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Analysis of Factors Causing Musculoskeletal Disorders using Rula (Rapid Upper Limb Assessment) Method in Computer Operators

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Abstract

Musculoskeletal disorders are the most common health problem. There were 553,000 of Work Related Musculoskeletal Disorders (WRMSDs) in the United Kingdom. Darussalam University (UNIDA) has been recognized that some administrative computer operators had pain in the back and neck. WRMSDs generally occur in workers related to computers and peripheral devices. Twenty percent of computer users reported computer related injuries because of poor workplace design, facilities used, including chairs and tables. This study want to analyze factors associated with musculoskeletal disorders using RULA method.

This was a quantitative study. The sample size was 20 individuals, variable of musculoskeletal disorders (MSDs) was measured using Nordic Body Map (NBM) method and anthropometric variables of body size were measured using a bow and body posture measurement used RULA. Data processing was using crosstab and correlation coefficient (CC).

The result of CC between age (0.283), year of work (0.189), smoking (0.330) with musculoskeletal disorders was in low category. CC between work station anthropometry (0.418) and MSDs was in moderate category. The body posture using RULA method showed that all respondents were in action level 2, means that further investigation may be required and changes may be necessary. Most of the administrative computer operators complaints were MSDs of low level. Further studies are needed working station (seat), and working station design. The provision of ergonomic working chairs and desk

is necessary, as well as the need for education about the importance of reducing the frequency of smoking.

Keywords: Musculoskeletal Disorders, RULA, Computer Operators.

INTRODUCTION

Musculoskeletal disorder is the most common health problem in the United Kingdom. Prevalence of Work Related Musculoskeletal Disorders (WRMSDs) in year 2014/2015 was 553,000 out of a total of occupational diseases of 1.243 million. Estimates of lost work days caused by WRMSDs is 9.5 million and the average working days lost per case was 17.1 [1]. Work Related Musculoskeletal Disorders (WMSDs) commonly occurs in labor related to computers and peripheral devices. It was reported that 25% of computer users had computer related injuries. This is because of poor workplace design. In India, 76% of professional computer users reported various musculoskeletal disorders as demonstrated by various epidemiological studies [2].

Employment and static work attitude potentially accelerates the onset of fatigue and pain in muscles involved. If these conditions take place every day and for a long time (chronic) pain can cause permanent damage to the muscles, joints, tendons, ligaments and other tissues. In addition, working with pain can reduce the productivity and efficiency of work and when working with this pain is continued then it will result in a disability, which ultimately eliminates the job for the worker. There are more than a third of all working time lost (lost time injuries) because of this condition [3] . Musculoskeletal complaints are often also called MSDs (Musculoskeletal Disorder), RSI (Repetitive Strain Injuries), CTD (Cumulative Trauma Disorders), Work-related Musculoskeletal Disorders (WMSDs), and RMI (Repetitive Motion Injury).

Darussalam University (UNIDA) is a new university which was previously an institute of Islamic studies. Majority of UNIDA adminsitrative computer operatorss are workers who work every day with a computer. Work with a computer or a so-called visual display unit (VDU) is one job that creates risk muskuloskletal disorders (MSD's) [4]. Observational studies of some of the administrative computer operators revealed that some had experience of pain in back and neck. Unergonomic work station may cause danger or health risk (health hazard), for example, when the dimension of the seats is not ergonomic or not in accordance with the dimensions of the body of the computer operators, which can cause poor posture, discomfort, and fatigue [5] . Ergonomic workplace design is one form of adjustment means for humans, and if the design of the workplace is not in accordance with ergonomic principles, the workers would require extra exertion to carry out his work. The facilities used, including chairs and tables, can affect the posture of computer operators to become less ergonomic. Obviously there are other factors that trigger MSD's. It is therefore necessary to study the analysis of factors associated with musculoskeletal disorders in UNIDA Gontor administrative computer operators.

METHODS

This was a quantitative research using cross sectional design. Sampling technique used was total sampling with a sample size of 20 individuals. The independent variables in this study were the individual factors, age, smoking habits, working year, labor climate and worker facilities (workstation). The dependent variable was the Musculoskeletal Disorders (MSD's). Data collection was performed using interview sheets, questionnaires, observation sheets using RULA method, cameras, arc, stopwatch and scales. Data were analyzed descriptive and analitic using cross tabulation.

