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Research Paper

The Use of Seated Grinders Reduces Complaints of Musculoskeletal Disorders, Workload, and Increases Work Productivity of Pandai Besi in Gubug Village, Tabanan-Bali

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ABSTRACT

Pandai Besi is one of the small industries that is developing in the village of Gubug, Tabanan Regency. One of the processes in the manufacture of household utensils in the form of small knives, large knives, sickles, and machetes will be faced with a tool in the form of a grinder. The purpose of this study was to determine the effect of using a seated grinder to reduce complaints of musculoskeletal disorders (MSDs), workload, and increase work productivity of Pandai Besi in the village of Gubug Tabanan. Methods of this research is an experimental study with treatment by subject design. The population is 40 people from 10 industries. The results of this research mean age of the subjects was 49.112±12.15 years, body weight was 66.68±6.64 kg, height was 162.31±6.78 cm and the subject's body mass index were 25.29±1.71 kg/m². There was a decrease in musculoskeletal complaints by 13.23%, a decrease in workload by 12.77%, and an increase in productivity by 50.14%. There was a significant decrease between musculoskeletal complaints, and workload before and after the use of the seated grinder (p<0.05), and there was a significant increase in work productivity before and after the repair of the seated grinder.

Keywords: Seated Grinder, Musculoskeletal Complaints, Workload, and Work Productivity

INTRODUCTION

Skeletal muscle complaints can be caused by the use of uncontrolled muscle power, continuous exercise, and a static body position for an extended period of time (Suma'm⁷, 2013). Musculoskeletal diseases (MSDs) are complaints that occur in the portions of the skeletal muscles as a result of long-term forced movement and acceptance

of large loads (Tarwaka, 2015). Occupational risks are listed as one of the top 10 causes of mortality and illness by the World Health Organization (WHO). According to the Workplace Safety and Health Institute's Global Estimates of Occupational Accidents and Work-related Illnesses 2017, 2.4 million employees died from occupational

diseases in 2015. In 2016-2017, over 507,000 workers in the United Kingdom were sickened by work-related musculoskeletal disorders (Indonesian Ministry of Health, 2016).

The prevalence rate of diagnosed musculoskeletal disease is 24.7 percent, and work attitude is one of the factors that influences the incidence of musculoskeletal complaints (Indonesian Ministry of Health, 2014). Workload and musculoskeletal complaints in pelvic workers in the Candi Industrial Area of Semarang City have a p-value of $0.003 > 0.05$, and the test results are considered significant (Masliyah, 2014). According to the International Labor Organization, one person dies in a workplace accident every 15 seconds, and 160 employees suffer from work-related illnesses. Every year, the International Labour Organization (ILO) records up to 2 million deaths due to accidents and occupational diseases (ILO, 2013). The world suffered losses of 1.25 trillion dollars, or 4% of global GDP (Indonesian Ministry of Health, 2014), as a result of this tragedy.

Pande Besi is one of the small industries that is growing in the village of Gubug, Tabanan Regency. These craftsmen have been in the job for quite a long time and are hereditary from their ancestors. They accept the inheritance as it is and engage in this work as the responsibility of their ancestors. One of the processes in the manufacture of household utensils in the form of small knives, large knives, sickles, and machetes they are faced with a tool in the form of a grinder to smooth and sharpen the knife. In this process, the worker holds a vibrating grinder, weighing more than 1.5 kg with one hand, with the other hand holding the knife to be ground. Working with hands exposed to vibration for a long time is a burden that will cause complaints and musculoskeletal diseases for workers

such as Hand Arm Vibration Syndrome, Raynaud's Syndrome, Tenosynovitis, and Carpal Tunnel Syndrome (Newington, et.al, 2015).

