

# Load Lifting and the Risk of Work-Related Musculoskeletal Disorders among Cabin Crews

Nurhayati Mohd Nur<sup>1\*</sup>, Mohd Amirul Syazwan Mohamed Salleh<sup>1</sup>, Mulia Minhat, Nurul Zuhairah Mahmud Zuhudi<sup>1</sup>

<sup>1</sup> Aerospace Department, Universiti Kuala Lumpur, Malaysian Institute of Aviation Technology, 43800 Dengkil, Selangor, Malaysia

\*Corresponding author: nurhayatimn@unikl.edu.my

**Abstract.** Lifting and loading passengers' hand-carry luggage into the overhead compartment in the flight cabin is one of the tasks performed by the cabin crews. The hand-carry luggage weight varies and can be up to 10 kg. The task involved load lifting over the head, awkward posture and repetitive that could lead to the risk of work-related musculoskeletal disorders (WMSDs). Hence, further investigation of those factors stimulates this study. An industrial survey was conducted and WMSDs symptom data were collected using Nordic Musculoskeletal Questionnaire (NMQ). Rapid Upper Limb (RULA) assessment was performed to analyse the posture during the load lifting task. The results of the industrial survey indicated that 88.3% of the workers experienced WMSD symptoms in various regions of the body. The highest symptoms reported at lower back (80.0%), followed by the neck (68.0%) and shoulder (59.0%). The result is supported with the result of RULA with final score 7, which indicated the load lifting task performed involved awkward posture, needs changes and further improvement should be immediately implemented. In conclusion, the cabin crews exposed to the risks of WMSDs and the results of this study can be used as references by the aviation industry to mitigate WMSDs issues among the cabin crews specifically and contribute to the improvement of the society well-being generally.

## 1. Introduction

WMSDs involved pain and injuries which are commonly experienced in the neck, cervical spine, muscle tendons and joints in the body [1]. There are many factors that contribute to the risk of contracting WMSDs. The demands at work and the capacity of the worker to perform work-related activities may play a role in the development of this pain. WMSDs are known to be associated with work-related physical risk factors such as force, posture and repetition [2]. The trend of WMSDs increased every year [3] and its adverse effect on the workers' health and performance over time is significant [4]. Even though the number of the cases reduced about 3% in 2015 but the occurrence rate is still high [5]. The occurrence of WMSDs is costly due to high compensation cost and lost wages [6].

WMSDs provide a significant threat to the employees in many industries including aviation industry. It is important to reduce the work-related physical risk factors in order to reduce the risk of WMSDs. It is the major challenge to design tasks to prevent or reduce work-musculoskeletal disorders (WMSD). In performing manual handling work, workers are exposed to the work-related physical risk factors whereby the tasks involve repetitive work, high force, extreme or awkward posture, short cycles, high movements and lack of recovery [2]. In a real work, these factors are less considered that could lead to the increasing number of WMSDs cases per year.

Lifting and loading hand-carry luggage into the overhead compartment in the flight cabin is one of the common manual handling tasks performed by the cabin crews. The hand-carry luggage weight varies and can be up to 10 kg, depending on the airline's policy. As stated in the passenger boarding policy of airlines inside their website, the hand-carry luggage allowed on premium airlines is up to 10



kg for each passenger on board which usually limited to one laptop bag and one cabin bag which both total up the approved weight by the airlines. For the low-cost airlines, technically they are applying maximum 7 kg hand-carry luggage policy to all their passengers. However, most of the passengers carried a hand-carry luggage more than approved weight into the cabin which means that the cabin crews may handle the hand luggage which is more than 7 kg or less. The lifting tasks might involve the upper limb body parts and the previous study found that the risk of WMSDs in arm, shoulder and neck region are prevalent even though with light exertion [7].

The load lifting tasks performed involved work-related physical risk factors which are known as force, repetition and posture. These factors either single factor or combined could lead to the risk of WMSDs. The load lifting task is not totally the responsibility of the cabin crews and sometimes the passengers performed the task themselves. Is the passenger also vulnerable to the WMSDs risk? The answer depends on the exposure to the work-related physical risk factors involved as discussed earlier. In this study, the scope is limited to the cabin crews since based on the preliminary assessment, most of the cabin crews performed the task and might be exposed to the risk of contracting WMSDs. In addition, there is a lack of studies conducted to evaluate the load lifting task which involved hand-carry luggage and the prevalence of WMSDs among the cabin crews. Therefore, it is timely to investigate this issue. The result of this study could provide knowledge and awareness to the airline companies specifically and aviation industry generally to mitigate this issue from becoming catastrophic.

## 2. Methodology

### 2.1 Industrial Survey

The Nordic Musculoskeletal Questionnaire (NMQ) is used to collect data on the risk of WMSDs. It consists of structured, forced, multiple-choice questions and can be used as a self-administered questionnaire as an on-paper interview method. The subjects involved in this study are 59 respondents from the cabin crew profession which are 30 stewards and 29 stewardesses.