RESULTS AND DISCUSSION

Individual factors

Identification of respondents' body posture is seen in Table 1.

Table 1. Respondents' anthropometry and body posture

Measured body parts	Standing position (cm)			Measured body parts	Sitting position		
	Mean	Min	max		Mean	Min	Max
Arm reach	209.4	201	223	Shoulder width	42.7	38	49
Body height	165.5	158	173	Hip width	31.15	23	48
Shoulder height	135.7	129	143	Sitting height	86.55	81	93
Standing elbow height	104.5	100	112	Hip height	22.15	15	27
Hip height	95.75	90	102	Elbow height	26	20	31
Arm span	171	161	179	Knee height	49.45	31	57
Arm length	60.95	56	72	Kneefold height	53.9	50	58
Upper arm length	26.65	20	34	Buttock knee length	43.7	41	49
Lower arm length	44.55	42	47	-	-	-	-

The process of measuring and taking pictures of respondents' anthropometry (body postures) was conducted to determine the risk level of work using rapid upper limb assessment (RULA). The image was taken on each respondent and their place of work. In each process, photo taking was carried out more than once to acquire images to describe working conditions at the time. The conclusions of rapid upper limb assessment is presented in Table 2.

Table 2. Analysis of improvement based on RULA final score in the respondents

No	Respondent's name	Score of A table	Score of B table	Final Score	Improvement
1.	Mr. D	4	4	4	Changes necessary
2.	Mr. A	4	4	4	Changes necessary
3.	Mr. M	4	4	4	Changes necessary
4.	Mr. H	4	4	4	Changes necessary
5.	Mr. S	4	4	4	Changes necessary
6.	Mr. Y	4	4	4	Changes necessary
7.	Mr. M	4	4	4	Changes necessary
8.	Mr. M	4	4	4	Changes necessary
9.	Mr. M	4	4	4	Changes necessary
10.	Mr. T	4	4	4	Changes necessary
11.	Mr. J	4	4	4	Changes necessary
12.	Mr. A	4	4	4	Changes necessary
13.	Mr. R	4	4	4	Changes necessary
14.	Mr. S	4	4	4	Changes necessary
15.	Mr. Y	4	4	4	Changes necessary
16.	Mr. D	4	4	4	Changes necessary
17.	Mr. A	4	4	4	Changes necessary
18.	Mr. E	4	4	4	Changes necessary
19.	Mr. R	4	4	4	Changes necessary
20.	Mr. A	4	4	4	Changes necessary

After obtaining final scores that indicate the level of action, that is 4 for all respondents, the level of action was entered into level 2, which means that further investigation is needed and changes may be necessary for work attitude improvement This is presented in Table 3 [6].

Table 3. Level of action needed based on final scores

Level	RULA Action Level
1	Final score 1 or 2, the person is working in the best posture with no risk of injury from their work posture
2	Final score 3 or 4, The person is working in a posture that could present some risk of injury from their work posture, and this score most likely is the result of one part of the body being in a deviated and awkward position, so this should be investigated and corrected..
3	Final score 5 or 6, The person is working in a poor posture with a risk of injury from their work posture, and the reasons for this need to be investigated and changed in the near future to prevent an injury
4	Final score 7+, The person is working in the worst posture with an immediate risk of injury from their work posture, and the reasons for this need to be investigated and changed immediately to prevent an injury

Age, Smoking habit and Working periode

Description of age, smoking habits and working periode were descript in table 4.

Table 4. Description of age, smoking habits and working periode

Variables	Total	(%)
Age :		
< 23 years old	8	40
> 23 years old	12	60
Total	20	100
Smoking habits :		
Smoking	11	55
No smoking	9	45
Total	20	100
Working periode :		
< 1 year	13	65
> 1 year	7	35
Total	20	100

Tabel 4 shows that the administrastive computer operatorss aged ≥ 23 years were as many as 12 respondents. Administrative computer operatorss aged ≥ 23 years were 12 respondents. Most of the respondents have smoking habit (55%) and (45%) have no smoking habit. Most of the respondents have working years of ≤ 1 year (65%) and 7 respondents (35%) had working years of more than 1 year.