In high-risk work on the wrist, the prevalence of Carpal Tunnel Syndrome is between 5.6% and 15%. Musculoskeletal complaints found include tingling and pain in the fingers, reduced grip strength, and difficulty holding small objects. There are disorders of blood vessels, and disorders of the nerves caused by compression of the median nerve that passes through the carpal tunnel, these nerve disorders are related to work that has repeated exposure to vibration in the long term (Indonesian Ministry of Health, 2016 and Vihlborg, et.al, 2017). After conducting limited interviews with seven workers, they found that all workers felt pain, tingling, and stiffness in their hands, wrist pain, and pain in the right arm, elbow, waist, back, and neck. Working with heavy grinding tools and being exposed to vibrations for more than an hour certainly has an impact on the health of workers. Based on this, the researchers raised the above problems by using a sitting grinder to reduce complaints of musculoskeletal disorders (MSDs), and workload and increase the work productivity of blacksmiths in Gubug Tabanan Village.

MATERIALS AND METHODS

This research is an experimental study with treatment by subject design (Nasir, 2013). The total population is 40 people from 10 industries. Sample selection by simple random sampling with a table of random numbers. The minimum number of samples was calculated using the Colton formula so that the sample size was determined to be 16 people. The sample inclusion criteria included: blacksmith workers living in the village of Gubug Tabanan aged 20-60 years, physically healthy with a doctor's

examination, at least one year of work experience, and willing to be research subjects. While the exclusion criteria were not present during the trial, those who became unwell during it withdrew from the sample for various reasons. Data analysis and processing: Age, weight, height, and BMI are all descriptive tests for subject condition data. The following data was subjected to a normalcy test: musculoskeletal complaints, workload data, and work productivity data. On data that is normally distributed, parametric statistical tests (different test paired samples t-test at significance level = 0.05) were used in treatment I and treatment II on musculoskeletal complaints, workload, and work productivity, and non-parametric statistical tests (Wilcoxon's difference test at significance level = 0.05) were used if the data was not normal.

RESULTS

Subject Condition

In the village of Gubug Tabanan, the research subject discovered 16 blacksmiths. The age, weight, height, and BMI of the participant in this study were all recorded (BMI). Table 1 shows the results of the analysis of the subject's condition description.

Musculoskeletal complaints

Measurement of musculoskeletal complaints was done by interviewing respondents with a Nordic Body Map questionnaire. Complaint data was collected before and after work in Treatment I (manual grinding) and before and after work in Treatment II (rotating grinding). After working in Treatment I and Treatment II, there was a 13,23 percent reduction in complaints. Test the normality of the data with the Shapiro-Wilk test at a confidence level of = 0,05, demonstrating that all data are normally distributed ($p > 0,05$), and then

use a Paired Sample-t-Test test at a confidence level of = 0, 05 to evaluate the difference in treatment effects. Table 3 shows the results of the various test data for musculoskeletal symptoms. Table 3 shows the results of the Paired Sample-t-Test difference test before working in Treatment I and Treatment II, with no significant difference ($p > 0,05$), showing that the initial conditions in Treatment I and Treatment II were the same. While there was a significant difference ($p < 0,05$) between Treatment I and Treatment II following the analysis.

Workload

In treatment I and treatment II, the workload was measured by measuring the pulse before and after working. Workload was reduced by 12,77 percent after working in treatment I and treatment II. Test the normality of the data with the Shapiro-Wilk test at a confidence level of = 0,05, demonstrating that all data are normally distributed ($p > 0,05$), and then use a Paired Sample-t-Test test at a confidence level of = 0, 05 to evaluate the difference in treatment effects. Table 4 shows the results of the workload data difference test.

Paired Sample-t-Test analysis of workload data in treatment I and treatment II before working, got no significant difference ($p > 0,05$). This shows that the initial conditions of the two periods are the same or comparable. Analysis of treatment I and treatment II after work found that there was a significant difference ($p < 0,05$).

