The Use Of Anti-Vibration Gloves Reduces Musculoskeletal Disorders (Msds) And Workload Of Gambelandi Artisans In Tihingan Klungkung Village, Bali

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ABSTRACT

In making gamelan instruments, craftsmen are faced with the grinding process. Working with their hands exposed to vibrations for long periods of time will certainly cause musculoskeletal complaints such as stiffness and pain in the hands, tingling, loss of sensation (numbness), tremors, and can also cause several diseases such as Raynaud's Syndrome, Tenosynovitis, and Carpal Tunnel Syndrome. The purpose of this study was to determine the effect of providing anti-vibration gloves on musculoskeletal complaints, workload, and work productivity among gamelan craftsmen. This study is an experimental study with a different subject design. The population is gamelan craftsmen in Tihingan Village, Klungkung Regency. The sample was determined based on small industry groups using simple random sampling. The sample size was determined based on musculoskeletal complaint scores, resulting in a sample size of 33 people. The sample was divided into 3 groups, namely the control group, treatment group I, and treatment group II. Each group consisted of 11 gamelan craftsmen. The results obtained showed a decrease in musculoskeletal complaints of 15.34% in the control group with treatment I, and 17.69% in the control group with treatment II. There was a decrease in workload of 11.64% in the control group with treatment I and 13.80% in the control group with treatment II. There was an increase in work productivity of 4.05% in the control group with treatment I and 5.50% in the control group with treatment II. Conclusion: There was a significant decrease in musculoskeletal complaints and workload between the control group with treatment I and the control group with treatment II ($p<0.05$).

1. Introduction

Health is an important factor in making the workforce more productive as a human resource. Good health is key to achieving good work productivity. Poor working habits can cause musculoskeletal problems in every worker. When the body moves away from its natural position, the further the body parts are from the center of gravity, and the greater the risk of musculoskeletal issues (Tarwaka, 2019). Worker protection includes several important areas, such as occupational safety and health, keeping workers motivated, and treating them with respect and according to national values. This protection is designed to ensure safety and improve the health of workers (Kmentrian Ketenagakerjaan, 2022). In general, every job or type of work can put someone at risk for musculoskeletal disorders. This includes jobs that involve staying in one position for a long time, sitting, bending, standing for too long, or working in jobs that require a lot of physical strength and heavy lifting. Musculoskeletal complaints are injuries or problems that affect the muscles and bones because of repeated exposure to harmful workplace conditions. These disorders can cause serious issues at work, like higher costs for treating injuries, less efficient work performance, and a lower quality of life (Kattang *et al*, 2018).

Using muscles too much, moving around a lot, or staying in the same position for a long time can lead to problems in the muscles and bones. These are called musculoskeletal complaints. Musculoskeletal disorders happen when you do repetitive movements or lift heavy things for a long time. This can cause a range of issues, from minor discomfort to serious pain. There are three main factors that lead to these problems: personal factors like age, gender, weight, how long someone has worked, and their lifestyle; work-related factors such as how long you work, your posture, how much you do, and how often you do it; and environmental factors like shaking or cold temperatures (Adriansyah, 2018)**.**

The risk threshold that causes complaints is difficult to correlate with the intensity, frequency, or duration of vibration exposure. However, there is a strong correlation between working with vibrating tools and musculoskeletal symptoms (Vihlborg *et al.*, 2017; Nafasa, Nurimaba and Tresnasari, 2019)**.** The overall work environment, including ergonomic factors, contributes to these symptoms. Exposure to vibration from grinding tools combined with several factors such as grip strength, repetitive wrist movements, hand and wrist posture, and long working hours increases the risk of musculoskeletal problems (Utami, Astuti and Lubis, 2022)**.**

In jobs where the wrist is at high risk, Carpal Tunnel Syndrome occurs between 5.6% and 15% of the time. Common musculoskeletal issues include tingling and pain in the fingers, weaker grip, and trouble holding small items (Brocal FA, Sanchez C, González JL, Fuentes MA, 2017). Problems with blood vessels and nerves happen because the median nerve gets pressed in the carpal tunnel, which is linked to jobs that involve repeated vibrations over a long time (Vihlborg *et al.*, 2017; Sitompul, 2019)**.**

Klungkung is a tourist spot in Bali that has many opportunities for developing tourist sites. According to a decree by the Klungkung Regent, number 335 in 1998, Tihingan Village was named a cultural tourist site. This village is special because of its beautiful cultural arts, especially in making traditional musical instruments like gongs, angklung, and semara pegulingan. Gamelan is a traditional Balinese music style that is used as a tourist attraction. People from Bali and tourists can enjoy it, especially when it is played along with Balinese dance (Sugriwa, 2024).

