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The Degree of Subjective Complaints of Students Practice in Mechanical Technology Laboratories

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Abstract

The working practice of the engineering students is part of the learning process that is irreducible and indispensable. The composition of lecturing between theoretical and practical one is 40% to 60%. With this condition, the students spend more time at the laboratory. Generally, the students perform in the laboratory work by standing position. The design of research is observational cross-sectional. The method applied is observation, interview and measuring. The subjects of research are practicing students amounting to 21 students. Referring to the analysis of statistical test or Wilcoxon signed ranks test, the difference of effect of work position is significant, namely $p < 0.05$ towards musculoskeletal disorders (MSDs) before and after working. The quantity of the average complaint after working is score 44.62 ± 9.47. The result of Wilcoxon signed rank test shows that there is significant different effects of standing work position, namely $p < 0.05$ towards fatigue generally before and after working. The degree of the *working* pulse is on the average of 110.78 ± 17.80 bpm (beats per minutes) which can be categorized into the medium workload. Using paired t-test, the result is $p < 0.05$.

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1. Introduction

The working practice is the core of the learning process in the Engineering Department of Bali State Polytechnic. The working practices involve turning, cutting, scraping, welding, grinding training and so on. Almost all working practices are conducted in standing position. With eight hours a day, it can be predicted that there will be a lot of disorders, especially the subjective ones such as the musculoskeletal disorders and general fatigue as well as the workload.[1]

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Nowadays, at the general workshops and construction ones, especially those located in Denpasar and Badung regency have been devised to decrease the disorders resulted from works. The efforts are such as providing working seat for the operator, short-term rest or supplying water while practicing. To be able to compete, hence, the industry has to be able to give the best service to the customers, have a comfortable working atmosphere, the interesting and friendly performance of the students, fast service, and the products fulfill the customer's expectation.[2,3] Consequently, the efficiency and productivity of work must be accelerated optimally to reach the above goal. The improvement of the work productivity can be reached by pressing all kind of input into the minimum level and increasing output into the maximum one.[4] The input, especially related to resources, has to be employed optimally. To reach such as condition, the students must be facilitated with comfortable, safe, and efficient work facilities. The work facilities comprise of workstation, work environment and work organization that is the capability, skill, and limitation of students in the hope that the productivity can be reached at the highest level.[5,6] Based on the background above, we can formulate the following problems. Is there any difference of work position effect before and after working towards the musculoskeletal disorders, general fatigue and workload on the students and how big is the effect of standing work position towards the musculoskeletal disorders, general fatigue, and workload on the students?

2. Research Methods

This research is conducted at the mechanical workshop of the engineering department of the state polytechnic of Bali Jimbaran, dated 11-15 January 2017, at 08.00 until 15.00 WITA. The research design is performed with the observational cross-sectional. The work process comprises cutting, forming and finishing. The number of students or students observed are 21 students who are all male, aged 18-21 years old, being on the third semester.

The standing work position is frequently performed by the students at the cutter station. They rarely perform the work with sitting position as they consider it can slow the finishing process of working. They do not realize that such condition can affect the musculoskeletal disorders, fatigue, and workload. According to Habibi and Soury[8] and Chaff's,[9] the standing position is an alert position physically and mentally. Therefore the work activity performed is faster, stronger and more careful. Standing is more tiring than sitting, and the energy spent when standing is more, 10-15 % compared to sitting.

The tools used to retrieve data consist of fatigue questionnaire and Nordic body map questionnaire, Japanese olympus FE-15 digital camera for documentation, table of psichrometry to determine relative humidity by % unit, stop watch - British-made diamond brand with seconds units, used for recording the time of the pulse, as well as the working time of the subject, sound level meter (measuring the noise), lux meter (for measuring the intensity of light), black globe thermometer (measuring radian temperature), sling thermometer (measuring wet temperature and dry temperature), anemometer (to measure wind speed).

3. Results and Analysis

The descriptive analysis results of average, stretches of time, the standard deviation of the subject characteristics that involve age, height, weight, and body mass index is presented in table 1 below.

Table 1
Characteristics of subjects

No	Variable	N	Average	SD	Range
1	Age (year)	21	19.48	0.68	18.00 – 21.00
2	Height (Cm)	21	157.48	3.98	150.00 – 166.00
3	Weight (kg)	21	56.62	3.47	49.00 – 67.00
4	Body Mass index	21	22.88	1.98	19.88 – 29.77

Description: SD = standard of deviation

The average age of subjects is 19.48 ± 0.68 years old, which means within productive ages. Body mass index (BMI) is a comparison of weight (kg) and height quadrate (m). The average of body mass index of subjects is 22.88 ± 1.98 kg/m^2, which shows a normal body mass. According to Erensal and Albayrak,[10] bodies mass index of the Indonesian is considered to be normal if it reaches an average value of 18.5 – 25.0 kg/m^2, therefore body mass index of the subjects is considered to be normal as it is within the value range.