Productivity

It is defined as the output to input ratio per unit of time. Productivity is measured in this study by comparing the number of successfully forged plates (output) with the number of work pulses (input) in one hour of work

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Table 1: Descriptive Analysis of Subject Conditions

No.	Subject Condition	Means±SD	Min	Max
1.	Age (year)	49,12±12,15	23	60
2.	Height (cm)	162,31±6,78	150	172
3.	Weight (kg)	66,68±6,64	56	78
4.	Body Mass Index (BMI (kg/m ²))	25,29±1,71	22,55	29,14

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Table 2: Results of Different Tests for Musculoskeletal Complaints in Treatment I and Treatment II (Before and After Work)

No	Complaints	Period I	Period II	t	P
1.	Before Work	34,93±1,87	34,68±1,74	1,168	0,261
2.	After Work	41,56±2,09	36,06±1,34	9,409	0,000

Table 3: Workload Data Difference Test Results

No	Workload	Period I	Period II	T	p
1.	Before Work	79,12±1,70	79,13±1,40	0,000	1,000
2.	After Work	102,38±3,70	89,31±2,15	20,140	0,000

Table 4: Productivity Data Difference Test Results

No	Productivity	Perlakuan I	Perlakuan II	Z	p
1.	The resulting plate (1 hour)	3,63±1,25	4,75±1,29	-13,17	0,000
2.	Productivity (1 hour)	0,35±0,12	0,53±0,14	-15,77	0,000

(time). The average plate generated in treatments I and II increased by 30,85%, from 3.631,25 to 4.751,29, and the productivity in treatments I and II increased by 50,14, from 0.350.12 to 0.530.14.

After using the Shapiro-Wilk Test at a confidence level of $= 0,05$ to determine the normality of the data in treatment I and treatment II, it was determined that all data were not normally distributed ($p < 0,05$). To determine the difference in the effect of treatment on treatment I and treatment II, the Wilcoxon difference test was used at a confidence level of $= 0,05$. Table 5 summarizes the results of the various productivity data checks.

The analysis of the different tests on plate data produced and productivity in one hour in Period I and Period II found that there was a significant difference ($p < 0,05$).

DISCUSSION

Subject Condition

16 subjects participated in the complete study, and all of them were in good health based on a physical examination from a doctor. Subjects aged between 20-60 years follow the limits that have been determined in the determination of the sample. This type of work to make knives is a craft that is passed down from generation to generation so that workers will always work even though they are already elderly, as long as they are still able to do this work.

The patient weighed between 56 and 78 kg and was between 150 and 171 cm tall. The average BMI of the subject after calculating the body mass index (BMI) to estimate the nutritional state of the subject was 25,29 kg/m², with a range of 22,55 - 29,14 kg/m². The subject's BMI was assessed as overweight (Altmasier, 2009 and Indonesian Ministry of Health, 2015) when compared to WHO norms. The BMI

measures how well a person's dietary intake is balanced. In the long run, an unbalanced state can be generated by the consumption of nutrients, particularly carbohydrates and excessive fats, thus this situation must be remedied and examined so that the subject does not embark on the path to obesity. A high nutritional status will boost immunity and enhance health, allowing them to function better in daily activities and so improve their quality of life.

Complaints of Musculoskeletal Disorders

A Nordic Body Map questionnaire with 28 question items was used to assess the subjects' musculoskeletal problems. Following a 13.23 percent improvement, the study discovered a drop in complaints. There was a significant difference ($p < 0,05$) in the difference test between Treatment I and Treatment II after work. As a result, the addition of a sitting wheel has an impact on complaints.

SDs are complaints or disturbances that are felt by a person ranging from mild complaints to feeling very sick in the skeletal muscles which include the joints, nerves, muscles, and spine due to unnatural work. If the muscles are disturbed, the activities of doing daily work can be disrupted, because muscle strength is one of the most important parts of the body's organs to be able to move. In this study, it was found that there was a decrease in complaints among workers who used a seated grinder 13,23%. The results of this study are in line with other studies which state that improving ergonomics-based work systems can reduce worker complaints. This research is supported by research that explains that the work is in a static posture in the lower body and experiences repetitive movements in the hands (Ulfah, 2014). When in a

static position, the body will experience a blockage of blood flow, resulting in a lack of oxygen and glucose from the blood in that section. In addition, the body will produce lactic acid which can cause pain. Muscles cannot work naturally if a person works with an unnatural posture, this causes the muscles to require more strength to carry out their duties, thus triggering fatigue and tension in the muscles and tendons (Andreani and Paskarini, 2013). This research is supported by research on improving work attitudes to reduce musculoskeletal complaints by 34,6% (Arjani, et.al, 2021), research in the form of improving work systems and the work environment reducing worker fatigue by 22,09% (Santosa, 2012), research in the form of improving ergonomics-based SKKB work stations reducing worker fatigue by 18, 84%, and research in the form of improving ergonomics-based work aids reduces worker fatigue by 30,31%. The higher the workload, the higher the perceived musculoskeletal complaints (Diana, 2012).