The village of Tihingan, which is in the Banjarangkan subdistrict, is a main place where people make gongs, which are part of a traditional musical set called gamelan. To make these gongs, craftsmen go through steps like melting, hammering, grinding, and finishing. During the grinding part, they use a

vibrating tool that weighs over 1.7 kg. When people work with their hands exposed to this vibration for a long time, it can lead to problems like stiff hands, pain that makes it hard to move, tingling, shaking, and conditions such as Raynaud's Syndrome, Tenosynovitis, and Carpal Tunnel (Ms Lisa Newington, Dr E Clare Harris, 2016). A study showed that when ergonomic gloves were given, there was a 31.28% decrease in these hand problems, a 6.07% drop in how much work people had to do, and a 12.12% improvement in how much they could produce. However, after asking 15 people, 10 still said they felt tingling and numbness in their fingers. So, to help even more, it's needed to provide gloves that are thicker and more flexible on the palms and fingers, which should help reduce the amount of vibration the craftsmen's hands are exposed to.

2. Methodology

This study is an experimental study with a different subject design. The population is gambelan craftsmen in Tihingan Village, Klungkung Regency. The sample was determined based on small industry groups using simple random sampling. The sample size was determined based on musculoskeletal complaint scores, resulting in a total of 3 small industry groups. Each group consisted of 11 people, resulting in a sample size of 33 people.

3. Result and Discussion

3.1 Result

Subject Conditions

There were 33 subjects in the study, all of whom were gamelan craftsmen living in Tihingan Village, Klungkung Regency, consisting of 11 people in the control group, 11 people in treatment group I, and 11 people in treatment group II. The conditions of the subjects recorded in this study were age, height, weight, and body mass index (BMI). Based on Table 1, the average age of respondents was 45.09±11.13 years, height 164.61±3.40 meters, weight 63.09±3.31 kg, and body mass index (BMI) 23.27±0.86 kg/m2. The descriptive analysis of the subjects' conditions is presented in Table 1.

Table 1. The Descriptive Analysis of Subject Conditions

No.	Subject conditions	Mean±SD	Min	Max
1.	Age (years)	45.09±11.13	20	60
2.	Height (cm)	164.61±3.40	160	172
3.	Weight (kg)	63.09 ±3.31	60	70
4.	Body Mass Index (BMI ($^{kg/m^2}$)	23.27 ± 0.86	21.51	24.98

Musculoskeletal Disorders (MSDs)

Musculoskeletal complaint data were obtained using the Nordic Body Map questionnaire through direct interviews with workers. Measurements were taken in the control group, treatment group I, and treatment group II before and after work. Table 2 shows that the average complaints in the control group with treatment group 1 and treatment group II before work were almost the same, ranging from 34.45 to 34.73. However, when compared after work between the control group with treatment I and the control group with treatment II, there was a decrease in musculoskeletal complaints. The control group with treatment group 1 experienced a decrease of 15.34%, and between the control group and treatment group II, the decrease was 17.69%. The Shapiro-Wilk test for data normality at a confidence level of $\alpha = 0.05$ showed that all data were normally distributed ($p>0.05$). Therefore, to determine the difference in treatment effects between the control group with treatment I and the control group with treatment II, a Paired Sample-t-Test was conducted at a confidence level of $\alpha=0.05$. The analysis of the difference

test for musculoskeletal complaint data is presented in Table 3.

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Table 2. Descriptive Analysis and Normality Test of Complaint Data in the Control Group, Treatment I and Treatment II Before and After Work

No	MSDs Complaints	Control Group Mean±SD	p*	Treatment I Mean±SB	p*	Treatment II Mean±SB	p*
1.	Before Work	34.45 ± 3.11	0.90	34.73 ± 3.259	0.88	34.36 ± 3.233	0.78
2.	After Work	62.18 ± 3.02	0.23	52.64 ± 3.384	0.22	51.18 ± 4.644	0.29

* normally distributed if p > 0.05

Table 3 shows the analysis of the Paired Sample-t-Test between the control group with treatment I and the control group with treatment II. Before work, there was no significant difference (p>0.05), but after work, there was a significant difference (p<0.05) between the control group with treatment I and the control group with treatment II.

