaluation of injury risk exposures across the various jobs/tasks performed in this industry has not been compiled and analyzed, although aircraft mechanics and avionics equipment technicians experience high rates of workplace injuries (5). One of the proposed strategies stated in the Occupational Safety and Health Master Plan (OSHMP25) under Strategy 4: Empowerment of Occupational Health, is to increase workers' health and well-being and manage the risk of workers' health based on safety prevention.

Prevention of WMSDs is less costly than rehabilitation, and preventive measures aim to detect potentially harmful ergonomic work situations at an early stage. In view of this, this study was conducted to predict the impact of discomfort/pain of WMSDs arising from working conditions on workers' well-being and the overall system performance among military personnel, specifically aviation maintenance personnel. This study is in accordance with one of the components of the National Security Policy under Strategy 16: Improve the People's Well-Being, which focuses on improving workers' quality of life and well-being by providing comprehensive amenities and services in a safe and healthy environment. Therefore, this study aimed to investigate the prevalence of WMSDs and identify the risk factors among aviation maintenance personnel. There is a significant association between individual risk factors and WMSDs among aviation maintenance personnel.

MATERIALS AND METHODS

There were a total population of 45 aviation maintenance personnel in RMAF. Based on the Krejcie and Morgan 1970 (Figure 1), sample size calculation, the samples size for this research is 40 military aircraft maintenance personnel from various RMAF units in RMAF bases participated in this study. The 40 numbers of participant were involved only male as in this department there was no female involve in the maintenance works. The sample size was determined according to the Krejcie and Morgan (6) sample size calculation, which amounted to a minimum of 40 participants (n = 40). The probability sampling was used in this study. Random sampling was performed on the Air Force maintenance personnel in the engineering department. The individuals performed tasks at specific maintenance locations, including six main workstations: the structure inspection area (engine

inspection, avionic, electric, airframe, and instruments) and engine, tyre, hydraulic, non-destructive test (NDT), and modification bays. Participants were selected under the uniform inclusion criteria: (1) at least 18 years old, (2) job experience (current position) ≥1 year; (3) informed consent of the participants. Only consenting personnel participated in the current study and filled out a consent form.

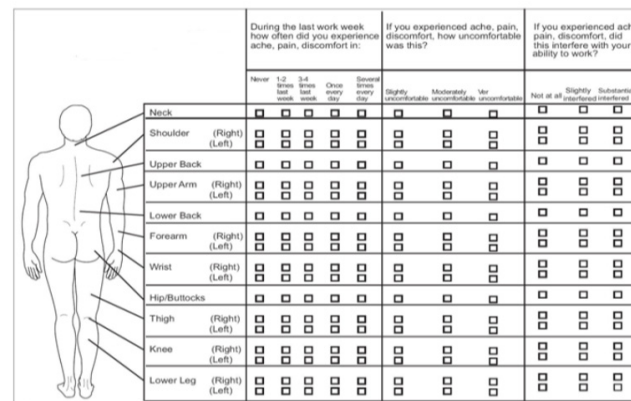


Figure 1: Male version of the Cornell Musculoskeletal Discomfort Questionnaire (CMDQ).

The prevalence of MSDs was evaluated using Cornell Musculoskeletal Discomfort Questionnaire (CMDQ). The CMDQ is a 54-item questionnaire comprising a body map diagram and questions about the prevalence of musculoskeletal aches, pain, or discomfort in 18 regions of the body an individual experienced over the previous week (Figure 1). The consent form containing information about the present research was attached to the questionnaires. Workers were asked to identify body regions that experienced pain. Using a Likert scale, they were asked to rate the frequency (how often they experience pain) and the intensity (how much pain) using CMDQ. A video recorder was also placed in the respective workstation during data collection to record the participants' posture and movements when conducting maintenance tasks to assess the ergonomics risk factor by using Quick Exposure Checklist (QEC).

