ORIGINAL ARTICLE

ASSOCIATION BETWEEN ERGONOMIC RISK FACTORS AND MUSCULOSKELETAL DISCOMFORT AMONG THE HOSTEL'S RESIDENCE OF UNIVERSITY PUTRA MALAYSIA

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ABSTRACT

Numerous studies are conducted to study the ergonomics risk factors among schoolchildren and office workers. No study had been conducted yet on the ergonomic risk factors for university students in Malaysia. The aim of this study was to investigate the risk factors associated with musculoskeletal discomfort among the university students. This is a cross-sectional study. The respondents were selected using a simple random sampling method. Musculoskeletal discomfort (MSD) was recorded using MSD Questionnaire. Rapid Upper Limb Assessment (RULA) was used to assess awkward posture of student's torso namely bending forward movement, leaning, sitting and twisting. Rapid Office Strain Assessment (ROSA) was used to quantify risk associated with the work station of the students with computer related activities. Anthropometric measurement which consist of weight and sitting measurement of a respondents using anthropometry set to measure the possible mismatch between the body dimension of the students and furniture dimension. Four possible mismatch that measured were popliteal height and seat height; buttock-popliteal length and seat depth; knee height and table clearance; and elbow rest height and table height. Results showed that the prevalence of discomfort among the students was 76.7%. Results of Chi Square test showed that there was no association between discomfort and demographic factors for gender, age, BMI and ethnicity. There was no association between discomfort and ergonomic factors including ROSA (x^2 = 2.635, p-value = 0.105), RULA (x^2 = 4.634, p-value = 0.099), MSD complain (x^2 = 0.032, p-value = 0.857) and mismatch (x^2 = 0.332 p-value = 0.564). The prevalence of discomfort was high among the students. Therefore, a recommended chair dimension was recommend for the use in hostels to avoid the increasing of risks among the students.

Keywords: *musculoskeletal discomfort (MSD), rapid upper limb assessment (RULA), rapid office strain assessment (ROSA), mismatch*

INTRODUCTION

Musculoskeletal disorders are injuries and disorders that affect the human body's movement or musculoskeletal system, which include bones, nerves, tendons, ligament, joints, cartilage, blood vessels and spinal discs. While musculoskeletal discomfort (MSD) includes musculoskeletal aches and pains which are self-assessed[5]. MSD also are the precursor to clinically defined health events[5]. Since there is no specific definition for MSD, so the MSD define musculoskeletal aches, pains and discomfort that affecting an identified body site[16].

In work-related MSD, many physical and physiological factors are related to the musculoskeletal discomfort. The factors are prolonged static posture, repetitive task, prolonged periods of exposure to a given task, job satisfaction, stress and organizational structure. However, the risk factors that influence the prevalence of MSD among students are student posture, anthropometrics and furniture, computer use and vision[4]. This is a review article which discuss about multiple factors affecting postures, comfort and health in classroom environments. The incidence of musculoskeletal discomfort increase with the muscular strain. Besides, the static muscular effort can also cause short term lumbar and dorsal pain[19]. Extensive exposure to risk factors of musculoskeletal discomfort can lead to musculoskeletal disorder[4].Sociodemographic factors like gender and ethnicity are also related to the musculoskeletal discomfort. Sex differences can be seen from the variation of body proportions and variation in strength. Generally, the lengths of upper and lower limbs are greater in men while the length of buttock-knee are greater in women[14]. In variation of strength, women strength is said to be two-thirds as strong as men with average value of F/M ratio is 61%[4]. Ethnic group is a population of peoples that inhabit a specified geographical distribution and have certain physical characteristics in common. One product may not be suitable for different ethnic groups due to difference in anthropometrics differences among them[14]. Thus, the variation of body portion of a person may lead to mismatch of furniture dimension and body dimension. The problems of musculoskeletal discomfort or disorder is a common case among school students and workers

either in the office or industrial fields. The study related to musculoskeletal discomfort among university student at hostels in the university in Malaysia is not yet conducted. The study furniture available at hostels in the university has a potential of being in the research. This is due to the emerging issues related to health that need to be explored.

