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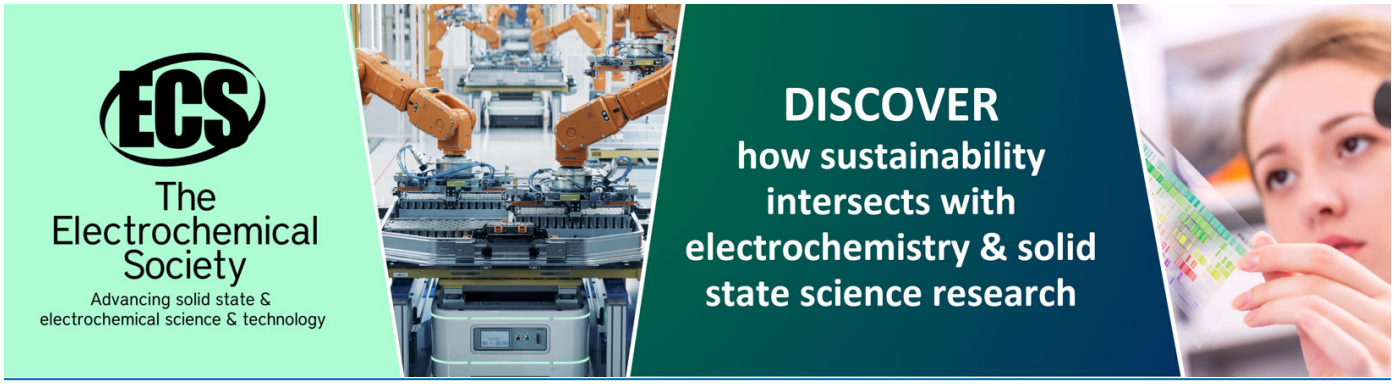

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Evaluation of Working Posture on Bus Traffic Controllers

Farhan Najmi Ferdinand Bakri[1], Jalil Azlis-Sani[1], Mohd Zamani Ngali[1], Muhammad Nur Annuar Mohd Yunos[1], Jacquelyne Anne Boudeville[1], Syazwan Ismail[1], Munzilah Rohani[2], Nor Aziati Abdul Hamid[3], Mohd Saiful Izwan Aazizi[4] and S.M. Sabri S.M. Ismail[5]

[1]Faculty of Mechanical Engineering & Manufacturing, Universiti Tun Hussein Onn Malaysia (UTHM), 86400 Parit Raja, Johor, Malaysia
[2]Faculty of Civil and Environment Engineering, Universiti Tun Hussein Onn Malaysia (UTHM), 86400 Parit Raja, Johor, Malaysia
[3]Faculty of Technology Management and Business, Universiti Tun Hussein Onn Malaysia (UTHM), 86400 Parit Raja, Johor, Malaysia
[4]Rapid Bus Sdn Bhd, Kompleks Rapid Bus Cheras Selatan, 71, Jalan Kb 2/15, Kampung Baru Balakong, 43300 Seri Kembangan, Selangor, Malaysia
[5]Strategy & Transformation Office, Prasarana Malaysia Berhad, Level 21, Tower B, Menara UOA Bangsar, No 5, Jalan Bangsar Utama 1, 59000 Kuala Lumpur, Malaysia

E-mail: azlis@uthm.edu.my

Abstract. This study aimed to evaluate the working posture of bus traffic controllers. The Musculoskeletal Disorders (MSDs) prevalence and the exposure to the ergonomic risks factors (ERFs) among bus traffic controllers were determined. There were 26 respondents (16 male and 10 female) who were bus traffic controllers (BTC) at a prominent bus service provider were selected as the subjects. Data for Musculoskeletal Disorders (MSDs) prevalence among the bus traffic controllers were collected using Nordic Musculoskeletal Questionnaire (NMQ) and direct observation and assessment of ergonomic risks factors were conducted via Rapid Office Strain Assessment (ROSA). By using ROSA, the BTCs working posture and work environment were checked and measured in order to quantify the risks to ERFs. According to the assessment, more than half (15/26 respondents) of the bus traffic controllers were found to have an extreme posture with the ergonomic risk level was high (more than 4) (action level 3) which required a further investigation and changes of work habits soon. The research showed that most of the bus traffic controllers (BTC) were exposed to high ergonomics risk for MSDs development. To avoid MSDs, the personal working behaviours and the design of the computer-based workstations must be improved based on ergonomic principles.