Table 3. Results of the Difference Test for Musculoskeletal Complaint Data In the Control Group, Treatment I, and Treatment II Before and After Work

No	MSDs Complaints	Control Group	Treatment I	Treatment II	P
1.	Before Work	34.45 ± 3.11	34.73 ± 3.25	34.36 ± 3.23	0.120
2.	After Work	62.18 ± 3.02	52.64 ± 3.38	51.18 ± 4.64	0.001
3	Decrease	1.24	0.80	0.52	

Workload

Workload was assessed by measuring heart rate before and after work in the Control, Treatment I, and Treatment II groups. Descriptive analysis and normality tests of workload data are presented in Table 4. It shows that the average workload in the control group and treatment groups I and II before work was almost the same, ranging from 76.82 to 77.09. However, when compared after work, the control group with treatment I and the control group with treatment II experienced a decrease in workload. The control group with treatment group 1 experienced a decrease of 11.64%, and the control group with treatment group II experienced a decrease of 13.80%. The ShapiroWilk test for data normality at a confidence level of $\alpha = 0.05$ showed that all data were normally distributed (p>0.05). Therefore, to determine the difference in the effect of treatment on the control group with treatment I and the control group with treatment II, a Paired Sample-t-Test was conducted at a confidence level of α=0.05. The workload difference test analysis is presented in Table 5.

Table 4. Descriptive Analysis and Normality Test of Workload Data in the Control Group, Treatment I and Treatment II Before and After Work

No	Workload	Control Group Mean±SE	p*	Treatment I Mean±SD	p*	Treatment II Mean±SB	p*
1.	Before Work	77.09 ± 0.831	0.01	77.09 ± 1.04	0.46	76.82 ± 0.874	0.97
2.	After Work	96.82 ± 1.328	0.01	85.55 ± 2.22	0.46	83.45 ± 0.934	0.97

*Note: Normally distributed if p>0.05

Table 5 shows the analysis of the Paired Sample-t-Test between the control group with treatment I and the control group with treatment II before work. There was no significant difference ($p>0.05$), but after work, there was a significant difference ($p<0.05$) between the control group with treatment I and the control group with treatment II.

Table 5. Results of the Workload Data Difference Test in the Control Group, Treatment I, and Treatment II Before and After Work

No	Workload	Control Group	Treatment I	Treatment II	P
1.	Before Work	77.09 ± 0.831	77.09 ± 1.044	76.82 ± 0.874	0.452
2.	After Work	96.82 ± 1.328	85.55 ± 0.934	83.45 ± 0.934	0.001

Work Productivity

This is a comparison of output with input per unit of time. In this study, productivity was assessed by comparing the number of plates successfully forged (output) with the work pulse rate (input) in one hour of work (time). Descriptive analysis and normality tests of productivity data are presented in Table 6.

Table 6. Descriptive Analysis and Normality Test of Productivity Data in the Control Group, Treatment I, and Treatment II Before and After Work

No	Work Productivity	Control Group		Treatment I		Treatment II	
		Mean±SB	p*	Mean±SD	p*	Mean±SB	p*
1	Productivity (1 hour)	3.45 ± 0.522	0.001	3.59 ± 0.503	0.001	3.64 ± 0.505	0.001

Productivity in the control group with treatment I increased by 4.05%, while the control group with treatment II also increased by 5.50%. After testing the normality of the data in the control group with treatment I and the control group with treatment II using the Shapiro-Wilk Test at a confidence level of $\alpha=0.05$, all data were found to be normally distributed. To determine the difference in treatment effects between the control group with treatment I and treatment II, a difference test was then conducted at a confidence level of $\alpha=0.05$. The analysis of the difference test for productivity data is presented in Table 7. Wilcoxon test analysis of productivity data per hour in treatment I and treatment II showed no significant difference ($p>0.05$).

Table 7. Results of the Productivity Data Difference Test in the Control Group, Treatment I, and Treatment II

No	Treatment Group	Mean ± SD	*Kruskal Wallis Test*
1	Control Group	3.45 ± 0.522	p = 0.071
2	Treatment Group 1	3.59 ± 0.503	
3	Treatment Group 2	4.64 ± 0.505	

3.2 Discussion

The people in this study were 33 healthy gamelan instrument makers living in Tihingan Village, Klungkung Regency. Their ages were between 20 and 60 years old, as set by the sample selection rules. Making gamelan instruments is a traditional craft that has been handed down through generations, so the workers often continue their work even when they are older, as long as they are still physically able. Their weights were around 63.09 kg with a standard deviation of 3.31 kg, and their heights were about 164.61 cm with a standard deviation of 3.40 cm. After calculating their Body Mass Index (BMI) to check their nutritional health, the average BMI was 23.27 with a standard deviation of 0.86 (Kemenkes RI, 2020). According to the guidelines from Permenkes No. 2 of 2020, this BMI falls into the normal range. BMI shows how well someone's nutrition is balanced. Keeping good health and proper nutrition is important for maintaining a good quality of life and strong human resources. Physical activity, like the grinding movements that craftsmen do, is a type of body movement that uses skeletal muscles and increases the body's energy use (calorie burning). This matches findings from several studies that say physical activity affects how much energy the body uses. Nutritional deficiencies and excesses in adults over 18 years old are important issues to address (Akbar & Dainy, 2023; Wahyuniardi & Reyhanandar, 2018). The problem of nutritional deficiency and excess in adults (aged 18 years and above) is an important issue because, in addition to being a risk factor for certain diseases, it can also affect work productivity. An unbalanced diet and lack of physical activity are risk factors for non-communicable diseases. Therefore, maintaining a normal body weight allows a person to achieve a longer life expectancy (Newington et al., 2015).