Working climate

Working climate or working environment examination (temperature of room AC) of the respondents, including the temperature in the respondents working room. Working environment climate examination was done in 3 different rooms (rector secretariat, BAAK, and D4 K3 program offices, BAUK and treasurer's office) and presented in Table 4.

Table 5. Working climate (room temperature) examination

AC Temperature of Respondent's Room	Frequency	Percentage
Meeting the NAB (28-32°C) (SNI 16-7061-2004 Regulation of the Minister of Labor and Transmigration, Republic of Indonesia No. 13 Tahun 2011)	5	100%
Does not meet NAB (>32°C)	0	0%
Total	**5**	**100%**

Table 5 shows that all respondents' rooms have room AC temperature in safe range according to NAB 28-32°C for moderate work load.

Workers Facility (Workstation) and Musculoskeletal disorder symptoms

Workstation in this study included the respondents' tables and chairs anthropometry. Anthropometric measurement process of the tables and chairs was performed by the laboratory worker and enumerators. Figure 6 shows anthropometric measurement results of respondents' working tables and chairs.

Table 6. Workers Facility (Workstation) and Musculoskeletal disorder symptoms

Variables	Total	(%)
Workers Facility		
Abnormal value	4	20
Normal value	16	80
Total	20	100
Musculoskeletal disorder symptoms		
Low	12	60
Moderate	7	35
High	1	5
Total	20	100

Figure 6 showed that there were 16 respondents (80%) whose tables and chairs work in accordance with normal value of work station anthropometry. Four respondents (20%) had other workstation anthropometry not in accordance with normal value. There were 12 (60%) respondents had complaints of low musculoskeletal disorders

(score 28-49). Respondents with moderate complaints (score 50-70) were 7 (35%), and those with high complaints (71-91) only 1 (5%). The most common complaints were felt in neck, shoulders, back and wrist.

Cross-tabulation between age and Musculoskeletal Disorders (MSD's)

Table 7. Cross-tabulation between age and Musculoskeletal Disorders

Age	Level of MSD's						Total	
	Low		Moderate		High			
	(f)	(%)	(f)	(%)	(f)	(%)	(f)	(%)
Age ≥ 23	8	66.7	4	33.3	0	0	12	100.0
Age < 23	4	50	3	37.5	1	12.5	8	100.0
Total	12	60	7	35	1	5.0	20	100.0
Correlation Coefficien= 0.283								

Table 7 showed that respondents in age group <23 (50%) have low complaint rates, 3 respondents (37.5%) had moderate complaint rate , and one respondent (12.5%) high complaint rate. The number of respondents with low complaint rate in the age group ≥23 years were as many as 8 respondents (66.7%) and moderate complaint rate was as many as four respondents (33.3%). There are respondents under age 23 years who have high rate of complaints. This may be because the workers were still adapting to the working culture at the university, but due to limited data, the exact cause could not be found. Based on the above table, the correlation coefficient was 0.283, which means that the strength of correlation between respondent's age and musculoskeletal disorders incidence was low.

Cross-tabulation between smoking habit and Musculoskeletal Disorders (MSD's)

Table 8. Cross-tabulation between smoking habit and Musculoskeletal Disorders (MSD's)

Smoking Habit	Level of MSDS						Total	
	Low		Moderate		High			
	(f)	(%)	(f)	(%)	(f)	(%)	(f)	(%)
No	7	77.8	2	22.2	0	0.00	9	100.0
Yes	5	45.5	5	45.5	1	9.1	11	100.0
Total	12	60.0	7	35.0	1	5.00	20	100.0
Correlation Coefficient = 0.330								

Table 8 shows that of the respondents with smoking habit, those with low musculoskeletal disorders complaint rates were 5 respondents (45.5%), moderate complaints rate were 5 respondents (45.5%) and high complaint rate 1 respondent (9.1%) , Respondents who did not have smoking habit also showed complaints ie, respondents with low complaint rate were 7 respondents (77.8%), and moderate complaint rate was 2 respondents (22.2%). There was one respondent who had a smoking habit with high complaint rates. This was because their smoking habit decreased muscle condition and had high work targets. However, because of data limitations, the exact cause could not be identified. Based on the above table, the correlation coefficient was found to be 0.330, which means that the strength of correlation between the incidence of smoking history and musculoskeletal disorders was low.