To minimize the effect of musculoskeletal disorders, fatigue, and workload, consequently, the work must be designed in such a way that it does not reach forth, bend down, or performing unusual positions of the head.

Figure 1. Work position of students

The result of normality test to the environmental condition data, both for the working environment condition during before and after activity shows that normal distribution data is light intensity data, while dry temperature data, wet temperature, humidity, ball temperature, wind speed, noise and WBGT index not normally distributed. If one of the data is not normal then the test using non-parametric test equipment. Thus the data were tested by Mann-Whitney test. The results of data analysis of environmental conditions in the workshop of the crafters can be seen in Table 2.

Table 2
Environment conditions

Variable	Period I		Period II		Value	Value
	Average	SD	Average	SD	Z	p
Dry temperature (ºC)	30.14	0.78	30.11	1.12	-1.621	0.068
Wet temperature (ºC)	26.61	1.11	26.47	1.23	-1.127	0.121
Relative humadity (%)	78.68	4.50	78.72	4.55	-0.639	0.361
WBGT index (ºC)	27.67	1.13	27.62	1.22	-1.266	0.071
Wind speed (m/min)	13.65	3.06	13.57	2.78	-1.012	0.387
Light Intensity (lux)	265.00	4.81	268.00	6.77	-0.143	0.865
Ball temperature (ºC)	32.27	0.91	31.81	0.88	-1.296	0.064
Noise (dBA)	76.837	6.45	77.11	6.76	-0.213	0.654

Environmental conditions consisting of dry temperature, wet temperature, relative humidity, wind speed, light intensity, ball temperature and noise also greatly affect the subject condition. The data of light intensity, wind speed and noise are measured at five points and at different times. The result of data analysis shows that environmental condition seen from dry temperature, wet temperature, ball temperature, relative humidity, wind speed, light intensity and noise before and after the activity is no different. It is said that because all values p> 0.05 or it can be said that (A) the average of dry temperature in the study before activity is not significantly different with the average of dry temperature at the time of observation after activity; (B) the average of wet temperature at observation before activity was not significantly different with mean wet temperature of after activity; (C) the average of sphere temperature at observation before activity was not significantly different with mean of ball temperature of after activity; (D) the relative humidity average at observation before activity was not significantly different with the mean of relative humidity during observation after activity; (E) the average of wind velocity in observation of before activity is not significantly different with mean of wind velocity of after activity, and (f) average of noise, WBGT and light intensity at observation before activity is not significantly different with mean of noise, WBGT and light intensity of after activity.

To find out the musculoskeletal disorders of the students at the cutter station, one of the ways is by filling questionnaire of Nordic Body Map before and after working with the Likert scale scored from 1 to 4. From the tabulation data, the musculoskeletal disorders are analyzed descriptively and by normality test supported with the application program of SPSS for Windows. The result of data tabulation of musculoskeletal disorders before and after working with statistical analysis can be seen in table 3 below.

Table 3
Results of descriptive analysis and normality test

No	Variable	n	Average	SD	Normality test K-S test
1	Musculoskeletal disorders before working	21	28.67	1.06	p = 0.002
2	Musculoskeletal disorders after working	21	44.62	9.47	p = 0.515
3	Difference before and after working	21	15.95	9.59	p = 0.000

The table 3 above shows that data of musculoskeletal disorders before working is not distributed normally p=0.002 ($p<0.05$). As there is one of data is not distributed normally, therefore the nonparametric test is applied namely the Wilcoxon signed test. The result is, there is a significant difference standing work position effect towards musculoskeletal disorders before and after working on the students with p=0.000 ($p<0.05$).The average amount of effect of standing work position towards musculoskeletal disorders score is 44.62 ± 9.47. Musculoskeletal disorders felt according to the percentage per item of disorders, with the details (a) 100% stiff on the upper and lower neck, right shoulder, back, right upper arm, waist, right elbow, right wrist, right hand, right and left thighs, right and left knees, right and left calves, right and left tarsus, and right and left legs; (b) 91,67 % aches on left shoulder and left hand; (c) 50% aches on left elbow and left tarsus.

