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The Effectiveness of Ergonomic Chairs on Traditional Silk Weaving Craftsman in Polewali Mandar District, West Sulawesi

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ABSTRACT
Objectives: This research examines the effectiveness of providing interventions in the form of ergonomic chairs in increasing productivity and reducing work fatigue, and the risk of musculoskeletal disorders in silk weavers in Polman Regency, so that it can provide information for policy makers in formulating optimal health management for workers, especially in the sector. informal or small scale.
Methods: This research used a quasi-experimental design on silk weaving craftsmen in Polewali Mandar Regency, West Sulawesi, to evaluate work fatigue, productivity, work resilience, and musculoskeletal risk through a subjective assessment scale. Research subjects were selected using a purposive sampling method, involving 20 craftsmen (10 treatment groups and 10 control groups). Data was collected through direct observation and structured interviews, and pre-tests and post-tests were carried out to evaluate changes before and after the intervention. Data analysis used the Wilcoxon and Mann-Whitney tests to test significant differences.
Results: The results of statistical analysis show that the intervention is effective in reducing fatigue levels p=0.002, risk of musculoskeletal disorders p=0.000, and shortening production time for silk weavers in producing silk woven sarongs p=0.001. The length of the weaving results shows a p value of 0.146 which indicates there is no statistically significant difference between the intervention group and the control group in terms of the length of weaving produced in a week. However, the observation results showed that the average weaving results in the intervention group remained higher than those in the control group.
Conclusions: The main results prove that the intervention is effective in reducing fatigue levels, the risk of musculoskeletal disorders, and shortening production time for silk weaving.

Keywords: Silk Weaving, Ergonomic Chair, Productivity, Work Fatigue, Musculoskeletal Disorders

INTRODUCTION
The aesthetic patterns in woven silk fabric provide a high aesthetic appeal that is passed down from generation to generation [1] . However, behind the weavers' expertise, they face health risks [2,3] which in principle are causal to work-related illnesses and demotivation while working, which can be prevented by ergonomics standards [4,5] including preventing injuries [6,7] . Various studies highlight complaints of musculoskeletal disorders (MSDs) among weavers [2,3,8,9] studies conducted in Ethiopia, India, and Arunachal Pradesh reported prevalence rates ranging from 46.9% to 85% [3,8,10,11] especially the neck, shoulders, back, and wrists, where handloom weavers experience a higher prevalence of MSDs than machine loom workers [3,10–12] .
The main cause of MSDs is high physical demands such as inappropriate work posture which results in fatigue [8,13] , long-term fatigue risks increasing health problems and injuries in various sectors, both formal and informal [8,11,14–16] . Although rest can help muscle recovery after work [17] , prolonged fatigue lowers

immunity, such as decreasing thymus and T cell function. [18] . As a result, workers who do not have good health management tend to experience a decline in their health, including affecting their work abilities and safety.
However, the complexity of unfavorable factors in silk weaving production necessitates preventive measures, such as supporting facilities to reduce diseases that cause temporary loss or long-term disability [19,20] . Therefore, it is important that every worker receives ergonomic interventions to reduce the risk of MSDs and work fatigue [10,11,21] . Findings centered on silk weavers in Mandar Regency by Mallapiang [22] reported that all respondents in the observation (42 samples) experienced MSDs complaints related to unergonomic work postures.
In connection with a comprehensive study of occupational safety and health problems for weavers, especially silk woven fabrics, as one of the scientific contributions this research aims to conduct a study on the provision of ergonomic chair interventions in increasing productivity and reducing work fatigue and the risk of MSDs among silk weavers in Polman Regency so that it becomes an illustration for policy makers to create good occupational safety and health governance for workers in the small-scale informal sector.

MATERIALS AND METHODS

Study Design

This research uses a draft design quasi-experimental design on traditional silk weaving craftsmen in Polewali Mandar Regency, West Sulawesi to evaluate work fatigue as measured using the Work Fatigue Measuring Tool Questionnaire (KAUPK2), productivity of weaving products as measured by length in meters on average in a week, durability work measured in working hours, as well as subjective assessments from craftsmen regarding musculoskeletal pain based on the Nordic Body Map questionnaire before and after using an ergonomic chair.

Observation Subject

Research subjects were selected using a purposive sampling method, where subjects were determined based on certain criteria relevant to the research objectives, namely traditional Mandar silk woven craftsmen who do not use weaving machines and are still active in production. Due to limited costs, we only used 20 craftsmen, of which 10 were treated (using ergonomic chairs) and 10 controls without treatment (without using ergonomic chairs) . Data was collected through direct observation and structured interviews with weaving craftsmen. This research also involved a pre-test and post-test to evaluate changes that occurred before and after the intervention.