This study was approved by Department of Management, Faculty of Defence Studies and Management, National Defence University of Malaysia (NDUM), reference number UPNM (FPPP) 16.04/01 Jld 2 (106) and Markas Tentera Udara MTU.PTU 100. / 2-4- 6.

RESULTS

Table I shows the respondent's demographic profile. Generally, all respondents in this study were males and mainly from the Malay ethnic. In this work location only, male workers are involved in the maintenance task. They were generally composed of two aged groups of 26–35 (80%) and 36–45 (20%). Accordingly, 17 personnel worked at the structure inspection area, while the remaining were stationed at the engine bay (10), tire bay (4), hydraulic bay (3), NDT bay (4), and

modification bay (2).

Table I: Respondent's demographic profile.

	Characteristics	Frequency (n)	Percentage (%)
Gender	Male	40	100
	Female	0	0
	Total	40	100.0
Ethnicity	Malay	37	92.5
	Indian	1	2.5
	Chinese	0	0
	Others	2	5
	Total	40	100.0
Age group	20–25	0	0
	26–35	32	80
	36–45	8	20
	46–55	0	0
	> 55	0	0
Working duration	Total	40	100.0
	1–7	1	2.5
	8	34	32.3
	> 9	5	12.5
Highest education level	Total	40	100.0
	PMR	0	0
	SPM	24	60
	STPM	0	0
	Diploma	0	0
	Degree	16	40
	Others	0	0
Work location	Total	40	100.0
	Structure inspection area	17	42.5
	Engine bay	10	25
	Tire bay	4	10
	Hydraulic bay	3	7.5
	Non-Destructive Test (NDT) bay	4	10
Modification bay	2	5	

Note: PMR = *Penilaian Menengah Rendah* (Lower Secondary Assessment); SPM = *Sijil Pelajaran Malaysia* (Malaysian Certificate of Education); STPM = *Sijil Tinggi Persekolahan Malaysia* (Malaysian Higher School Certificate)

Table II shows the prevalence of WMSDs for each body region. The highest prevalence of WMSDs for the past 12 months was detected in the lower back region (77.5%, n = 31), followed by the neck (70%, n = 28), left shoulder (52.2%, n = 21), upper back (47.5%, n = 19), both left and right knees (45%, n = 18), and wrist (42.5%, n = 17). Chi square analysis for the 12 months prevalence shows no association between socio-demographics factor and prevalence of musculoskeletal symptoms Table III. Based on the last work week prevalence of body discomfort and pain, the highest percentage of prevalence was neck (45%) followed by right shoulder (37%) Table IV. Chi square analysis for the one-week prevalence shows that there is association between age (p=0.012) and duration of services in Royal Malaysian Air Forces (p=0.008) with prevalence of musculoskeletal symptoms. Age and duration of services in Royal Malaysian Air Forces is directly associated. (Table V). Personal risk factor such as age and Ergonomics risk factors, duration of exposure were directly associated with the effect of MSD.

Table II: The prevalence of WMSDs for each body region last 12 months.

No.	Body region	Prevalence (%)	95% CI
1	Neck	28 (70.0)	0.55–0.85
2	Right shoulder	21 (52.5)	0.36–0.69
3	Left shoulder	15 (37.5)	0.22–0.053
4	Upper back	19 (47.5)	0.31–0.64
5	Right upper arm	15 (37.5)	0.22–0.53
6	Left upper arm	8 (20.0)	0.07–0.33
7	Lower back	31 (77.5)	0.64–0.91
8	Right forearm	15 (37.5)	0.22–0.53
9	Left forearm	5 (12.5)	0.02–0.23
10	Right wrist	17 (42.5)	0.26–0.59
11	Left wrist	8 (20.0)	0.07–0.33
12	Right hand/fingers	14 (35.0)	0.20–0.50
13	Left hand/fingers	12 (30.0)	0.15–0.45
14	Hip/buttocks	11 (27.5)	0.13–0.42
15	Right thigh	10 (25.0)	0.11–0.39
16	Left thigh	6 (15.0)	0.03–0.27
17	Right knee	18 (45.0)	0.29–0.61
18	Left knee	18 (45.0)	0.29–0.61
19	Right lower leg	11 (27.5)	0.13–0.42
20	Left lower leg	11 (27.5)	0.13–0.42
21	Right foot	8 (20.0)	0.07–0.33
22	Left foot	7 (17.5)	0.05–0.30

Table III: Chi-Square test showing an association between socio-demographic data and exposure risk factors of Musculoskeletal Disorders (12 months).