1. Introduction

In contemporary years, rapid development and use of computers has affected the workers and their workplace [1]. Introduction of computers into the workplace has changed the working environment, work organization, appearance of new risk factors, and a different use of worker physical and mental potential. These changes may have a bad effect on their health [2].

Malaysia is one of the developing countries having musculoskeletal disorders (MSDs) as a major occupational health issue for workers [3]. Many aspects or factors including personal aspects, work related factors (WRF) and psycho-social factors (PSF) can lead to musculoskeletal disorders (MSDs). Generally, musculoskeletal disorders (MSDs) are caused by static body positions, repetitive movements, prolonged muscular contraction, and the use of force. Musculoskeletal disorders (MSDs) consist of minor physical disabilities as this term is used to describe various conditions that affect the muscles, bones, and joints. Work-related musculoskeletal disorders (MSDs) can affect shoulders, arms, elbows, wrists, hands, back, legs and feet [4].

Computer and office-based work, such as customer service work, is a growing occupation that is correlated with an increase in Work Related Musculoskeletal Disorders (MSDs) [5]. Based on a survey in Malaysia, it was found that 50% of 136 computer users from a sample of population of university students and office staff suffered some lower back pain did not have an adjustable backrest on their seats. Most of the users had higher Rapid Upper Limb Assessment (RULA) scores of the wrist and neck as it showed an increased risk of developing occupational overuse syndrome [6].

Studies have reported a high prevalence of musculoskeletal disorders among call center workers who sit daily for a prolonged length of time. The workers spent most of their time working in a workspace that uses a computer desk and chair. The musculoskeletal disorders were caused by the awkward posture from the use of fingers, wrists and arms in repetitive posture and always looking on the screen while working using computer [7]. Along with musculoskeletal disorders, they might suffer from eye, ear, and throat related health problems [8].

Therefore, a study was conducted among a prominent bus service provider workers to evaluate the working posture of bus traffic controllers at the control room which is a computer-based workstation. Their daily working activities and working postures were observed in order to identify the possibilities of musculoskeletal symptoms and their exposure to the ergonomic risk that lead to musculoskeletal disorders.

This study of evaluation of working posture on bus traffic controllers could provide better understanding regarding ergonomics. The identification of musculoskeletal disorders or symptoms and the exposure level to the ergonomic risks among bus traffic controllers who works in a computer-based workstation can be determined and this could develop better understanding regarding their working activity, posture and its effect. This research would help for improvements in terms of ergonomics which involved the working posture, working habits of the bus traffic controllers and the design of the workstation. The safety of the workers and the working environment can be improved to ensure the quality and efficiency of the bus control services.

2. Methodology

In this research, two methods were used for data collection. Structured interview sessions using Nordic Musculoskeletal Questionnaire (NMQ) was carried out in order to determine the MSDs among bus traffic controllers. Besides, direct observation using Rapid Office Strain Assessment (ROSA) was conducted to assess the ERFs among bus traffic controllers.

2.1. Subjects and Task Description

This study has been conducted among 26 bus traffic controllers (BTC) at the control room of a prominent bus service provider which is categorized as a computer based workstation. In this study, each BTC has to work at their workstation which during that time, their working posture or responsiveness and interaction with equipment was observed. Included in this study were the BTC who had to use the computer for their normal workday. The daily work tasks performed by the bus traffic controllers are such as key in the data using computer, letter writing, dealing with telephone and email enquiries.

2.2. Nordic Musculoskeletal Questionnaire (NMQ)

The Nordic Musculoskeletal Questionnaire [9] has been widely used to identify the possibilities and severity of self-rated musculoskeletal symptoms. The questionnaire includes questions asking about the experience of musculoskeletal problems in nine body areas which are neck, shoulders, elbows, wrists/hands, upper back, lower back, hips/thighs, knees, and ankles/feet over the past week and over the past year.

NMQ consists of three parts. Part A was about the demographic items including gender, age, height, weight, hand dominance, working experience, and hours of work per week. Part B is concentrated on trouble for locomotive organs which included questions about trouble during last 12 months regarding neck, shoulders, elbows, wrists/hands, upper/lower back, hips/thighs, knees, ankles and feet. The last part was Part C which concentrated on common area of musculoskeletal symptoms which are lower back, neck and shoulder. There were specific questionnaires on the details for the musculoskeletal symptoms on each body parts.