Statistical analysis

Data analysis in this research involves the stages of entry, coding, cleaning and tabulating using SPSS version 23 statistical software. Tables and graphs are presented to illustrate descriptive statistics, while evaluating significant differences using the Wilcoxon test followed by the Mann-Whitney test. The Wilcoxon test was used to analyze the differences between two paired measurements in the safety group of weavers, then the Mann-Whitney test to compare significant changes in the variables measured after the intervention on controlling the risk of occupational diseases and work productivity of traditional silk weaving craftsmen.

Ethical considerations

This research had ethical approval from the Ethics Commission of the Faculty of Public Health, Hasanuddin University, with the protocol number was 14324105009 and the letter number was 759//UN4.14.1/TP.01.02/2024

RESULTS

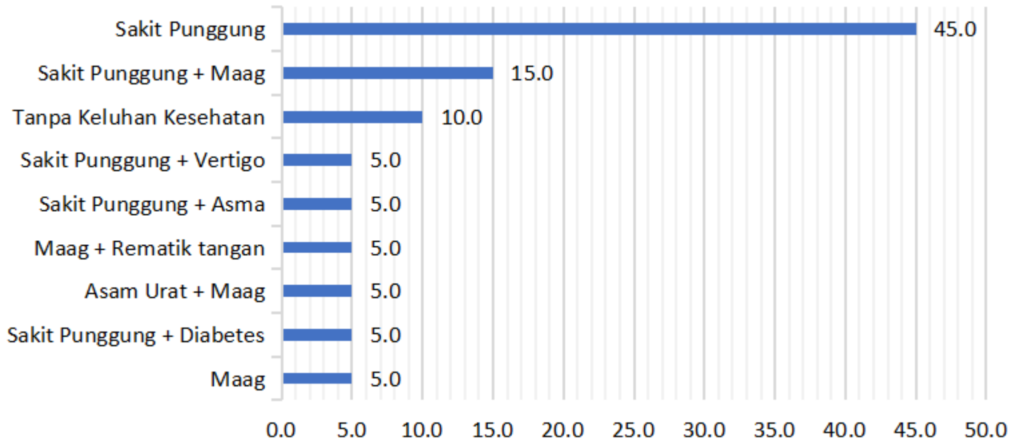
Table 1: Distribution of Respondents Based on Characteristics

Characteristics	Overall		Intervention Group		Control Group	
	n	%	n	%	n	%
Age Group						
20-29 Years	1	5.0	0	0.0	1	10.0
30-39 Years	5	25.0	3	30.0	2	20.0
40-49 Years	8	40.0	4	40.0	4	40.0
50-59 Years	4	20.0	1	10.0	3	30.0
60-69 Years	2	10.0	2	20.0	0	0.0
Education Group						
Didn't finish elementary school	4	20.0	4	40.0	0	0.0
elementary school	11	55.0	2	20.0	9	90.0
Junior High School	2	10.0	2	20.0	0	0.0

Characteristics	Overall		Intervention Group		Control Group	
	n	%	n	%	n	%
Senior High School	3	15.0	2	20.0	1	10.0
Years of service						
≤10 Years	3	15.0	2	20.0	1	10.0
>10 Years	17	85.0	8	80.0	9	90.0
Length of Work Per Day						
6 Hours	1	5.0	1	10.0	0	0.0
7 Hours	15	75.0	6	60.0	9	90.0
8 Hours	4	20.0	3	30.0	1	10.0
Rest Pause						
1 hour	1	5.0	1	10.0	0	0.0
2 hours	19	95.0	9	90.0	10	100
Range of Number of Working Days (Per Month)						
15 Days	6	30.0	6	60.0	0	0
20 Days	14	70.0	4	40.0	10	100

Overall, the respondents were female workers, where table 1 shows the largest age group, namely in the 40-49 year age group, 8 people (40.0%) with a division of 4 people in the intervention group and 4 people in the control group. 55% of respondents only completed elementary school education, in fact another 20% did not complete elementary school, and then worked as weavers so that the majority of respondents or 85% had a working period of more than 10 years. Based on work productivity conditions, the average length of work for weavers is 75% at 7 hours of work, with a break of 2 hours (for 95% of respondents). The number of working days in a month is generally 20 days or for 14 respondents (70%).