Cross-tabulation between working years and Musculoskeletal Disorders (MSD's)

Table 9. Cross-tabulation between working periode and Musculoskeletal Disorders (MSD's)

Working Periode	**Level of MSDS**						**Total**	
	Low		**Moderate**		**High**			
	(f)	(%)	(f)	(%)	(f)	(%)	(f)	(%)
< 1 Year	8	61.5	4	30.8	1	7.7	13	100.0
> 1 Year	4	57.1	3	42.9	0	0	7	100.0
Total	12	60.0	7	35.0	1	5.0	20	100.0
Correlation Coefficient = 0.189								

Table 9 shows that there are 8 respondents (61.5%) with working year less than 1 year who have low rate of musculoskeletal disorder complaints, those with moderate complaint rate were four respondents (30.8%), and higher complaint was one respondent (7.7%). Respondents with working periode of more than 1 year who have low complaint rates of musculoskeletal disorders were 4 respondents (57.1%) and those with moderate complaint rate were 3 respondents (42.9%). Based on the table, the correlation coefficient was found to be 0.189, which means that the correlation between working years of the respondents and the incidence of musculoskeletal disorders is low.

Cross-tabulation between Working Environment (Romm Temperature) and MSD's

Air condition in the workplace, a combination of temperature, humidity, wind speed, and temperature of radiation, called as working climate, whose influence on MSD's was identified, can be seen in Table 8 and 9.

Table 10. Cross-tabulation between Working Environment (Room Temperature) and MSD's

Room Temperature	**Level of MSD's**						**Total**	
	Low		**Moderate**		**High**			
	(f)	(%)	(f)	(%)	(f)	(%)	(f)	(%)
>NAB	0	0	0	0	0	0	0	0
<NAB	12	60	7	35	1	5	20	100
Total	12	60	7	35	1	5	20	100

Table 10 shows that the room temperature of the respondents' workplace was all under the NAB. NAB of room temperature is between 28-32 degree C for moderate workloads. The level of the working climate risks is described in Table 11.

Table 11. Cross-tabulation between working climate (risk level) and MSD's

Risk Level	**Level of MSDS**						**Total**	
	Low		**Moderate**		**High**			
	(f)	(%)	(f)	(%)	(f)	(%)	(f)	(%)
Level 1	0	0	0	0	0	0	0	0
Level 2	12	60	7	35	1	5	20	100.0
Level 3	0	0	0	0	0	0	0	0
Total	12	60	7	35	1	5	20	100.0

Table 11 shows that all respondents belong to risk level 2. Level action 2 indicates the need of further investigation and change for a better working position.

Cross-tabulation of workstation anthropometry and MSD's

Workers' facility is explained based on anthropometric size of chairs dan tables used by the respondents.

Table 12. Cross-tabulation of workstation anthropometry and MSD's

Workstation Anthropometry	**Level of MSDS**						**Total**	
	Low		**Moderate**		**High**			
	(f)	(%)	(f)	(%)	(f)	(%)	(f)	(%)
accordance with body anthropo metry	10	62.5	6	37.5	0	0	16	100
Not accordance with body anthropometry	2	50	1	25	1	25	4	100
Total	12	60	7	35	1	5	20	100
Correlation Coefficient = 0.418								

Table 12 shows that the respondents with workstation anthropometry in line with normal value, those with low MSD's complaint rate were 10 respondents (62.5%), and those with moderate complaint rate were 6 (37.5%). From respondents with workstation anthropometry not in line with normal value, those with low MSD's complaint rate were 2 respondents (50%), those with moderate complaint rate were only 1 (25%), and those with high complaint rate was also 1 (25%). The correlation coefficient was 0.418, indicating moderate correlation between respodents' workstation and the incidence of MSD's.