Variables	X ²	df	p-value
Marital Status	21.982	17	0.185
Highest Educational Level	16.042	17	0.521
Race	33.108	34	0.511
Weight	368.056	374	0.577
Height	284.444	289	.0565
Age	194.524	221	0.900
Working Duration (in hours)	32.647	34	0.534
How long have you been working with the Royal Malaysian Air Forces?	537.222	510	0.195

Table IV: The prevalence of WMSDs for each body region last week.

No.	Body region	Prevalence (%)	95% CI
1	Neck	18 (45.0)	0.36–0.89
2	Right shoulder	15 (37.5)	0.23–0.72
3	Left shoulder	9 (22.5)	0.09–0.56
4	Upper back	10 (25.0)	0.09–0.56
5	Right upper arm	8 (20.0)	0.16–0.54
6	Left upper arm	6 (15.0)	0.12–0.53
7	Lower back	10 (25.0)	0.03–0.27
8	Right forearm	5 (12.5)	0.60–1.35
9	Left forearm	1 (2.5)	0.08–0.52

CONTINUE

Table IV: The prevalence of WMSDs for each body region last week. (CONT.)

No.	Body region	Prevalence (%)	95% CI
10	Right wrist	7 (17.5)	0.04-0.34
11	Left wrist	4 (10.0)	0.07-0.38
12	Right hand/fingers	7 (17.5)	0.00-0.20
13	Left hand/fingers	5 (12.5)	0.13-0.62
14	Hip/buttocks	6 (15.5)	0.04-0.56
15	Right thigh	3 (7.5)	0.07-0.48
16	Left thigh	2 (5.0)	0.00-0.25
17	Right knee	9 (22.5)	0.02-0.22
18	Left knee	8 (20.0)	0.18-0.67
19	Right lower leg	9 (22.5)	0.09-0.36
20	Left lower leg	9 (22.5)	0.09-0.36
21	Right foot	5 (12.5)	0.02-0.23
22	Left foot	4 (10.0)	0.00-0.20

Table V: Chi-Square test showing an association between socio-demographic data and exposure risk factors of Musculoskeletal Disorders (last week).

Variables	X ²	df	p-value
Marital Status	8.769	17	0.947
Highest Educational Level	13.993	17	0.668
Race	47.324	34	0.064
Weight	391.861	374	0.252
Height	322.667	289	0.084
Age	271.452	221	0.012
Working Duration (in hours)	31.912	34	0.570
How long have you been working with the Royal Malaysian Air Forces?	590.278	510	0.008

DISCUSSION

As mentioned earlier, aircraft mechanics and avionics equipment technicians are highly vulnerable to workplace injuries. Aparajita and Astini (7) concluded that aircraft maintenance engineers mostly perform high-risk work tasks. Despite that, there is yet any systematic assessment of injury risk exposures across the various jobs/tasks performed in this industry (5). Moreover, maintenance and repair services are commonly neglected in literature studies, although they are included in the occupational category and contribute to the highest number of WMSD cases. Dave *et al.* (8) revealed that large numbers of defense personnel involved in maintenance and repair suffer from WMSDs. However, these personnel consider aches and pain arising from the workplace as a norm or part and parcel of the work routine.