Musculoskeletal complaints were measured using the Nordic Body Map quMusculoskeletal complaints were measured using the Nordic Body Map questionnaire, which contained 28 items. In this study, the average complaints after work decreased by 15.34% between the control group and treatment group I, and by 17.69% between the control group and treatment group II. Analysis of the difference test in the three treatments after work found a significant difference ($p<0.05$). Globally, work-related musculoskeletal disorders (MSDs) are one of the most important health problems faced by workers. Musculoskeletal disorders are the most common health- related illnesses today and are prevalent throughout the world (Kementerian Kesehatan RI, 2016). In this study, a decrease in complaints was found among workers using anti-vibration gloves in the control group with treatment I of 15.34% and between the control group with treatment II of 17.69%. These results are in line with other studies that state that improvements in ergonomics-based work systems can reduce worker complaints. A study on improving work posture reduced musculoskeletal complaints by 34.6% (Arjani et al., 2021). While a study on tool design reduced musculoskeletal complaints in the neck, elbow, and knee muscles by 50% (Hari & Setiawan, 2020). Research in the form of workstation improvements reduced musculoskeletal complaints in the cracker packaging process by 17.30%, and research in the form of using a bench grinder at an iron smith reduced musculoskeletal complaints by 15.60%, which contained 28 items.

Craftsmen do a lot of repetitive hand movements while using heavy hammers, which puts more strain

on their right hand. When the grinding stone spins and hits the steel plate, it creates vibrations that travel from the tool to the hands or wrists. Even though the workers don't feel the vibrations directly, they are still affected. If they keep working like this for a long time, the constant vibrations can lead to Hand Arm Vibration Syndrome (HAVS), a condition caused by repeated hand vibration. This same type of exposure, along with working with bent wrists for long periods and doing the same motion over and over, can also lead to Carpal Tunnel Syndrome (CTS) (You, Smith, & Rempel, 2014).

Workload means the amount of work someone is supposed to do based on their ability and how much they can handle in a certain time. It is connected to how productive someone is at work, which in turn affects their performance. If someone has too much work, it can lower their productivity. The more tasks a supervisor adds, the higher the workload becomes**22**. Before starting work, the average workload was almost the same for the control group, treatment group 1, and treatment group 2, ranging from 76.82 to 77.09. However, after work, there was a drop in workload for both treatment groups compared to the control group. The control group with treatment 1 saw a 11.64% decrease, and the control group with treatment 2 had a 13.80% decrease (Arjani et al., 2019). A difference test showed that there was a significant difference ($p<0.05$) among the three groups after work.

Improving working conditions leads to higher productivity and more income for craftsmen and entrepreneurs. Worker productivity, which is measured by how much is produced compared to how much is used in a certain time, went up by 4.05% when comparing the control group to treatment I, and by 5.50% when comparing the control group to treatment II. As productivity rises, workers can make more gamelan instruments, which means they earn more money. Along with higher income, these improvements also help lower the chance of workers getting sick from their jobs (Arjani et al., 2019). Other studies have also shown that using ergonomic methods can boost productivity. The increase in productivity comes from better body responses, faster work speeds, and more output. In Singaraja, using solar dryers with an ergonomic design helped increase productivity by 54.95% in making dodol (Santosa & Sutarna, 2018). Some studies showed that when seamstresses were given stretching exercises and sweet tea, their work output went up by 66.67%. In the steamed bread industry, using a better-designed tool for pouring helped raise productivity by 12.1% (Rusni et al., 2017). The study also looked at how musculoskeletal problems affect workers' ability to do their jobs and how they feel overall. By regularly checking workers' abilities and any limits they face, and making changes to their work setup, like giving anti-vibration gloves to gamelan makers, it helps improve their performance and their quality of life.

Conclusion

There was a significant decrease in musculoskeletal complaints and workloads between the control group and Treatment I group and the control group and Treatment II group ($p<0.05$). Ergonomic improvements, namely providing anti-vibration gloves, have been proven to reduce musculoskeletal complaints and workload. Therefore, to achieve the best possible results, it is hoped that gamelan craftsmen will always apply and pay attention to ergonomic principles.

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