Besides, this study aim to determine the possible mismatch of the body dimension of subjects and furniture dimension used in the hostels. If the percentage of mismatch is high among the subjects, the data obtain from this study can be used to redesign the furniture so as to conform to the student's physiological measurement.

According to previous study, fitting execution of classroom ergonomics may be required to those upkeep for beneficial health, enhance academic performance, learning and motivation[11]. Ill-fitted and improper design to the body dimension of the students can result in quicker fatigue, faulty posture and the station of obsessive states which might influence their performance in studying[11]. Students spend a lot of time at their room after the classes at the faculty finished. They spend hours doing their assignments using a computer and studying. This prolonged seating postures can make them susceptible to have musculoskeletal discomfort from a bad design of study furniture.

Many research that had been done concluded that the awkward postures and mismatch of body dimension to the furniture dimension were the factors that contribute to the development of musculoskeletal discomfort (MSD) among workers and school children. This can also be concluded to the group of young adults especially university students. Therefore, this study was aim to determine the prevalence of MSD, prevalence of MSD complaints, mismatch and posture scores.

METHODOLOGY

Subject recruiting and selection

A cross sectional study was conducted at the hostel of a local university. Respondents were randomly selected among males and females students who stayed at the hostel. A total of 120 respondents were involved in this study. The selection of the respondents were based on specific criteria such as both male and female students,

Furniture Measurement

The dimensions of the chair and table were measured. The chair dimensions that had been measured are:

undergraduate students and age around 19 to 26 years old. The sampling frame was a list number of students which obtained from Bahagian Hal Ehwal Pelajar of UPM.

Questionnaire

A set of questionnaire namely Musculoskeletal Discomfort (MSD) Questionnaire was used in this study. It consists of three parts. Part A was used to determine the respondent's background such as age, gender, ethnic and BMI. Part B was used to obtain information on the musculoskeletal discomfort experienced by the students when using the study furniture provided at the hostel. Part C was used to obtain the MSD complaint of the students. This part was adopted from Body Part Discomfort (BPD) Scale[3]. This part contained a diagram of 9 body parts which are neck, shoulder, upper arms, lower arms, wrist/hands, upper back, lower back, hips/buttocks and tight that assist the respondents to answer the questions for correct body parts.

Anthropometric Measurement

Seven anthropometric dimensions identified were measured using the measuring equipment such as anthropometry set, metal tape and weighing scale.

a. Height measurement
b. Weight measurement
c. sitting measurement

1. Shoulder height
2. Elbow-rest height
3. Buttock-popliteal Length
4. Popliteal height
5. Knee height

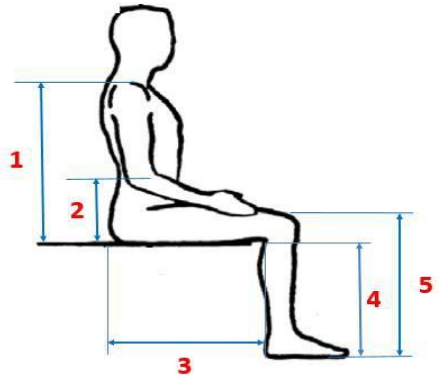

Figure 1: The measurement taken for body dimension.

1. Seat height — Distance from the highest point of the seat to the floor
2. Seat depth — Back of the sitting surface of the seat to its front

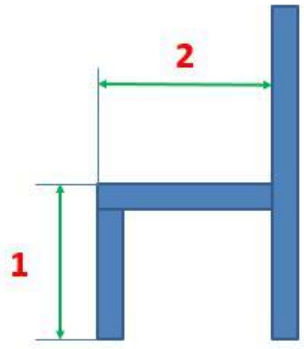

Figure 2: The measurement taken for seat dimension.