Such condition results from the standing work position of the students that is performed continuously and repeatedly. The complaint of skeletal muscles occurs as the muscle contracts exceedingly due to the excess of workload and long duration of loading.[3,11] The muscle disorders may not occur if the muscles contraction is ranging from 15-20% of the maximum muscle power. If the contraction of the muscle is over 20%, so the blood circulation to the muscle will reduce according to the contraction level that is influenced by the capacity of energy needed.[9,12] The oxygen supply to the muscle decreases, the carbohydrate metabolism process is blocked, and as a result, the accumulation of lactate acid occurs which results in muscle aches.[13,14] To obtain data on fatigue, the questionnaire is used which contains 30 items of general fatigue before and after work.[4,10] The results of the questionnaire applies the Likert scale with scores from 1 to 4. The result of tabulation data and general statistical fatigue test before and after working with the students is obtained with the descriptive analysis and normality test. For more details, the analysis results of the general fatigue before and after working are clearly defined in table 4.

Table 4
The results of descriptive analysis and normality test

No	Variable	n	Average	SD	Normality test K-S test
1	General fatigue before working	21	30.00	0.00	
2	General fatigue after Working	21	53.90	6.71	P=0.17
3	Difference between before and after working	21	23.90	6.71	P=0.17

Seen from Table 4, it is ascertainable that one of the data of general fatigue before working is not distributed normally as p is zero. Therefore the general fatigue data is tested non-parametrically with the Wilcoxon signed rank test. The data analysis data is revealed that there is a significant difference of standing position effect towards the general fatigue before and after working on the students, in which p=0.000 ($p<0.05$). The average amount of the standing position effect towards general fatigue on the students is 53.90 ± 6.71. Based on the questionnaire of 30 general fatigue items, it can be grouped into 3 (three) namely (a) group of questions 1-10 showing the attenuation of activity of 77%, (b) group of questions 11-20 showing the attenuation of motivation of 86% and (c) group of questions 21-30 showing the general physical fatigue description of 53%.

The fatigue results from the body condition that accepts excessive workloads, continuously, repeatedly and also the standing position as well as the uncomfortable working environment. The fatigue will be recover if a short-term rest is applied to the temporary fatigue. The permanent fatigue will be recovered if a one-day sleeping rest is taken.[15,18] The quantity of workload of the students can be discovered by calculating the pulse when having a rest and working with the ten-pulse method. The calculation is done with the formula = (60 x 10)/t bpm.[19,21] The results of the calculation of the pulse when resting, and when working then are analyzed with statistical tests. Data is analyzed descriptively and then continued with normality tests. If the data is normally distributed, the paired T-test is applied, and if the data is not distributed normally, then the Wilcoxon signed ranks tests is applied. For more details, table 5, shows the results.

Table 5
Descriptive analysis results and normality test

No	Variable	N	Average	SD	Normality Test K-S Test
1	Pulse when resting	21	72.27	8.15	p = 0.108
2	Pulse when working	21	110.78	17.80	p = 0.145
3	Working pulse	21	38.51	18.84	p = 0.504

4. Conclusion

Based on the previous discussion can be concluded some of the essences of research to answer the existing problems, as follows. Based on Wilcoxon signed rank test, it shows that there is a difference of effect of standing work position significantly towards the musculoskeletal disorders before and after working on the students with p=0.02 ($p<0.05$). The degree of standing work position effect on the students is on the average score of 72.27 ± 8.15. The musculoskeletal disorders are suffered according to the percentage per item of complaint of ache with the details. (a) 100% stiff on the upper and lower neck, right shoulder, back, right upper arm, waist, right elbow, right and left wrist and right and left feet. (b) 91.67 % aches on left shoulder, and right hand. (c) 50% aches on the left elbow and left wrist. Based on the analysis of Wilcoxon signed rank test, it is ascertainable that the difference of standing work position effect is significant towards general fatigue before and after working on the students with p = 0.002 ($p<0.05$). The degree of the effect of standing work position towards general fatigue is on the average of 53.90 ± 6.71.

Based on the questionnaire of 30 items of general fatigue can be grouped into 3 (three) namely (a) group of question 1-10 showing activity attenuation of 66.67 %; (b) group of questions 11-20 showing a motivation attenuation of 52.08% and; (c) group of questions 21-30 showing general physical fatigue description of 54.17%. Based on *paired t-test*, it is ascertainable that there is a difference of pulse beat while having a rest and working on the students with p = 0.00 ($p<0.05$). The degree of the effect of the *standing* work position towards the workload on the students is on the average of 110.78 ± 17.80 bpm and can be categorized into a medium workload. The students can accept hard and soft of the workload depending on the length they perform the activity of work which is adjusted to their capability. The workload can be influenced by the continuous, repeating works and the *standing* position while working, as well as the working environment that is hot.

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