2.3. Rapid Office Strain Assessment (ROSA)

Rapid Office Strain Assessment (ROSA) is a picture based posture checklist which is designed to quantify exposure to risk factors in an office work environment. It is modelled after other picture based checklist and chart scoring systems such as RULA and REBA [10]. But ROSA is more specific for computer usage risk assessment compared to RULA [11].

ROSA consists of three sections which are Section A, Section B and Section C. Section A are scoring section for office chair which combined the height of the chair, its pan depth, the armrests and back support. Section B consists of sub-section for monitor and telephone score while Section C combined the scores for mouse and keyboard. When conducting an assessment by using ROSA, the observer will choose the most suitable scores based on the posture of the worker that being observed. From ROSA, there are 4 risk assessment score levels which are low (1-2 points), medium (3-4 points), high (5-7 points) and very high (8-10 points).

2.4. Data Collection

In this research, the data was collected using two methods that have been explained in previous sections which were Nordic Musculoskeletal Questionnaire (NMQ) and Rapid Office Strain Assessment (ROSA). The subjects were 26 bus traffic controllers (BTC) from a prominent bus service control room.

Firstly, a face to face structured interview was conducted among bus traffic controllers by using Nordic Musculoskeletal Questionnaire (NMQ). The questionnaire consists of three parts which are A, B and C. For Part A, they were asked for some demographic items such as gender, age, height, weight, hand dominance, years of work and hours of works per week. As for Part B, the questionnaire is concerning on the trouble with the locomotive organs. The BTCs were asked on information about the musculoskeletal symptoms frequency of pain and the intensity of the pain. The 12 months prevalence, 7 days point prevalence and intensity of musculoskeletal troubles were identified and questioned from the workers. The last part which was Part C is where the workers were questioned about the details area of musculoskeletal symptoms which involved lower back, neck and shoulder.

In addition, an observation on the working activities and working posture of the bus traffic controllers was conducted. A direct observation on the BTC's working posture using Rapid Office Strain Assessment (ROSA) in the computer based control room was performed in order to assess the ergonomics risk factors [12]. Posture and work environment were checked step by step and included sitting on chair, monitor and telephone used, mouse and keyboard respectively. Also considered was the estimated work duration which was reported by the computer user (BTC). This value was used as the assumed duration of use for all components of the workstation. Their working postures and work environment score were recorded and evaluated.

2.5. Data Analysis

From the collected data of Nordic Musculoskeletal Questionnaire (NMQ) which contain demographic variables, number of self-reported symptoms and reported lower back, neck and shoulder trouble, descriptive statistics was used to analyse the data such as percentages, mean and standard deviation. While for the result of ROSA obtained which included the scores for office chair (Section A), scores for monitor and telephone (Section B), scores for mouse and keyboard (Section C) and ROSA Grand scores were analysed as mean, standard deviation and action level. Results of both Nordic Musculoskeletal Questionnaire and Rapid Office Strain Assessment (ROSA) were carried out using Microsoft Excel and SPSS Software Version 23.0. Figure 1 shows the flowchart of data analysis.

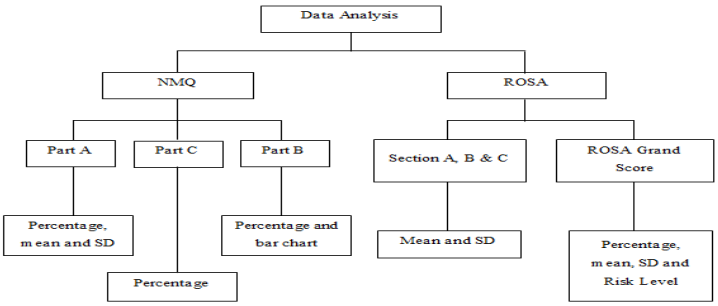

Figure 1. Data Analysis Flowchart

3. Results & Discussion

3.1. Nordic Musculoskeletal Questionnaire (NMQ)

3.1.1. Demographic Variables

Table 1 is a presented summary of the demographic variables. Based on the analysis, there was more male bus traffic controllers compared to female. Majority of the bus traffic controllers are aged between 21 to 40 years old and only 3 of them are 40 years old and over with the mean score for age was 30.31. Their total year of working experience was 2.89 years on average. Most of the bus traffic controller's working experiences were between 1 to 5 years with only 3 of them with 6 years and more working experience.