### 2.2 Experimental Tasks,

The tasks involved the lifting and placement of different weight of hand-carry luggage into the aircraft overhead compartment. The luggage weights used are 5kg and 7kg. The maximum luggage weight allowed by the low-cost airlines is used in this experimental study. There are 10 subjects involved (5 males, 5 females). The subjects are required to lift and place the luggage every 2 minutes for 20 minutes, as depicted in Figure 1. The subjects' height and weight are between 160 -180 cm and 40 – 70 kg respectively. The subjects fulfill the characteristics required as cabin crews in terms of physical, height weight and normal body mass index (BMI).



**Figure 1.** Load lifting task

The posture of the subject during load lifting tasks is evaluated using Rapid Upper Limb Assessment (RULA) method. After the task completion, the subjects will rate their discomfort level using Borg's Scale [8] as shown in Table 1.

**Table 1.** The Borg's Scale

<b>The Borg General Scale</b>		
0	---	nothing at all
0.5	---	extremely weak (just noticeable)
1	---	very weak
2	---	weak
3	---	moderate
4	---	somewhat strong
5	---	strong
6	---	
7	---	very strong
8	---	
9	---	
10	---	extremely strong (almost maximal)

### 3. Results

#### 3.1 Industrial Survey

Complete responses were obtained from 59 cabin crews from two main Airlines in Malaysia. The demographic data of the respondents are summarized in Table 2. It can be seen that 50.8% of the respondents are males whereas the remaining 49.2% are females. Based on age distribution, it can be seen that majority of the respondents fall within an age range of 18-33 years old, giving a value of 91.5% and the remaining 8.5% fall within an age range of more than 33 years old.

**Table 2.** Demographic Data of the Respondents

<b>Gender</b>	Male	30 (49.2%)
	Female	29 (50.8%)
<b>Age</b>	18 – 22	2 (3.4%)
	23 – 27	40 (67.8%)
	28 – 33	12 (20.3%)
	> 33	5 (8.5%)
<b>Flying hours in a week</b>	1 – 20	14 (23.7%)
	21 – 40	36 (61.0%)
	41 – 60	9 (15.3%)
<b>Number of placing loads per flight</b>	1 – 10	9 (15.3%)
	11 – 20	14 (23.7%)
	21 – 30	15 (25.4%)
	31 – 40	17 (28.8%)
	41 – 50	4 (6.8%)

The demographic data show that the highest percentage of respondents have to work with flying hours between 21-40 hours, giving a value of 61.0%. The number of respondents with 1-2 flying hours and 41-60 hours constitute 23.7 and 15.3%, respectively. It can be observed that 61.0% of the respondents have to do repetitive load lifting task (placing the luggage in the overhead compartment) more than 20 times per flight while the remaining 39.0 %, the frequency of repetitive load lifting per flight is 20 times and less.

### 3.1.1 WMSDs for the last 12 months

The prevalence of WMSD symptoms among cabin crews over the past 12 months is summarized in Table 3. It can be observed that the occurrence of WMSD symptoms varies from 6.8 – 68.0%, depending on the region of the body. The results indicate that 88.3% of the cabin crews experienced WMSD symptoms in various regions of the body. The prevalence of musculoskeletal symptoms is highest at the lower back, followed by the neck, shoulder, upper back, knee, ankle, hand wrists/elbow and least of all, the thigh/hip.

**Table 3.** Prevalence of WMSD symptoms over the past 12 months.

Body Region	Frequency (N)	Percentage (%)
Neck	40	68.0
Shoulder	35	59.0
Elbow	8	13.6
Hand/Wrists	18	30.5
Back (U)	30	51.0
Back (L)	47	80.0
Thigh/Hip	4	6.8
Knee	22	37.0
Ankle	19	32.0

### 3.1.2 WMSDs for the last 7 days

The prevalence of WMSD symptoms among cabin crews over the past 7 days is summarized in Table 4, and it can be seen that the percentage of occurrence ranges from 3.3 – 29.0%, depending on the body region.

**Table 4.** Prevalence of WMSDs symptoms over the past 7 days

Body Region	Frequency (N)	Percentage (%)
Neck	17	29.0
Shoulder	12	20.3
Elbow	5	8.5
Hand/Wrists	17	28.9
Back (U)	17	28.8
Back (L)	19	32.2
Thigh/Hip	2	3.3
Knee	8	13.5
Ankle	8	13.5

It is found that 54.2% of the cabin crews experienced WMSDs symptoms in various regions of the body. The prevalence of WMSD symptoms is highest at the lower back, followed by the neck, hand/wrist, upper back, shoulder, knee, ankle, elbow and least of all, the thigh/hip.