In knife grinding, workers are presented with repetitive movements of the hand with a hammer weight that is quite heavy, so that the load on the right hand is more dominant. When the grinding wheel rotates and hits the steel plate, the vibrations arise and propagate from the tool to the hands when the vibrations are not felt directly by the workers. The vibrations that are felt continuously while working will accumulate over time and can have an impact on causing Hand Arm Vibration Syndrome (HAVS), which is a disease caused by vibrations in the hands. Exposure to hand-arm vibration, prolonged work with flexed hands, and repetitive use of CTS as well.

Workload

One of the most crucial aspects in determining the lightness or severity of a job, including grinding work, is the workload. Workers' workloads must be tailored to their physical and psychological capacity in order to avoid compromising their health (Andreani and Paskarini, 2013). Planning and/or building a technology that can prevent complaints due to an unreasonable workload (Brighenti, et.al, 2016) can be done in an effort to reduce worker workload. Because the pulse is one of the markers that may be used to measure the amount of a person's workload, the workload can be estimated from the frequency of the worker's pulse. After a 12,77 percent increase in productivity, the study discovered a decrease in workload. After working, the examination of the difference test revealed a significant difference ($p < 0,05$) between Treatment I and Treatment II.

The drop in workload in Treatment I and Treatment II was projected to be attributed to a reduction in workplace stress. An increase in pulse rate (Arjani, et.al, 2019) is one of the impacts of external stress. External stress can be reduced in this study by using a seated grinding wheel to make improvements. As assessed by the work pulse, there is an efficiency of energy utilization that can lower workload. Workload reductions of 21,43% in the modification of Tri Hita Karana-based ergonomics for rice mill workers (Ruliati, et.al, 2017), 15.3% in the dodol industry workers in Bali (Santosa and Yusuf, 2017), and 3.41% in the steamed bread industry workers in Denpasar (Dinata, 2018). The findings of this study support the notion that suggests that as workload increases, so do musculoskeletal complaints (Mindhayani and Hari, 2016).

Work Productivity

Crafters and entrepreneurs will see an improvement in production and income as a result of improved working conditions. The increase in productivity in this study was demonstrated by a 30,85% increase in the number of metal plates successfully forged by workers in one working hour, from 3.631.25 to 4.751.29. Worker productivity grew by 50,14%, from 0.040.01 to 0.050.01, when output was divided by input per unit of time. There was a significant difference ($p < 0,05$) between Treatment I and Treatment II, according to the analysis of the difference test.

Increased productivity from increased plate production will result in a rise in the number of knives produced by workers, hence boosting their revenue. This innovation will minimize the likelihood of workers developing occupational diseases (Tarwaka, 2015), in addition to increasing their pay.

Several other studies have demonstrated that improving productivity through an ergonomic approach can boost output. An increase in productivity was achieved as a result of improved physiological response, faster processing time, and increased production volume. The intervention by stretching and giving sweet tea to tailors was also reported to increase worker productivity by 66,67% (Santosa and Sutarna, 2018), an increase in productivity of 54,95% in the use of a solar dryer with a Techno-Ergonomic approach in making dodol in Singaraja.

CONCLUSION

According to the findings of this study, there was a considerable decrease in musculoskeletal complaints and workload before utilizing a seated grinder, as well as a significant boost in job productivity. *Pande Besi* craftspeople should always employ and pay attention to ergonomics approaches since

enhancements such as seated grinding have been shown to minimize musculoskeletal complaints, workloads, and increase job efficiency.

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