The table dimensions that were measured are:

1. Desk height — From the floor to the front edge of the desk
2. Desk clearance — From the floor to the front edge of the shelf under the writing surface

In order to determine incompatibility of the body dimension of subjects and furniture dimension, four rules were determined:

1) Popliteal height and seat height mismatch: Seat height that is either >95% or <88% of the popliteal height[2].
2) Buttock-popliteal length and seat depth mismatch:
Seat depth is either >95% or <80% of the buttock-popliteal height[12].
3) Knee height and table clearance mismatch: Occurring when the table is <2cm higher than the knee height[8].
A = Desk clearance – Knee height
4) Elbow rest height and table height mismatch:
Elbow rest height and table height mismatch occurred when the desk height was either shorter than minimum desk height or taller than the maximum desk height calculated from the formula.

Acceptable desk height equation[13] is determine by the equation:

$$hE = hEv + \mu [(1 - \cos \theta) + \cos \theta (1 - \cos \beta)$$

where,
hE = vertical distance from the top of the desk to the student's sitting surface
hS = shoulder height
hEv = elbow height
U = hS – hEv = upper arm length shoulder flexion

Rapid Office Strain Assessment (ROSA)

ROSA[17] was a picture based posture checklist which designed to quantify exposure to risk factors. ROSA method has been developed by Sonne. ROSA was used to analyze the awkward posture of the students in sitting position. Scores of greater than 5 are deemed to be "high risk" and the workstation should be assessed further.

Rapid Upper Lim Assessment (RULA)

RULA[3] was used to evaluate the awkward posture of the respondents while using the study furniture at their hostel. RULA was develop by McAtamney and Corlett. Observations that had been conducted were expressed in numeric scores which then recorded in RULA form. The final scores for RULA was determined through the matrix of scoring. The score was classified into one of four categories which are posture is acceptable, further investigation is needed and change may be required, investigation and changes are required soon and investigation and changes are required immediately.

Statistical Analysis

Statistical Package for Social Science (SPSS) version 22.0 was used for data analysis. Descriptive analysis was performed for sociodemographic of respondents, number of mismatch case, prevalence of musculoskeletal discomfort and prevalence of body parts complaints. Chi square test was performed for ergonomics risk factors and sociodemographic background with musculoskeletal discomfort.

Ethical Issues

This study obtained an approval from University Ethics Committee for researches involving human of University Putra Malaysia. Reference item of Ethical Approval was UPM/TNCPI/RMC/1.4.18.1 (JKEUPM)/F2. Permission from college management to conduct this study was obtained. Permission from respondents that who took part in this study were obtained from written consents of the respondents before the data collection process was conducted. Besides, the privacy of information and confidential of the respondents were protected.

RESULTS AND DISCUSSION

Questionnaire Analysis

MSD Questionnaire was used to determine the sociodemographic background, MSD complaints and musculoskeletal discomfort experienced by the university students. Table 1 illustrated the demographic background of the respondents. The total number of students that involved in this study were 120 people with 33 male and 87 female students. The age ranged between 20 to 26 years old with the mean age of 22.41 ± 1.260. Nearly

70% of the respondents are having a normal BMI. Majority of the respondents were Malay with 84.2% and only a few of them were India, Chinese and others.

Table 1 : Demographic information of the students. (N=120)

Variable	Frequency	Percentage (%)	Mean ± S.D
Gender			
Male	33	27.5	
Female	87	72.5	
Age			
≤ 23	60	50	22.41 ± 1.260
≥ 24	60	50	
BMI			
Normal	84	70	
Abnormal	36	30	
Ethnicity			
Malay	101	84.2	
India	6	5	
Chinese	5	4.2	
Others	8	6.7	

More than 95.8% of the students complained that they are suffer from body aches while using the study furniture provided at their hostel. From Table 2, among all the 9 body parts that being asked, shoulders, lower back, hips/buttocks and neck having as the most pain areas. A study from a researcher, suggested that the fixed postures and prolonged seating are the risk factors for the development of low back pain[15]. The overall complaint received was more than the number of respondents, this means that there are certain respondents that have more than one parts of their body experienced discomfort. This study showed a high prevalence of musculoskeletal discomfort among the students (76.7%). The data for the prevalence of musculoskeletal discomfort was in Table 3. The prevalence of musculoskeletal symptoms among undergraduate students was 52.8%[7].