DISCUSSION

Anthropometry and Body Posture Analysis of Administrative Computer operators

Rapid Upper Limb Assessment (RULA) method was used to analyze the anthropometric (body postures) of the respondents. This method was developed by the ergonomics of Nottingham's Institute of Occupational Ergonomics England. This method observes upper body segment and then translated in the form of scores that aims to determine appropriate improvement suggestions [6] . The entire observed administrative computer operators teachers performed jobs that were not different. The anthropometry (body postures) and work stations (chairs and tables) have no significant difference. All administrative computer operatorss operated computer in a slightly bent body position during observing the monitor, head straight and sometimes slightly bent, feet trample and hands typing and holding the mouse. The basic principle of RULA is measuring base angle formed by the body with a specific point on the body posture to be assessed [6].

After the assessment of work postures, all administrative computer operatorss had a total score of 4. RULA method divides grand scores into the action level (action level) performed as a guideline after assessment. [6] states that if the grand score is 4, the action level will be 2, which means that further investigation is needed and changes may be needed to correct work attitude. A study by David [7] found that the use of ergonomic risk factors exposure assessment method depends on research objectives. The results of the ergonomics assessment using RULA can be used as consideration to determine appropriate interventions to address the complaints of the workers [8] . These complaints, however, were determined using another method, the Nordic Body Map one of tools to assessing musculoiskeletal disorders, which was filled by the respondents themselves [9].

Anthropometric analysis of workstation

Work stations (tables and chairs) used by administrative computer operatorss are some of the risk factors measured by the laboratory computer operatorss and enumerators. The design of work stations is ideally be adjusted to principal roles and

functions of working system components involved, ie. man, machine or equipment, and working physical environment. The role of humans in this regard is based on the capabilities and limitations, particularly with regard to observation, cognitive, physical or psychological aspects. Likewise, the role or function of the machine or equipment should be part of human support in performing specified duties. Machinery or equipment also works to improve human ability, not to cause additional stress due to work load and to help carrying out specific work, which is above the capacity or ability of human beings. Furthermore, the role and function of working physical environment is related to the effort to create working conditions that guarantee human and machines to function in full capacity. In regard to physical environment of work, work system planners even often put more attention to the machinery or equipment to be protected than to the interest of the human workers [10].

The results showed that 80% of workstations used by administrative computer operatorss were in accordance with their anthropometry. While 20% of workstations did not correspond to the body anthropometry of those computer operatorss. Research by Vinaya et al. (2014) found that the station not in accordance with the body anthropometry of the respondents would result in reduced productivity and raises musculosceletal disorders.

Analysis of respondent's working environment

Work environment (room temperature) will affect the administrative computer operatorss' work performance, and even may lead to musculoskeletal disorders. Men will be able to carry out its activities properly if supported by a good working environment. A good working environment needs to pay attention to several aspects: lighting, noise, temperature, ventilation, vibration, radiation, humidity, odor, and color [11] . Basically, the design of working environment is aimed at creating working conditions that are effective, convenient, safe, healthy and efficient for workers. The results showed that all rooms had work environment in accordance with the threshold value. Based on these results it was found that the educational computer operatorss' working environment was in good condition. However, the workplace and administrative computer operators chairs could not be set according to their needs and a part of the rooms had no AC.

The physical environment of work is part of the overall environment, which is one of 14 principles of environmental science [12] . The tenth principle states that "In a stable environment, ratio between biomass and productivity (B/P) in the course of time will rise to an asymptote". In this principle it can be interpreted that the biological system undergoes evolution that leads to increased efficiency of energy used in the physical environment that enables diversity to grow. Therefore, the physical environment, if not controlled may exceed the threshold value, and may be the cause of environmental pollution. If this occurs in a factory environment, offices, and others, it will give negative impacts on the work ability of the employees or workers.