Graph.1 shows that back pain is the most dominant health complaint among respondents, both as a single complaint and in combination with other conditions such as ulcers or vertigo.



Graph 1: Percentage of History of Health Problems Experienced by Respondents

Based on table 2, the pretest values show that the average length of weaving produced in a week is around 3.30 for the intervention group and 4 meters for the control. However, there was a difference in value at the end of the observation, namely that the average respondent was able to produce weaving results in a week, namely 4 meters and for the control group 3.80 meters. There were no respondents in the Negative Ranks for the intervention group, meaning that no respondents experienced a decrease in weaving results with a p value = 0.038, meaning the value at the end of the observation was statistically significant. The control group p value = 0.157 which means there is no statistically significant difference in weaving results in this group.

Data related to the length/duration of work in a week in producing one woven silk sarong in table.2 shows the highest average in the intervention group, 33.70 hours and the control group, 30.80 hours. However, after giving the intervention, the intervention group was able to produce one silk woven sarong in 20.60 hours and the control remained at 30.80 hours. Wilcoxon test results for both groups were 0.017 in the intervention group and p=0.863 in the control group. In addition, the Wilcoxon test results showed a significant difference in the level of fatigue in the intervention group, p=0.007 and control, p=0.059. For the intervention group, the average score pre=23.50 and post= 19.60, shows a decrease in the average score of around 3.9 points, where there were 9 respondents in Negative Ranks, meaning 9 respondents experienced a decrease in fatigue levels. Meanwhile, in the control the average value pre=22.60 and post=23.10 or there was an increase in the average work fatigue value, with a value of 4 in Positive Ranks or there were 4 respondents who experienced increased fatigue in this group.

Table 2: Results of Comparison of Significance Values Using the Wilcoxon Signed Test

Variable		Group															
		Intervention								Control							
		Mean	Difference	elementary school	Min-Max	Negative Ranks	Positive Ranks	Ties	p-value	Mean	Difference	elementary school	Min-Max	Negative Ranks	Positive Ranks	Ties	p-value
Weaving Results	Pretest	3.30	0.7	0.823	2-4	0	5	5	0.038	4.00	-0.2	0,000	4-4	2	0	8	0.157
	Posttest	4.00		0,000	4-4					3.80		0.422	3-4				
Length/Duration of Work	Pretest	33.70	13.1	13,141	14-48	8	2	0	0.017	30.80	0	1,932	30-36	2	5	3	0.863
	Posttest	20.60		4,402	12-27					30.80		3,910	24-36				
Work Fatigue	Pretest	23.50	3.9	2,838	19-28	9	0	1	0.007	22.60	-0.5	2,066	20-27	0	4	6	0.059
	Posttest	19.60		1,838	17-23					23.10		1.853	21-27				
Risiko Musculoskeletal	Pretest	11.70	9.8	5.100	4-18	9	0	1	0.008	10.20	-2.9	2.700	4-12	0	10	0	0.004
	Posttest	1.90		2.470	0-7					13.10		3.695	5-18				

Based on the Wilcoxon test results in Table 2 for the musculoskeletal disorders risk variable , it shows that the intervention carried out had a significant impact on reducing the risk of MSDs in the intervention group. The average risk value in the intervention group decreased from 11.70 to 1.90, with a p value = 0.008 or statistically significant. A total of 9 respondents experienced a reduced risk of musculoskeletal disorders in the intervention group. In contrast, the control group saw an increase in the average value from 10.20 to 13.10 or all respondents were known to have increased risk, with a p value = 0.004 or statistically significant. Thus, it can be concluded that the intervention carried out was effective in reducing the risk of musculoskeletal disorders in the intervention group, while in the control group, the risk of MSDs increased significantly.

Based on the results of the Mann-Whitney test, table 3, the weaving yield variable in a week shows a p value of 0.146. This means that there was no statistically significant difference between the intervention group and the control group in terms of weaving results in a week, although there was a slight increase in the average weaving results produced. This p value >0.05 indicates the observed differences in weaving results between the two groups likely occurred by chance, and cannot be considered the result of the intervention. For the variable length/duration of work in a week in producing silk woven sarongs, it shows a p value of 0.001, meaning that there is a statistically significant difference between the intervention group and the control group in producing production.