Prolong seating may cause discomfort for the students like muscle fatigue, soreness, numbness and feeling pain. The main reason for increase in general discomfort in seated position was discomfort from lumbar region[19]. Low back pain cases are rare among young people[10].

Table 2: The prevalence of body parts complaints among the respondents.

Body Parts	Frequency	Percentage (%)
Head/neck	94	78.3
Shoulders	103	85.8
Upper Arms	63	52.5
Lower Arms	59	49.2
Wrist/hands	72	60
Upper Back	89	74.2
Lower Back	99	82.5
Hips/buttocks	96	78.3
Tight	62	51.7
Overall Complaint	**737**	

Table 3: Prevalence of discomfort among the students.

Variable	Frequency	Percentage (%)
Discomfort with Sitting on the Chair		
Yes	93	77.5
No	27	22.5
Discomfort with Height of the Chair		
Yes	80	66.7
No	40	33.3
Discomfort with the Length of Seat Pan		
Yes	80	66.7
No	40	33.3
Discomfort with the Angle of Back Support		
Yes	90	75
No	30	25
Discomfort with the Level of Monitor		
Yes	70	58.3
No	50	41.7
Discomfort with the Position of Keyboard and Mouse		
Yes	83	69.2
No	37	30.8
Overall Discomfort	92	76.7

Mismatch between Student Body Dimension and Study Furniture

The anthropometric data of the respondents are presented in Table 4. The mean, standard deviation, minimum, maximum and 5^{th}, 50^{th}, and 95^{th} percentile was presented in that table. These data were used to determine the design dimensions of the recommended chair. The data of elbow height, shoulder height, knee height, popliteal height and buttock-popliteal height were used to calculate the possible mismatch between body dimension and the furniture dimension.

Table 4 : Summary of anthropometric dimension among the respondents. (n= 120)

Anthropometric Dimension	Mean	SD	Min	Max	5th percentile	50th percentile	95th percentile
Age (years)	22.41	1.260	20	26	20	23	24
Elbow Height (cm)	22.59	2.559	15.00	31.00	18.00	23	26
Shoulder Height (cm)	58.38	3.476	50.00	67.00	53.00	58	64
Knee Height (cm)	50.08	2.917	44	58	45	50	57
Popliteal Height (cm)	42.33	2.381	34	49	39	42	47
Buttock-popliteal Height (cm)	45.07	3.392	37	56	40	45	51.95

As illustrated in Table 5, the prevalence of overall mismatch between anthropometry measurement of the respondents and the furniture dimension was 95%. From this, it can be concluded that the furniture provided at the hostels was not match with the student's anthropometry dimension. From this study, popliteal height and seat height mismatch was the highest mismatch cases (94.2%). It is reported that popliteal height was the important design factor for seat height[4]. A total of 93.75% of the respondents complained of neck, shoulder, upper and lower back pain that they attributed to the furniture they utilized[6].

Table 5: Mismatch between anthropometry measurements of the respondents and the furniture.

Variable	Frequency	Percentage (%)
Mismatch		
Knee Height and Table Clearance Mismatch		
Yes	0	0
No	120	100
Buttock-popliteal and Seat Depth Mismatch		
Yes	23	19.2
No	97	80.8
Popliteal Height and Seat Height Mismatch		
Yes	113	94.2
No	7	5.8
Elbow Rest Height and Table Height Mismatch		
Yes	0	0
No	120	100
Overall Mismatch	**114**	**95**

Association between Ergonomic Risk Factors and Musculoskeletal Discomfort

From Table 5, it showed that the ergonomics risk factors for ROSA, RULA, MSD complaint and mismatch were not shown to be significantly associated to the overall musculoskeletal discomfort of the respondents.

