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ORIGINAL ARTICLE

Effectiveness of Innovative Ergonomic Models in Preventing Occupational Fatigue in Rice Farmers

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ABSTRACT

Introduction: Ergonomic work hazards are potential hazards that can negatively affect the health of farmers. One of the ergonomic hazards that farmers often experience is fatigue. This study aims to analyze the effectiveness of innovative ergonomic models and the preparation of balanced calorie needs in preventing work fatigue in rice farmers. **Methods:** The type of research used is a randomized controlled trial (RCT) design, which is the most powerful design to evaluate the intervention used, namely the effectiveness of innovative ergonomic models and the preparation of balanced calorie needs in preventing occupational fatigue in rice farmers. The population in this study were all farmers in Pudak Village, Kumpeh Ulu Subdistrict, Muaro Jambi Regency, totaling 238 people. The number of research samples was 68 farmers has taken using simple random sampling technique. Data were analyzed to determine the effectiveness of innovative ergonomic models using the ANOVA test with ($\alpha = 0.05$). **Result:** There was a difference in the effectiveness of innovative ergonomic models in preventing work fatigue between at least two groups of rice farmers. **Conclusion:** the provision of stretching and snacks coupled with rest periods is most effective in preventing occupational fatigue. As for occupational fatigue, the provision of stretching, snacks, and rest time and the provision of simple education on the hazards of work ergonomics are effective in preventing occupational fatigue in rice farmers.

Keywords: innovative ergonomic, rice farmer, work fatigue

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INTRODUCTION

Work hazards that often affect work capacity and productivity are ergonomic hazards. Ergonomics is a science that harmonizes work facilities with human capacity (Tarwaka, 2019). Ergonomic hazards can have a negative impact on workers' health, one of which is fatigue, which can contribute to work accidents. Factors such as environmental conditions, social support, and psychosocial issues affect the level of fatigue (Beribe and Susilowati, 2024). Fatigue is the body's mechanism to protect itself and restore health after rest. Symptoms of fatigue include tiredness, drowsiness, boredom, and thirst, which can reduce physical and mental performance (Tarwaka, 2020). High physical activity and repetitive muscle use can increase the risk of fatigue, even though only a small proportion of muscles are active in each step when walking (Artayasa, 2022).

Workers who often work very long hours during peak production seasons, resulting in lack of sleep and fatigue, one of which is the agricultural sector (Elliott *et al*., 2022). Studies show that fatigue accounts for 13% of workplace injuries, and 43% of workers in the United States say they are sometimes too tired to do their jobs safely. Loss of health productivity is estimated to cost employers more than $136 billion each year due to burnout. This can also be fatal (Illinois.GOV, 2019).

According to data from the Directorate General of Labor Inspection Development, 7,298 cases of work accidents occurred in 2021, with 9% of the total caused by fatigue (Kemnaker RI, 2022). Based on the incidence of work fatigue in Jambi, according to BPJS Ketenagakerjaan data in 2019,

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there were 1,159 cases of work accidents, some of which were caused by fatigue in the industry (BPJS Ketenagakerjaan Provinsi Jambi, 2019). This figure provides a concrete illustration of how occupational fatigue can be a major risk factor in the occurrence of accidents in the workplace, demonstrating the need for preventive action and further attention to occupational fatigue management to improve safety conditions and worker welfare.

Research by Wurarah, Kawatu and Akili (2020) showed a relationship between workload and fatigue in farmers in Tumaratas Village. Workload must be balanced with the physical and cognitive capacity of workers (Sagala, Sucipta and Tika, 2022). Rahdiana Suhardiman and Sukarman (2022) found that the neck and waist have an MSD percentage of 98% and 95%, which indicates that these two body parts have a high ergonomic risk. To reduce long-term risks, farmers are advised to improve work procedures and equipment. (Rahdiana, Suhardiman and Sukarman, 2022). Latief *et al*. (2022) added that high workload and excessive energy use without adequate caloric needs and effective rest increases the risk of occupational fatigue (Latief, *et al*., 2022).

Physical activity, static work that is not in accordance with ergonomic principles, psychological work environment, monotonous work, insufficient calorie needs, and irregular work and rest schedules can trigger fatigue in farmers (Tarwaka, 2020). Excessive workload can cause occupational diseases such as abdominal pain, headaches, neck and back stiffness, sleep disturbances, anxiety, and feelings of hopelessness, as well as affect socialization patterns and smoking habits (Wurarah, Kawatu and Akili, 2020). Research by Antika and Prameswari (2023) found that the use of manual tools in rice field management caused dizziness, stiffness, shoulder and back pain, and fatigue in farmers (Antika and Prameswari, 2023).

Based on observations in Pudak Village, farmers' work involves processes such as hoeing, plowing, planting, mulching, lifting, and harvesting, with a duration of 8-10 hours per day in hot weather. High physical activity and repetitive muscle use increase the risk of fatigue. Interviews showed a lack of socialization on OHS and ergonomics, irregular rest periods, and a lack of understanding of caloric needs. This high risk of ergonomic problems prompted the need for research with a new approach that has never been applied in Pudak Village, namely an innovative ergonomics model intervention. This model includes stretching before work to improve muscle flexibility, structuring breaks, providing snacks to maintain energy balance, and education about the dangers of unergonomic work and how to prevent it. Thus, the ergonomic innovation in this study is expected to be a comprehensive solution to prevent ergonomic risks that are common in agricultural work. Based on the description of the background, researchers are interested in conducting research on "The Effectiveness of Innovative Ergonomics Models in Preventing Occupational Fatigue in Rice Farmers".