Table 3. Statistical Test Results for Differences in Significance Values Using the Mann Whitney Test

Group		Mean-Rank	Sum of Ranks	p-value
Weaving Results	Intervention	11.50	115.00	0.146
	Control	9.50	95.00	
Length/Duration of Work	Intervention	6.10	61.00	0.001
	Control	14.90	149.00	
Work Fatigue	Intervention	6.35	63.50	0.002
	Control	14.65	146.50	
Musculoskeletal Risks	Intervention	5.70	57.00	0.000
	Control	15.30	153.00	

The work fatigue variable in table 3, the intervention carried out shows a significant impact (p=0.002) on reducing the level of work fatigue in the intervention group compared to the control group. The lower Mean-Rank value in the intervention group (6.35) indicates that in general respondents in this group had a lower level of work fatigue compared to the control (14.65). As for the risk variable for musculoskeletal disorders, the intervention carried out also had a significant impact (p=0.000) on reducing the risk in the intervention group compared to the control. In the intervention group the Mean-Rank value = 5.70, while the control Mean-Rank was higher at 15.30. Thus, the results show that the intervention implemented was effective in reducing the risk of musculoskeletal disorders , where controls experienced an increased risk.

DISCUSSION

The results of this research indicate that intervention through ergonomic chairs is effective in reducing fatigue levels, the risk of musculoskeletal disorders , and shortening production time for silk weavers in producing silk woven sarongs. Although the intervention group showed a higher average length of weaving results per week than the control group, statistical tests showed that the difference was not significant for the weaving results variable. Based on findings in the field, the limitations of local natural raw materials can be attributed to the limited number (sheets) of weaving products in both groups.

The success of this intervention proves that a simple design in the form of a chair with a comfortable backrest and cushion, and not the core part of a traditional loom, is really needed by workers in an effort to prevent the risk of pain in the body and affect work output . As a systematic review of studies on ergonomic design that meets workers' physical needs can help reduce work-related musculoskeletal risks [13,23] and helps reduce muscle tension during the production process [24,25] , including increasing work productivity [26] .

Similar findings regarding the application of ergonomic design in work processes that are beneficial from a health perspective were also found by Syamsul et al [27] who showed that ergonomic work station modifications have been proven to reduce musculoskeletal disorders among lipa sabbe weavers, specifically in Wajo Regency. Similar benefits but in different respondents were also observed in traditional batik industry workers, namely the use of ergonomic chairs was proven to be effective in reducing musculoskeletal disorders among batik workers [28] .

A brief literature review reveals a significant positive correlation between the implementation of ergonomics interventions and a reduction in the incidence of musculoskeletal injuries in industrial environments [29] including reducing fatigue levels [30] so that the application of ergonomic principles is very important including reducing the burden of health costs related to MSD in industrial environments [31] . While some studies suggest that workplace modifications alone may not be sufficient to address MSDs [32] , recent studies show mixed results regarding the effectiveness of ergonomics interventions in reducing musculoskeletal disorders (MSDs) among workers. A study of manufacturing workers found that ergonomics-based Standard Operating Procedures reduced postural stress by 4.74-23.09% and work fatigue by 12.78%, while increasing employee income and company profits [33] .

A variety of research suggests that multi-layered ergonomics intervention programs, including training workshops and participatory ergonomics substantially reduce MSD risk factors and increase productivity, while training alone is not enough [34–36] . These findings collectively emphasize the importance of combining various ergonomic principles in the work environment as a form of engineering solution to improve comfort, health and productivity, especially in the traditional silk weaving industry which is relatively small scale.

Limitations and recommendations

A common challenge besides resources and time is difficulty interacting with respondents over language differences. Apart from operational problems, the budget available for research was inadequate to overcome the various challenges that emerged, so researchers limited the number of respondents. Facing these various challenges, it is recommended to implement several strategies to reduce their impact. First, establishing partnerships with local organizations or communities can facilitate access to research locations and increase interaction with respondents. Additionally, careful budget planning and resource allocation are essential to ensure readiness for unexpected challenges.

CONCLUSION

We found evidence that applying simple ergonomic rules such as providing back chairs with thick and comfortable seats can shorten work duration in terms of productivity, as well as reduce work fatigue and the risk of musculoskeletal disorders among silk weaving workers. The study recommends broader implementation of ergonomic design and regular assessment of working conditions to maximize health and productivity benefits, including further studies with larger samples and more controlled variables.

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CONFLICT OF INTEREST

No potential conflict of interest was reported by the authors.

Authors contributions

A.W and A.U.S designed research and wrote papers. M.S, M.A, and I.H.Y who had substantial contribution to the design of the study, were responsible for all aspects of the work in ensuring the accuracy or integrity in any part of the research which were properly resolved including analyzing the data. All authors provided comments and approved the final draft. All authors have read and approved the published version of the manuscript.

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