Analysis of Musculoskeletal Disorders in Administrative Computer operatorss, UNIDA, Gontor

According [10] musculoskeletal disorder is a symptom in the part of the skeletal muscles felt by a person, ranging from very mild to very painful complaints. When a muscle receives static load repeatedly and for a long time, it may cause a symptom of damage of the joints, ligaments, and tendons. Skeletal muscle complaints generally occur due to excessive muscle contraction as a result of the provision of too heavy workload with long loading duration. Conversely, muscle complaints may not occur when muscle contraction ranges only between 15-20% of maximum muscle strength. However, if the muscle contraction exceeds 20%, blood circulation to the muscles is reduced according to the degree of contraction which is influenced by the amount of force necessary. Decreased oxygen supply to the muscles, carbohydrate metabolism, and consequently inhibited accumulation of lactic acid finally causes muscle pain. A study on the construction workers showed that the body part that gets the most impact is the lower back, then neck, knee and shoulder [13].

[14] says that pain is the first signal that the tendon begins to feel ill and has to rest and recover. An injury can be a long and sometimes irreversible. The faster a person recognize the symptoms, the sooner they have to respond, so that musculoskeletal disorder can be overcome. The symptoms consist of a burning sensation in hand, reduced grip strength in hands, swelling or stiffness of the joints, pain in wrists, forearms, elbows, neck, or back followed with discomfort, reduced range of motion in the shoulder, neck or back pain, itching, dry, pain in eyes and cramps. Whereas, according to [15], early signs of musculoskeletal disorder is swelling , numbness, tingling, aching, and burning pain. These symptoms can take place gradually from mild to severe.

Based on the results of nordic body map questionnaires by 20 administraitive computer operators, the majority of operators (60%) had low rate of musculoskeletal disorders, but there were employees with moderate and high rate of complaints. Research by [16] found that musculoskeletal disorders related to employee's unergonomic work attitude. Complaints felt by respondents were musculoskeletal disorders. These complaints often felt during and after the respondent completed their work. Similar finding was also delivered by [17] who states that the respondents who work with working attitude of sitting in a long time mostly had pain.

Correlation between age and Musculoskeletal Disorders

The prevalence of musculoskeletal disorders increases when an individual starts to go to work. Increasing age is associated with decreased physical capacity. Increasing age will be followed by the decrease of maximum oxygen volume (VO2)max, which will reduce working capacity. Backache or musculoskeletal disorders begin to be suffered by workers at working age and the first episode of recurrence is usually felt at the age of 35 years [18] . This causes natural biological changes. In midlife, muscular strength and endurance begin to decline because of the aging process. In this study age is

categorized into two categories: <23 and ≥23 years. Table 3 shows that the operator who had age of more than or equal to 23 years had more musculoskeletal disorders, that supports the study findings of [19] and [20]. Workers aged less than 23 years had less musculoskeletal disorders, but had the same risk of the disorders, as they do the types of work that is almost the same.

Correlation between Working Years and Musculoskeletal Disorders

Work years is a factor related to the length of a person working in a workplace or company. In this relation, musculoskeletal disorders is a chronic disease that requires long time to develop and manifest. So, the longer the time of work, or the longer a person exposed to risk factors of musculoskeletal disorders, the higher the risk of developing the disorders [21]. Results showed that workers who worked for less than one year had more complaints of musculoskeletal disorders compared with those worked for more than one year. This result was slightly different from that of the study [22] which found that a person who worked for more than 5 years had increased risk of back pain, compared to those working with less than 5 years of exposure. This is because the workers who work with the computer are in a static position in a long term with recurrent activity, poor working posture, and poor seat design [2]. It may cause spinal loading in a long time, resulting in permanently narrowed disc cavity and also lead to spine degeneration that will cause chronic lower back pain.

Correlation between smoking habit and Musculoskeletal Disorders

Previous studies has confirmed that the increase of musculoskeletal disorders related to the length and level of smoking habits. The higher the frequency of smoking and the longer a person smokes, the higher the perceived level of muscle complaints. Several studies have observed that relationship and explained that onset mechanism of muscular complaints, starting from nicotine that causes reduced blood flow to tissue, until cigarette contents that cause the reduction of spinal mineral content and cause microfractures [22] . In addition, the link between smoking and lumbar muscle disorder is actually related to a person's physical health because smoking will reduce lung capacity, so the ability to consume oxygen is decreased and consequently the level of body fitness also decreases. The results of this study showed that the operators who had smoking habit had more musculoskeletal disorders compared to operators who did not have smoking habit. This underscores a study revealing that nicotine in cigarettes will increase plasma epinephrine that can cause insomnia and loss of mineral content in bones, causing pain due to the occurrence of cracks or damage to the bone [23].