According to Table II, the lower back recorded the highest prevalence of WMSDs for the past 12 months (77.5%, n = 31), followed by the neck (70%, n = 28), left shoulder left (52.2%, n = 21), upper back (47.5%, n = 19), both left and right knees (45%, n = 18), and right wrist (42.5%) (n = 17). Based on the last work week prevalence of body discomfort and pain, the highest

percentage of prevalence was neck (45%) followed by right shoulder (37%) Table IV. Anyhow, 25% reported symptoms for lower back symptoms. This figure is very much lower compared with the 12 months prevalence. In both scenarios, neck has always been highest. This could be explained with the job demand which required high visual demand during the maintenance and repairing of aircraft. Thus, intervention such as muscle conditioning and strengthening should be targeted to neck by engagement with occupational therapist or physiotherapist. Yusuf (9) and Stader (10) stated similar findings, where the highest prevalence was detected in the lower back region. The results indicate the presence of a high risk of injury to the lower back as well as hands and wrists due to work tasks, and the risks largely depend on the task duration. Asadi (5) also found that the lower back was the most reported region of the body experiencing aches, pain, and discomfort (41% of participants), while cabin maintenance workers recorded the highest prevalence of WMSDs in the knees (68%), most likely due to constraints in the aircraft cabin. In another study, Nogueira (11) reported that most aircraft maintenance workers complained of weekly and annual prevalence of pain in the lower back, neck, and upper back regions. The shoulder region also recorded a high percentage of reported symptoms. Work-related musculoskeletal symptoms are frequently reported among aircraft mechanics and avionics equipment technicians. Body regions affected include the low back, shoulders, legs and feet, neck, arms, and hands (11-16).

Based on the researcher's observations, workers were exposed to heavy and repetitive physical work, such as lifting, pushing, and pulling, where the body position and the load on the spine and back muscles increase the risk of WMSD. Other researchers have suggested potential musculoskeletal injury risk factors include bending and working with twisted trunks (14), lifting of aircraft parts (13), high physical loads (14-15), rapid muscle fatigue, and extended overhead activity (16). Injury risks were not limited to only task demands; studies have also suggested that the duration of employment (14) and technicians' time in the office (15) may also be predictors for work-related musculoskeletal injuries.

This finding implies that the nature of jobs and working conditions in the aviation maintenance areas were conducive to developing WMSDs. Therefore, ergonomic interventions and corrective measures are necessary to improve working conditions and minimize the exposure level of workers to WMSDs.

Chi square analysis for the 12 months prevalence shows no association between socio-demographics factor and prevalence of musculoskeletal symptoms Table III. Chi square analysis for the one-week prevalence shows that there is association between age (p=0.012) and duration of services in Royal Malaysian Air Forces (p=0.008) with prevalence of musculoskeletal symptoms. Age and

duration of services in Royal Malaysian Air Forces is directly associated. (Table V). Thus, appropriate work program should be design to ensure this group of workers are protected from serious musculoskeletal injuries.

Previous studies have demonstrated that aviation maintenance workers are fully vulnerable to WMSDs, yet minimal studies have been proposed to mitigate this problem (17). Acknowledging the limited WMSD studies focusing on the aircraft maintenance field, such investigations must be carried out (18). Besides, there are limited studies that focus on the risk factors of WMSD among aircraft maintenance technicians (17). Based on the results, this study recommends that aviation maintenance workers perform routine physical exercises as an alternative ergonomic intervention. The suggestion is in line with past evidence showing that workplace exercises effectively reduce the severity of low back pain (19). In addition, ergonomic interventions are vital to minimize the risks of WMSDs (20-21) and decrease the physical strain of WMSDs and the risk of injury (22).

CONCLUSION

The ergonomic risk assessments in this study revealed that aviation maintenance personnel were exposed to a high risk of WMSDs that affect their back, shoulders, and wrist regions, particularly those stationed at the engine bay. In conclusion, WMSD massively impacts workers' well-being in the aviation maintenance industry. Thus, an appropriate and effective ergonomic intervention, such as routine physical exercises, should be designed to protect workers from the severe impact of WMSDs.

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