### 3.1.3 Experimental Task

The experimental tasks involved 10 subjects which are volunteered among university students, which consist of 5 males and 5 females subjects. Each subject performed load (luggage) lifting tasks of 2 different weight of hand-carry luggage which are 5 kg and 7 kg. They repetitively lift the luggage for every 2 minutes for 20 minutes duration. The posture of the subjects during repetitive task was assessed using Rapid Upper Limb Assessment method and the result is presented in Table 5 and 6. In Table 5, the muscles involved are arm and wrist, which contributed to Part A score, 8.

**Table 5.** RULA results for Part A Score

Body Parts	Scores
Upper Arm	4
Lower Arm	3
Wrist twist	2
Wrist	4
Posture A	6
Muscle Use	0
Force/Load	2
Wrist&Arm (Posture A + Muscle use + Force/load)	8

In Table 6, the muscles involved are the neck, trunk and legs, which give results for Part B score, 8.

**Table 6.** RULA results for Part B score

Body Parts	Scores
Neck	3
Trunk	4
Legs	1
Posture B	6
Muscle use	0
Force/load	2
Neck, Trunk, Leg score (Posture B + muscle use + force/load)	8

The RULA scores for part B and Part A is then further analysed and assessed as presented in Table 7, It can be found in Table 7 that the RULA final score produced is 7.

**Table 7.** RULA Final Score Assessment

Wrist and Arm Score	Neck, Trunk and Leg Score						
	1	2	3	4	5	6	7+
1	1	2	3	3	4	5	5
2	2	2	3	4	4	5	5
3	3	3	3	4	4	5	6
4	3	3	3	4	5	6	6
5	4	4	4	5	6	7	7
6	4	4	5	6	6	7	7
7	5	5	6	6	7	7	7
8+	5	5	6	7	7	7	7

The participants were required to rate their perceived discomfort level after the task completion and the result of the discomfort level is presented in Table 8. It can be seen that the participants felt more discomfort while performing the task with a heavier load and the most discomfort area is found at the neck, with discomfort level is rated as somewhat strong.

**Table 8.** Perceived discomfort level

Luggage weight	Discomfort Level (mean)								
	Neck	Shoulder	Upper Back	Elbow	Wrist	Lower Back	Hips/Tight	Knee	Ankle/Fit
5kg	3.3	2.0	2.0	2.0	2.3	2.0	1.7	2.0	1.7
7kg	4.0	3.0	2.0	2.2	3.3	2.3	2.5	2.0	2.5

#### 4. Discussion

The aim of this study is to investigate the risk of WMSDs among cabin crews. Two approaches had been performed in this study which involved an industrial survey and experimental task. An industrial survey is conducted to investigate the prevalence of WMSDs among cabin crews while the experimental task is conducted to assess the work posture and the risk of WMSDs during lifting and loading the hand-carry luggage into the overhead compartment in the flight cabin.

The results of the industrial survey showed that the cabin crews experienced WMSD symptoms, whereby approximately 88.3% of the cabin crews experienced pain and discomfort in various regions of the body parts over the past 12 months. The most affected parts are lower back, followed by the neck and the shoulder. The results also revealed that the prevalence of WMSD symptoms ranges from 3.3 –32.2% for different body areas over the past 7 days. It can be observed from the results that the prevalence of WMSDs is highest at the lower back followed by the neck and the hand/wrists. The cabin crews felt more pain at the lower back and neck due to the heavy load lifting tasks since these muscles are the most affected muscles. More pain experienced on the particular muscles during the tasks indicated that the muscles are the most affected muscles [9].

Cabin crews performed load lifting tasks repetitively, involved force (load) and also awkward posture. Based on the industrial survey data, it is found that 61.0% of the cabin crews performed repetitive load lifting tasks more than 20 times per flight. The repetitive load lifting task done contributed to the prevalence of WMSDs risk among the cabin crews as showed by the high percentage of complaints (88.3%). Several studies have reported that repetitive task is one of the work-related physical risk factors that could lead to the risk of WMSDs [10–13] which supported the result of this study. In addition, the combination of force (load) with repetitive task tends to give more risk of WMSDs. The cabin crews lifting and loading the heavy hand-carry luggage (up to 10 kg) repetitively and the tasks involved a combination of force and repetition factors that could lead to the higher risk of WMSDs. The previous study also discovered that as the level of force and repetition increased, the level of pain and discomfort also increased, which indicated the risk of WMSDs [14].

The posture of the cabin crews while lifting and placing the load is further analysed with rapid upper limb assessment (RULA) method. The assessments involved two parts (Part A and Part B). The score of both parts is then calculated and compared with the guideline provided for RULA assessment. The final RULA score obtained for both forces (load) used is at level 7. The results indicated that the load lifting task performed in an awkward posture, the task needs changes and further improvement should be implemented [15] in order to reduce it. The result is aligned with the previous studies result which found that awkward postures lead to the risk of WMSDs [16]. On top of that, it is found that the mean perceived discomfort level while placing the heavier load (7 kg) is found 25.0% higher compared to the lighter load (5kg). The result indicated the higher risk of WMSDs when lifting heavier hand carry luggage with the awkward posture.