All of 26 of them spent more than 51 hours in the computer- based control room every week with the mean score for the weekly working time was 55 hours a week. From the questionnaire, it was found that 14 of the BTCs had normal weight for their Body Mass Index (BMI) while 9 of them were overweight. Besides, 1 of the BTC was underweight and 2 were obesity. The average body mass index for the BTC was 25.09 kg/m2 and only 2 of them were left handed.

Table 1. Demographic Variables of Bus Traffic Controllers (n=26)

Characteristic		N	%	Mean	SD
Gender	Male	16	61.54	-	-
	Female	10	38.46		
Age	≤20	0	0.00	30.31	7.70
	21-40	23	88.46		
	≥41	3	11.54		
Working Experience	1-5	23	88.46	2.89	2.15
	≥6	3	11.54		
Working hours in control room	40-50	0	0.00	55.00	0.00
	≥51	26	100.00		
Body Mass Index (BMI)	Underweight	1	3.85	25.09	4.10
	Normal Weight	14	53.85		
	Overweight	9	34.62		

	Obesity	2	7.69		
Hand Dominance	Right-handed	24	92.31	-	-
	Left-handed	2	7.69		

3.1.2. Number of Self-reported Symptoms

The numbers of self-reported symptoms among bus traffic controllers that occurred in the last 12 months were shown as percentage in Figure 2. The results of the research showed that different gender of the BTC had different prevalence of musculoskeletal symptoms on the same body region. The highest prevalence of body part trouble in last 12 months for bus traffic controllers was low back (84.62%), followed by upper back, neck, shoulder and knees while the least body part trouble were hips/thighs and ankles/feet both at 15.58% followed by elbows and wrists/hands which both was at 11.54%.

Female bus traffic controllers were more likely to get injured from their work activity as they had higher injury prevalence for all body parts compared to male bus traffic controllers. Their highest prevalence was upper back which suffered by all of the female bus traffic controllers. Meanwhile the least injury prevalence for female bus traffic controllers were elbows, wrist/hands, hips/thighs and ankles/feet as the score for all of the body parts were 20%. It was similar compared to previous study by Jensen et al (2002), as it showed that the same body region of MSDs suffered by female call-centre workers were neck with 53% prevalence of symptoms, shoulder (42%) and upper and lower back (30%) symptoms.

As for male bus traffic controllers, they had highest prevalence for low back injury which was at a rate of 81.3% as the least prevalence of body part trouble was elbows and wrists/hands which both scored 6.3%.

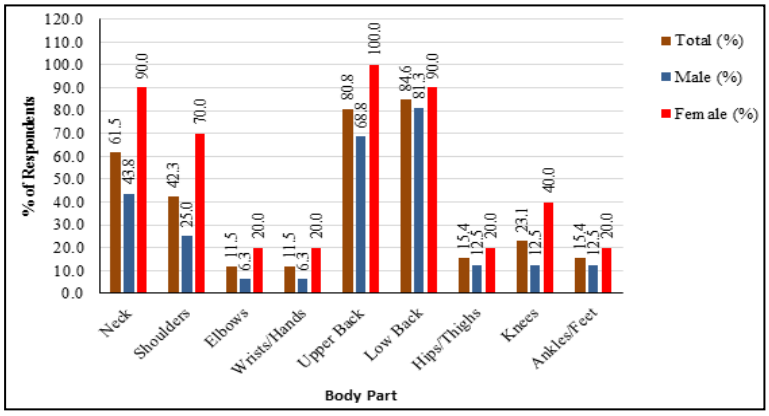

Figure 2. Percentage of NMQ Respondents with Body Part Trouble in Last 12 months

3.1.3. Reported Lower Back, Neck & Shoulder Trouble

There were additional results for lower back, neck and shoulder trouble which are related to accidents, work or leisure activities limitations, and treatment are constructed in Table 2. During the past 12 months, there were 5 of bus traffic controllers sought a professional for trouble regarding their neck, followed by 4 for lower back and 2 for shoulder trouble. Some of the bus traffic controllers claimed that they had to change their job or duty due to the trouble which there were 4 of them who had to change their duty due to lower back trouble and 2 due to neck trouble.