Correlation between body anthropometry (RULA risk level) and Musculoskeletal Disorders

This method can be used to assess the activities of workers who use much the upper limb, especially workers who sit or stand without much movement. Examples of activities suitable in using RULA are activities that use computers, manufacturing and cashier activity [24] . RULA measurement method is done by direct observation of the worker or the operator while working for some of the duty cycle to select the task and the posture for measurement. This tool incorporates a single score as an illustration of a job, which describes expected rating of posture, force or load and the movement is expected. Poor sitting posture operator identified as one of the independent determinant cause of the MSDS [25].

Risk is the result of the calculation into a score from 1 (low) to 7 (high). The score classifies four levels of movement or action and becomes an indication of the time frame feasible to expect the risk control that will be provided. Based on the measurement results, it has been found that all respondents have level of action 2. Level of action 2 indicates further investigation and changes in working attitude improvement are needed. Results of the study did not show cross tabulation analysis and strength of relationship analysis because all data on level of action showed similar results, the level of action 2.

Correlation between work stations and Musculoskeletal Disorders

Work stations (tables and chairs), which are not in accordance with the physical condition of the workers, can lead to discomfort, which ultimately can reduce the effectiveness and efficiency of work. If the size of the work stations are not adapted to the size and physical condition of the workers, it can result in the body's stress in a certain time period. The body stress, among others, can be uncomfort, fatigue, pain, dizziness and others [26] . Feelings of pain, aching, tingling, stiffness and excessive fatigue are the early symptoms of musculoskeletal disorders [27]. The research result shows that the majority of musculoskeletal disorders experienced by workers who have a work station (seat) in accordance with the operator's body container cranes. A study by [27] showed that workers with unergonomic (awkward) working position will experience pain in certain body parts. The results showed that operators have been working with appropriate work station, but the majority of workers have musculoskeletal disorders due to unergonomic working position.

Correlation between working environment and Musculoskeletal Disorders

Workers exposed to cold temperatures or excessive heat may have reduced agility, sensitivity and strength, so that their movement becomes slow and difficult, and having decreased muscle strength. Too high differences between environmental temperature and body temperature causes most of the energy in the body be utilized by the body to adapt to the environment. If this is not offset by sufficient energy supply, there will be a shortage of energy supply to the muscles. As a result, blood

circulation will be slowed down, decreasing the supply of oxygen to the muscles, carbohydrate metabolism is inhibited and lactic acid accumulates resulting in muscle soreness [28]. The results showed that the temperature of the entire rooms examined were below threshold value (NAB). This condition actually favored the work performed by the workers. Results of the study did not show cross tabulation analysis and strength of correlation analysis because all data on temperature in the rooms showed similar results, is below NAB.

CONCLUSION

a. The age of the administrative computer operatorss is mostly ≥23 years, majority has the working years of less than 1 year and most have the habit of cigarette smoking.

b. Anthropometric analysis of body posture of the administrative computer operatorss are in action level 2, indicating that it requires further investigation and may be changes.

c. Most of the work stations used by the administrative computer operatorss are in accordance with body anthropometry.

d. The entire rooms have working climate in accordance to the threshold value (28-32 degrees C).

e. Most of the administrative computer operatorss have MSD's at low level.

f. Correlation coefficient between age, working years, and smoking habit and MSD's is low. Whereas, the strength of the relationship between work station anthropometry and musculoskeletal disorders is the moderate category (0.418).

SUGGESTIONS

Advice can be given based on the results of this study are as follows:

a. Further research is needed on the work station (seat) in regard with the design of the work station.

b. Universities need to provide chairs with height corresponds to the table's height to fit the body size of the administrative computer operatorss.

c. Replacement of work stations (seats) with new, more ergonomic ones.

d. Providing directives to the administrative computer operatorss to reduce smoking and to provide education about the dangers of smoking.

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