The overall results showed that load lifting tasks performed involved work-related physical risk factors (force, repetition and posture) that contributed to the risk of WMSDs among the cabin crews.



Therefore, it is important to re-attend the existing method of performing the load lifting tasks to reduce the effects of those work-related physical risk factors and the risk of contracting WMSDs.

## 5. Conclusion

Based on the results obtained from this study, the cabin crews performed repetitive load (hand-carry luggage) lifting task with the weight varies from 5-10 kg are found to expose to the risk of work-related musculoskeletal disorders. The results of the industrial survey indicated that 88.3% of the workers experienced WMSD symptoms in various regions of the body parts. The highest symptoms for the last 12 months was reported at lower back (80.0%), followed by the neck (68.0%) and shoulder (59.0%). Further investigation on the work posture (RULA analysis) showed that the load lifting task performed involved awkward posture and the task needs changes on the implementation. The overall results showed that the work-related physical risk factors (force, repetition and posture) involved in the load lifting tasks lead to the risk of WMSDs among cabin crews. Therefore, it is important to re-attend the load lifting tasks to reduce the effects of those factors in order to mitigate the WMSDs risks. The outcome of this study could be used as references by the aviation industry to mitigate WMSDs issues among the cabin crews specifically and contribute to the improvement of the society well-being generally.

## References

- [1] NIOSH 1997 Musculoskeletal Disorders and Workplace Factors. *NIOSH Publ No 97B141*
- [2] Nordander C, Hansson GA, Ohlsson K, Arvidsson I, Balogh I, Strömberg U, Rittner R and Skerfving S 2016 Exposure-response relationships for work-related neck and shoulder musculoskeletal disorders - Analyses of pooled uniform data sets. *Appl Ergon* **55** 70–84.
- [3] SOCSO 2014 SOCSO Annual Report 2014
- [4] Walt R, Winnie I and James M. 2013 Musculoskeletal Disorders, Five Common Management Approaches. *Pers Saf* 35–42.
- [5] SOCSO 2015 SOCSO Annual Report 2015.
- [6] Joseph, B., Naveen, B., Suguna, A., and Surekha A 2016 Prevalence, Pattern and Factors Associated with Work-related Musculoskeletal Disorders (WRMD) among Housekeeping Workers in a Private Tertiary Care Hospital in Bangalore. *J Health Manag* **18** 545–54.
- [7] Bosch T, Mathiassen SE, Visser B, de Looze MP and van Dieën JH 2011 The effect of work pace on workload, motor variability and fatigue during simulated light assembly work. *Ergonomics* **54** 154–68
- [8] Borg G 1998 Borg's Perceived Exertion and Pain Scales Human Kinetics Publisher
- [9] Akmal, K., Norzaimi, M. C. A., and Hairizal MO 2014 Analysis on the Work- Related Musculoskeletal Disorders ( WMSD ) Based on Ergonomic Study in Case of Industry Study. *Int J Eng Res* **5013** 190–5.
- [10] Bosch T, de Looze MP, Kingma I, Visser B and van Dieën JH 2008 Electromyographical manifestations of muscle fatigue during different levels of simulated light manual assembly work. *J Electromyogr Kinesiol* **19** 246–56
- [11] Gooyers CE and Stevenson JM 2011 The impact of an increase in work rate on task demands for a simulated industrial hand tool assembly task. *Int J Ind Ergon* **42** 80–9.
- [12] Nordander C, Ohlsson K, Akesson I, Arvidsson I, Balogh I, Hansson GA, Strömberg U, Rittner R and Skerfving S 2009 Risk of musculoskeletal disorders among females and males in repetitive/constrained work. *Ergonomics* **52** 1226–39.
- [13] van Rijn RM, Huisstede BM, Koes BW and Burdorf A 2009 Association between work-related factors and specific disorders at the elbow : A systematic literature review. *Rheumatology* **48** 528–36.
- [14] O'Sullivan, L. and Clancy P 2007. Guideline threshold limit values (TLVs) for discomfort in repetitive assembly work. *Hum Factors Ergon Manuf* **17** 423–34.
- [15] Middlesworth M 2015 Rapid upper limb assessment ( RULA ) A Step-by-step guide. *Ergon*

*Plus* <http://ergo-plus.com/rula-assessment-tool-guide/> (accessed April 15, 2017).

- [16] Carey EJ and Gallwey TJ 2002 Effects of wrist posture, pace and exertion on discomfort. *Int J Ind Ergon* **29** 85–94