It was found that 22 out of 26 BTC suffered lower back trouble, 16 suffered neck trouble and 11 suffered shoulder trouble. In the last 12 months, most of the bus traffic controllers suffered lower back trouble for about 1 to 7 days followed by 15.38% for 8 to 30 days and 7.69% for more than 30 days of trouble. For neck trouble, the percentage was 46.15% for 1 to 7 days and 7.69% for both 8 to 30 days and more than 30 days. As for shoulder trouble, the percentage was 30.77%, 7.69% and 3.85% respectively. Those body parts trouble had negative effect on the bus traffic controllers work activity.

From the research, it was found that lower back symptom was severe enough to reduce bus traffic controllers' work activity and leisure activity during last 12 months with both at 26.9% followed by those who had neck trouble, 19.23% had to reduce work activity and 23.08% had to reduce their leisure activity. As for shoulder trouble, the percentage was 15.38% for both type of activity. Besides, 11.54% bus traffic controllers reported that they were prevented from work for 1 to 7 days while 3.85% of them were prevented from work for 8 to 30 days and more than 30 days due to lower back trouble. Furthermore, there were 7.69% bus traffic controllers prevented from work for 1 to 7 days, none for 8 to 30 days and 3.85% for more than 30 days due to neck trouble. Not to mention, there were also 3 bus traffic controllers prevented from work for 1 to 7 days due to shoulder trouble and only 1 for both 8 to 30 days and more than 30 days.

Similar to the result of Nordic Musculoskeletal Questionnaire for this study which found that 84.62% of BTC suffered lower back trouble, 61.54% suffered neck trouble and 42.31% suffered shoulder trouble, there were studies that reported high prevalence of MSDs among call centre workers. According to a study among call centre by neck pain, upper back pain and lower back pain were the top three ranked as highest prevalence during the last 12 months. Another study by Rocha et al (2005), reported that most of the call centre workers have high prevalence on neck symptom and shoulder symptom at 43.0% for both of the body region. The call centre workers were observed sitting daily for a prolonged length of time in their computer-based workstation performing several tasks such as key in the data using computer, letter writing, dealing with telephone and email enquiries which were similar to the task performed by bus traffic controllers (BTC).

Symptoms	Lower Back, % (n)	Neck, % (n)	Shoulder, % (n)
Any trouble ever	84.62 (22)	61.54 (16)	42.31 (11)
Ever had in accident	0 (0)	7.69 (2)	0 (0)
Change of job or duty	15.38 (4)	7.69 (2)	0 (0)
Total time with trouble last 12 months			
0 days	0 (0)	0 (0)	0 (0)
1-7 days	61.54 (16)	46.15 (12)	30.77 (8)
8-30 days	15.38 (4)	7.69 (2)	7.69 (2)
More than 30 days, but not every day	7.69 (2)	7.69 (2)	3.85 (1)
Every day	0 (0)	0 (0)	0 (0)
Reduce of Activity			
Reduce of work activity last 12 months	26.92 (7)	19.23 (5)	15.38 (4)
Reduce of leisure activity last 12 months	26.92 (7)	23.08 (6)	15.38 (4)
Total time prevented work last 12 months			
0 days	65.38 (17)	50.0(13)	23.08 (6)
1-7 days	11.54 (3)	7.69 (2)	11.54 (3)
8-30 days	3.85 (1)	0 (0)	3.85 (1)
More than 30 days	3.85 (1)	3.85 (1)	3.85 (1)
Sought a professional/Hospitalized	15.38 (4)	19.23 (5)	7.69 (2)
Trouble in last 7 days	42.31 (11)	34.62 (9)	34.62 (9)

Table 2. The Prevalence of Musculoskeletal Symptoms by Body Parts among Bus Traffic Controllers, (n=26)