Association between Rapid Office Strain Assessment (ROSA) and Musculoskeletal Discomfort

ROSA was used to quantify the risks associated with work station of the students with computer related activities. ROSA final scores were ranged from 1 to 10, it was then transformed into two level which are high risk and low risk. Students do have a lot of assignment that needs them to use computer. Computer use have a potential risk for development of musculoskeletal disorder through the hands and wrist, head and neck, shoulder, elbow and lower back. From this study, there was no significant association between ROSA and musculoskeletal discomfort among the respondents (x^2 = 2.635, p-value = 0.105). However, a study been reported that number of students that needs treatment for musculoskeletal injuries and discomfort associated with computer use was increasing. Chair design was emphasized in ROSA where the pan depth, chair height, back support and armrest were needed to be scored. According to Oxford, the ill-fitted furniture will impact the students, such as when they sit on chair that are too low, there is a probability for them to slouch and adopt a bad posture[4]. Also if the chairs are too high, they tend to perch to the front of the seat, thus they will not lean back to the back support.

Association between Rapid Upper Limb Assessment (RULA) and Musculoskeletal Discomfort

RULA was conducted through an observation of the student's posture while doing their work using the study furniture. These techniques were used to assess postural health of the students as they tend to sit in a long period of time and perform an awkward postures. The outcome for this study, there was no significant association between musculoskeletal discomfort and RULA score (x^2 =4.634, p-value= 0.099). Poor sitting habits were statistically associated to low back pain. It also reported that, a lot of adult who suffered low back pain had their first onset of back pain in their 20s[10].

Association between Mismatch and Musculoskeletal Discomfort

There was no significant association between musculoskeletal discomfort and mismatch between anthropometry measurement of the respondents and the furniture dimension (x^2 = 0.332 p-value = 0.564) (Table 7). However, improper design of the furniture and ill-fitted to the student's anthropometry can results in fatigue and awkward posture which could affect their focus in doing their works. An ill-fitted furniture has been shown to lead to increase of musculoskeletal strains and loads, decrease productivity and health of the respondents[1].

Table 6: Association of ergonomic risk factors and musculoskeletal discomfort.

Variable	Discomfort (%)		x^2	p-value
	Yes	No		
ROSA Assessment				
High risk	73	6		
Low Risk	41	0	3.278	0.070
RULA Assessment				
Posture acceptable if not maintained or repeated for long periods	0	0		
Further Investigation is needed and changes may be required	47	3		
Investigation and changes are required soon	65	3		
Investigation and changes are required immediately	2	0	0.260	0.878

Table 7: Recommended dimensions for chair for use in the hostels

Variable	Discomfort (%)		X^2	p-value
	Yes	No		
Mismatch				
Yes	108	6		
No	6	0	0.332	0.564

CONCLUSION AND RECOMMENDATIONS

The prevalence of musculoskeletal discomfort and mismatch was high among the students. Therefore, suitable furniture that fit to the body dimension of the students should be used to avoid the increasing risks among the students at the university. Awareness programme will help the students to become aware of the effects of awkward postures during performing their work. Table 8 showed the recommendation for the dimensions of chair that suit the anthropometric dimensions of the students.

Table 8: Recommended dimensions for chair for use in the hostels

Features	Anthropometric measure	Design Dimension	Criteria/Determinant
Seat surface height	Popliteal height	39cm	5^{th} percentile of popliteal height
Seat depth	Buttock-popliteal length	40cm	5^{th} percentile of buttock-popliteal length
Back rest height (upper) above seat	Sitting shoulder height	53cm	5^{th} percentile of sitting shoulder height
Back rest angle to horizontal		110˚	
Table height	-	70cm	Maximum acceptable height = (SHE + 7.5cm) + (PH – 5cm)

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