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The Degree of Subjective Complaints of Students Practice on 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 lab. Generally, the students perform the lab work by standing position. The research is conducted at the lab of engineering dept. on January 11, 2016 at 08.00-15.00 WITA. 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 with average ages of 19,5 ± 0,67. Body mass index on the average of 21.33 ± 2.13 kg/m2, considering normal. Referring to the analysis of statistical test of 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 44.52 ± 9.28. The musculoskeletal complaint is felt 100% on skeletal muscles with details as follows: (a) 76% is waist ache; (b) 71% left tarsus ache; (c) 67% back pain; (d) 62% felt stiff on upper neck, lower neck and left calf ache. 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 fatigue effects is on the average of 65% and 100% of practicing students feel tired. Based on the questionnaire, 30 items of general fatigue are grouped into 3 (three), namely: (a) Question group 1 – 10 shows the attenuation of activity of 77%; (b) questions 11-20 show the attenuation of motivation of 86% and; (c) questions 21-30 show the description of general physical fatigue of 53 %. The degree of *working* pulse is on the average of 110.00 ± 10.44 bpm (beats per minute) which can be categorized into the medium workload. By means of paired t test, the result is $p<0.005$. The concentration, consisted of the speed, correctness and constance also will be decrease each 15.23%, 11.20% dan 16.33%. It shows that there is a significant difference of standing work position effect towards the musculoskeletal disorders, fatigue, workload and concentration when having a rest and working of the practicing students. The efforts of working station repair, short term-rest and supplying drinking water are able to decrease musculoskeletal disorders, fatigue, workload and increase concentration as well as increase the work productivity.

Keywords: ergonomics, work position, musculoskeletal disorders, fatigue, workload, concentration

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, scrapping, welding, grinding training and so on. Almost all working practices are conducted in standing position. With eight hour a day, it can be predicted that there will be a lot of disorders, especially the subjective ones such as the musculoskeletal disorderss and general fatigue as well as the workload [1,2].

Nowadays, at the general workshops and construction ones, especially those located in Denpasar

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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. In order 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, interesting and friendly performance of the students, fast service, and the products fulfill the customers expectation [3,4].

Consequently, the efficiency and productivity of work must be accelerated optimally in order 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 in an optimal fashion. In order to reach such condition, the students must be facilitated with comfortable, safe, and efficient work facilities. The work facilities comprise of, work station, work environment and work organization that are in accordance with 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. CONCEPT AND METHODOLOGY

This research is conducted at the mechanical workshop of engineering department of the state polytechnic of Bali I Jimbaran, dated 11-15 January 2016, 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 amount 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 slower the finishing process of working. They do not realize that such condition can have an effect on the musculoskeletal disorders, fatigue and workload. According to reference 7 and reference 8, the standing position is an alert position physically and mentally, therefore the work activity performed is faster, stronger and more careful. Basically, standing is more tiring than sitting and the energy spent when standing is more, 10-15 % compared to sitting.

3. RESULTS AND DISCUSSION

The descriptive analysis results of average, stretches of time, standard deviation of the subject characteristics that involve age, height, weight, body mass index and work experiences is presented on 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 reference 9, body mass index of the Indonesian is considered to be normal if it reaches an average value of 18,5 – 25 kg/m^2, therefore body mass index of the subjects is considered to be normal as it is within the value

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range.

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

Figure 1 Work Position of Students

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 SPSS15,00 for Windows. The result of data tabulation of musculoskeletal disorders before and after working with statistical analysis can be seen on table 2 below.

Table.2. 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 2 above shows that data of musculoskeletal disorderss before working is not distributed normally p=0.002 ($p< 0.05$). As there is one of data is not distributed normally, therefore non parametric test is applied namely the wilcoxon signed test. The result is, there is a significant difference standing work position effect towards musculoskeletal disorderss 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 disorderss 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 generally occurs as the muscle contracts exceedingly due to the excess of workload and long duration of loading [10,11,12]. The muscle disorders may not occur if the muscles contraction ranging from 15-20% of the maximum muscle power. If the contraction of 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 [13,14]. 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 [15,16,17].

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To obtain data of fatigue, the questionnaire is used which contains 30 items of general fatigue before and after working [18,19]. 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 of 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 on table 3.

Table.3. The results of descriptive analysis and normality test

No	Variable	n	Average	SB	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 3, 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 work loads, 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 recover if a one day sleeping rest is taken [20,15,21].

The quantity of work load 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 [22,23]. 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 distributed normally, 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 4, shows the results.

Table.4. 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

Result of research indicate that all of indicators is decreased. Speed average work at period of I is 8.24 ± 1.05 and at period of II is 9.72 ± 1.56, or happened by the speed decrease work equal to 15.23%. Meaning analysis with the test t-paired indicate that the value $p < 0.05$ owning meaning that speed

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average work at second period differ to have a meaning. Correctness average hereafter conduct the work at period of I is 19.34 ± 6.68 and at period of II is 21.78 ± 5.54 or there is decrease equal to 11.20%.

Meaning analysis with the test t-paired indicate that the value P < 0.05. Matter of this means that correctness average at second period differ to have a meaning. average constance hereafter conduct the work at period of I is 4.51 ± 1.48 and at period of II is 5.39 ± 1.70, or decrease 16.33%.

4. CONCLUSIONS

Based on the research and discussion above, we can have conclusions 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 of 72.25 ± 2.63. 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 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 75.67 ± 5.84.

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 work load on the students is on the average of 110 ± 10.44 bpm and can be categorized into a medium work load [24,25]. Hard and soft of the workload can be accepted by the students depending on the length they perform the activity of work which is adjusted to their capability. The work load can be influenced by the continuous, repeating works and the *standing* position while working, as well as the working environment that is hot.

Concentration will decrease really if job attitude do not be natural in a condition. Concentration consisted of the speed, correctness and constance will experience of the degradation of each 15.23%, 11.20% and 16.33%.

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