Anatomical Region	Any trouble last 12 months, % (n)	Prevented from normal work, % (n)	Trouble last 7 days, % (n)
Upper Extremity			
Shoulders	42.31 (11)	19.24 (5)	34.62 (9)
Elbows	11.54 (3)	0 (0)	3.84 (1)
Hands/Wrists	11.54 (3)	0 (0)	7.69 (2)
Lower Extremity			
Hips/Thighs	15.38 (4)	0 (0)	0 (0)
Knees	23.08 (6)	3.84 (1)	3.84 (1)
Ankles/Feet	15.38 (4)	0 (0)	0 (0)
Axial Skeleton			
Neck	61.54 (16)	11.54 (3)	34.62 (9)
Upper back	80.77 (21)	15.38 (4)	42.31 (11)
Lower back	84.62 (22)	19.24 (5)	42.31 (11)

Table 3. 12-month prevalence of musculoskeletal symptoms and work interference by anatomical region

Besides having high prevalence of musculoskeletal symptoms which prevented them from doing their normal work, some of them had the musculoskeletal trouble in the last 7 days. For those having lower back symptom, 42.31% claimed to have the trouble during last 7 days. The percentage was the same for both who had neck and shoulder trouble as 34.62% reported to have the trouble during the last 7 days.

Referring to table 3, there were 3 anatomical regions which involved upper extremity, lower extremity and axial skeleton. For upper extremity, shoulders were the most affected region as there were 11 (42.31%) bus traffic controllers reported to have trouble. There were 3 (11.54%) of them who had trouble on their elbows and hands/wrists. For lower extremity, the most affected region were knees with percentage of respondent having the trouble was 23.08% followed by both hips/thighs and ankles/feet at 15.38%. Not to mention, the highest prevalence of musculoskeletal symptom among bus traffic controllers was the axial skeleton which involved lower back (84.62%). The results also showed that most of the bus traffic controllers were prevented from normal work due to shoulders(19.24%),

neck(11.54%), upper back (15.38%) and lower back (19.24%). It was also found that most of the bus traffic controllers had trouble at those four regions during last 7 days with percentage of 34.62% for shoulders and neck, and 42.31% for upper back and lower back.

3.2. Rapid Office Strain Assessment (ROSA)

3.2.1. Reported Lower Back, Neck & Shoulder Trouble

In order to assess the ergonomic risks that can lead to musculoskeletal disorders (MSDs) in working environment among bus traffic controllers Rapid Office Strain Assessment (ROSA) method was applied. ROSA was designed as a tool to identify and quantify the factors related to discomfort due to computer jobs. The assessment included sitting posture, work station which includes chair (chair height, pan depth, armrest and back support), computer (monitor, mouse and keyboard) and the usage of telephone. Besides, the working duration was also considered. All the bus traffic controllers work for 11 hours per day and had continuous work using computer for more than 4 hours per day.

Based on the results, it was found that most of the BTCs had appropriate or suitable chair height which their knees were at 90° (73.1%). There were also BTCs who had their knees too low (knee angle < 90°) and too high (knee angle> 90°) which the proportions were 23.1% and 3.8% respectively. For chair pan depth, 80.8% of the bus traffic controllers had approximately 3 inches of space between their knee and the edge of seat. Unfortunately, there were some of them having less than 3 inches of space (15.4%) and more than 3 inches of space (3.8%). In terms of design of work station, the chair used have non-adjustable pan (seat) at 100%.

Majority of the BTCs had relaxed shoulder during their working period which their elbows were supported in line with their shoulder (69.2%) and 30.8% of them were observed to be in inappropriate posture with their shoulder shrugged and arm's unsupported. Not to mention, the design of the chair that have non-adjustable armrests (100%) will increase the ergonomic risks which might lead to MSDs. There were 34.6% of BTCs who had good sitting posture with adequate lumbar support which their chair reclined between 95° to 110°. Besides, it was observed that most of the bus traffic controllers (65.4%) have a habit to lean forward (no back support) when using computer.

The bus traffic controllers sat in arm's length distance (45-75cm) from monitor with screen at eye level and only 3.8% had low monitor/screen which was below 30°. All of them had no holder for document which forces them to flex and twist their neck in order to view papers positioned on the desk. When dealing with calls or using telephone, most of the bus traffic controllers had one hand on phone and neutral neck posture (76.9%). Unfortunately, there were 11.5% of them who had a habit to hold the telephone using their neck and shoulder. Some had to reach to the telephone with greater distance than 30cm (23.1%) and there were 88.5% who had no hands-free option for their phone.

All of the bus traffic controllers used their computer mouse in line with their shoulder but 100% of them had their mouse and keyboard on different surfaces. Majority of BTCs observed to have relaxed shoulder and straight wrists when using keyboard (65.4%) but there were also 34.6% who used their keyboard on positive angle (>15°) which lead to wrist extension. Their bad working habit and the deficiency of the workstation design will increase the ergonomic risk level that will lead to MSDs.

3.2.2. Section A – Chair Score

Section A which was chair section consists of 4 smaller sub-sections involving chair height, seat pan depth, the position of armrest and the position of back support. Table 4 shows the score obtained for each risk factors for Section A.

3.2.3. Section B – Monitor & Telephone Score

Section B was a score section which involved monitor and telephone. In this section, the length and position of monitor for all workstation for each of the bus traffic controllers were assessed. The angle of neck twist, glare on screen and documents holder were also considered to be risk. As for telephone, the position of the telephone from the bus traffic controllers was measured and assessed. The posture of neck and shoulder when using the telephone was observed as an addition score for the risk factor.

Table 5 shows the score obtained for Section B. Mean score for monitor was 3.04 (SD = 0.20) and the score was 1.35 (SD = 0.85) for telephone. The final score for Section B was 2.31 (SD = 0.62).

Table 4. Section A Score for Office Chair (n = 26)

Risk Factors	Score	
	Mean	SD
Chair height	1.23	0.43
Pan depth	2.15	0.37
Armrest	2.31	0.47
Back support	1.65	0.49
Duration	1.00	0.00
Final Score	4.00	0.80

Table 5. Section B Score for Monitor & Telephone (n = 26)

Risk Factors	Score	
	Mean	SD
Monitor	3.04	0.20
Telephone	1.35	0.85
Final Score	2.31	0.62

3.2.4. Section C – Mouse & Keyboard Score

Section C involved the score for mouse and keyboard. It was a score section related to shoulder, hand and wrists postures of the bus traffic controllers while doing their work. The position of mouse and keyboard were assessed as it may lead to abducted postures of the shoulder, hand and wrists. During the assessment, it was found that all the workstation had mouse and keyboard placed on different surfaces. It was also observed that some of the bus traffic controllers used the keyboard with positive angle (>15°) which led to wrist extension. Table 6 shows the score for mouse and keyboard.

Table 6. Section C Score for Mouse and Keyboard (n=26)

Risk Factors	Score	
	Mean	SD
Mouse	4.00	0.00
Keyboard	2.35	0.49
Final Score	4.35	0.49

Table 7. ROSA Grand Score and Level of Action (n = 26)

Score	Score	
	Mean	SD
Section A	4.00	0.80
Section B	2.31	0.62
Section C	4.35	0.49
ROSA Grand Score	4.58	0.50

3.2.5. ROSA Grand Scores

Based on the analysed data, the risk level for the BTCs working in the computer-based bus control room was only at 2 risk levels which were medium and high. Majority of the bus traffic controllers was at high risk level of 57.7% which the mean score was 5.0 while the medium risk level was 42.3% with 4.0 mean score. The range for medium level was from 3 to 4 points but in this case study, all of the bus traffic controllers scored 4 point risk level with frequencies at 42.3%. Similar to high risk level, the bus traffic controllers only scored 5 point risk level at frequency of 57.7% although the range for high risk level was 5 to 7 point.

Table 7 shows the summarized results for each section which are chair section, monitor and telephone section and mouse and keyboard section. All the section's score were analysed in order to get ROSA Grand Score. As discussed in the subsection 4.3.2, 4.3.3 and 4.3.4, the final score for Section A, Section B and Section C were 4.00 (SD = 0.80), 2.31 (SD = 0.62) and 4.35 (SD = 0.49) respectively. The mean score for ROSA grand score for 26 bus traffic controllers was 4.58 (SD = 0.50). According to the assessment, more than half (15/26 respondents) of the bus traffic controllers

were found to have an extreme posture with the ergonomic risk level was high (5 to 7) (action level 3) which required a further investigation and changes of work habits soon. Not to mention, the rest of them (11/26 respondents) were at medium risk level with score from 3 to 4.

Similarly to this study, according to a study among call centre by Poochada & Chaiklieng (2015), neck pain (61.1%), upper back pain (55.7%) and lower back pain (53.1%) were the top three ranked as highest prevalence during the last 12 months. Another study reported that most of the call centre workers have a high prevalence on neck symptom and shoulder symptom at 43.0% for both of the body region [13]. Arvidsson et al (2008) [14] found that work-related musculoskeletal disorders (WRMSD) were frequently reported among computer operators and most of them focused on their neck and shoulder. The findings of previous studies found that MSDs among the call centre workers were related to the ergonomic factors which include personal working behaviours and the design of their workplace.

Based on ROSA, there were 3 sections of the assessment, Section A (Chair section), Section B (Monitor and Telephone) and Section C (Mouse and Keyboard) which related to the development of MSDs among bus traffic controllers. In this research, the ergonomics risk level was not very high. The assessment by using ROSA showed the final grand score for ergonomic risk level among bus traffic controllers was 4.58 (SD=0.50) which was considered as medium risk level. The reason might be that there was modern equipment used which can be adjusted to adapt to the individual in order to prevent MSDs [15] in the control room.

From the observation of the BTCs working posture related to the chair, it was found that most of the BTCs have a habit of leaning forward (no back support) when using the computer. Some of them also had their shoulders shrugged and their arms unsupported while working and had a habit of sitting in an awkward position with low (<90°) and high (>90°) knee angle. These behaviors along with static body positions and prolonged sitting will lead to MSDs such as back, shoulders, arms, elbows, wrists, legs and feet. In terms of workstation equipment and design, the non-adjustable pan depth and armrests of the chair will increase the risk level to MSDs.

From the assessment of the usage of monitor and telephone, it was observed that the deficiency of workstation design forced the BTCs to have non-neutral posture which then lead to symptoms of neck. Although the computer screens were designed to be at arm/s length distance (40-75cm) and at eye level, there was no document holder which forced the BTCs to flex and twist their neck in order to view papers positioned on the desk while using computer. Document holders to keep or hang printed materials such as papers are needed during tasks involving computers, and it must be placed close to the user and the monitor [17]. Previous studies proved that when using either a lateral or an in-line document location while working on a computer, needs both minimum neck movement and muscle activity than once they were placed on the desktop [16]. Besides, there were also telephones which placed too far to reach (outside 30cm) from the BTCs and did not have hands-free options which result in awkward postures of neck and shoulder when using telephone. Not to mention, prolonged conversation and the habit of bus traffic controllers to use the telephone by neck and shoulder hold (pinch) will increase the risk of having MSDs along their neck and shoulder.

Based on the observation on the usage of mouse and keyboard, the workstations were designed to have a mouse and keyboard on different surfaces. The keyboard was placed on the keyboard tray which was lower than the mouse located on the desk. This design will result in reaching for the mouse and the arms unsupported while using the mouse. Besides, some of the BTCs used their keyboard on a positive angle while typing (>15°) which forced to wrist extension. Working with the situation for a prolonged time and repetitive motion which forced the shoulder and arm to be in stress may lead to musculoskeletal disorders. Performing keying tasks with these awkward postures may lead to musculoskeletal disorders of the elbows, shoulders, hands, and wrists.

4. Conclusion

In a nutshell, the objectives of the research were successfully achieved, which the working posture of the bus traffic controllers was evaluated, the prevalence of musculoskeletal disorders (MSDs) and the

level of ergonomic risks among bus traffic controllers were determined. By using Nordic Musculoskeletal Questionnaire (NMQ), it was found that the highest prevalence of body part trouble in last 12 months for bus traffic controllers was low back (84.62%) while the least body part trouble elbows and wrists/hands which both was at 11.54%.

As for male bus traffic controllers, they had highest prevalence for low back injury which was at a rate of 81.3%. Female bus traffic controllers were more likely to get injury from their work activity as they had higher injury prevalence for all body parts compared to male bus traffic controllers. Their highest prevalence was upper back (100%) which suffered by all of the female bus traffic controllers.

From the research, it is proved that the use of computer has been identified as a risk related in developing work-related musculoskeletal disorders (WMSDs). The risk factors from using the computer include prolonged awkward posture of the shoulder, lower back, elbow, hands, wrists, head and neck affected the bus traffic controllers. The MSDs among the bus traffic controllers were related to the ergonomic factors which includes their personal working behaviours and the design of their workstation.

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