METHODS

This study, in the form of a randomized controlled trial (RCT) design, is the most powerful design to assess the interventions used, namely the effectiveness of innovative ergonomic models and the preparation of balanced calorie needs in preventing work fatigue in rice farmers. This study was conducted on farmers in Pudak Village, Kumpeh Ulu District, Muaro Jambi Regency with the implementation time of six months from April to October 2023. The ergonomic innovation referred to in this study refers to a new approach that has never been applied before to rice farmers in Pudak Village. The intervention consisted of: 1) Stretching before starting work to improve muscle flexibility and prevent injury; 2) Provision of snacks and effective timing of breaks to maintain farmers' energy balance; and 3) Simple education about the dangers of unergonomic work and how to prevent it. The independent variable in this study is the innovative ergonomics model, while the dependent variable is work fatigue in rice farmers. The population in this study were all farmers in Pudak Village, KumpehUlu District, Muaro Jambi Regency, totaling 238 people. The inclusion criteria for this study were: 1) Domiciled in Pudak Village, Kumpeh Ulu District, Muaro Jambi Regency; 2) As a rice farmer for at least 1 year with the age of 18-60 years; and 3) Farmers who are willing to follow the entire series of interventions. The exclusion criteria were: 1) Have a health condition that may interfere with the implementation of the intervention; 2) Undergoing treatment or therapy that may affect the level of fatigue; and 3) Farmers who are not willing to participate in this study. For the sample, calculations were used using the Lemeshow method. The number of research samples was 68 farmers who were taken using simple random sampling technique. Data sources were

obtained directly from the measurement process, respondent interviews and observations in the field. This research also requires secondary data obtained from Pudak Village, KumpehUlu Subdistrict in the form of farmer data and village profiles. A total of 24 trial participants successfully completed the entire trial within 3 weeks. The results showed that the innovative ergonomics model, which included stretching before work, providing snacks and effective break times, and simple education about the dangers of unergonomic work, was able to reduce symptoms of work fatigue and improve the farmers' energy balance.

Ethical Clearance

This research had been declared ethical by the Health Research Ethics Committee of the Universitas Fort De KockBukittinggi. This decision was based on a statement of ethics No: 1143/KEPK/X/2023.

RESULTS

Univariate Analysis

The research sample consisted of three groups of farmers, namely the first group that was given stretching, the second group that was given snacks and regulated rest time, then the third group, which was a sample that was only given simple education about the dangers of working ergonomics.

Based on table 1, the average age of group 1 farmers was 53 years old, the average working period was 27 years, the average length of work was 7 hours a day. For PPE, the average farmer is at a score of 2, namely only wearing a hat and long clothes when working, and for fatigue the average farmer is at a score of 52.04. Farmers in group 2 are on average 55 years old, the average tenure was 23 years, the average length of work was 7 hours a day. For PPE, the average farmer is at a score of 2, namely only using a hat and long clothes when working, the average farmer is at a score of 59.36. Group 3 farmers are on average 51 years old, the average working period is 28 years, the average length of work for farmers is 8 hours a day. For PPE, the average farmer is at a score of 2, namely only using a hat and long clothes when working, the average farmer is at a score of 72.36. The group given stretching and snacks as well as regular rest periods may have better energy regulation than the other groups as these direct interventions may affect their energy levels throughout the workday. Stretching helps to reduce muscle tension and improve blood circulation, snacks provide additional energy, and regular rest periods allow the body to recover energy. All of these factors contribute to better fatigue management and energy balance during work activities. Therefore, Group 1 with stretching and Group 2 with snacks and breaks had better energy balance based on their lower fatigue scores of 52.04 and 59.36, respectively, compared to Group 3 who only received simple education on occupational ergonomic hazards with an average fatigue score of 72.36.

Multivariate Analysis

The results showed that the fatigue of farmers in the group given stretching, providing snacks and setting break times and given education about ergonomics were all normally distributed with a

Table 1. Farmer Characteristics

Variable	Min	Max	Mean	Median	SD
Stretching					
Age	28	77	52.96	51.50	12.66
Years of service	5	50	27.08	25.00	11.53
Length of working	3	10	6.73	7.50	1.82
PPE	1	5	1.83	2.0	1.13
MSDs	5	60	20.29	17.0	15.29
Work Fatigue	27	67	52.04	54.0	9.99
Providing snacks and arranging rest times					
Age	35	72	54.95	55.00	9.08
Years of service	8	50	22.59	20.00	10.94
Length of working	4	10	7.16	7.00	1.06
PPE	1	5	1.77	2.00	0.87
MSDs	10	50	33.27	35.0	12.66
Work Fatigue	32	77	59.36	63.0	12.29
Simple education about the dangers of ergonomic work					
Age	25	75	51.36	50.50	12.25
Years of service	5	60	28.09	26.50	17.21
Length of working	7	11	8.18	8.00	1.01
PPE	1	5	1.73	2.0	0.88
MSDs	16	54	30.82	28.50	12.64
Work Fatigue	50	100	72.36	71.50	13.45

significance value of 0.314; 0.343 and 0.916 respectively. Then it must continue with the variance equality test. The results of the variance equality test on work fatigue in farmers. From these results, the p value = 0.238 is still greater than the alpha value of 0.05. So there is no difference in the variance of work fatigue between groups of farmers being compared, so the test used for multivariate analysis is the one way anova test.

The results of the analysis (one way ANOVA) obtained a p value = <0.001 which is still smaller than alpha 0.05 which means that there is a difference in the effectiveness of innovative ergonomic models in preventing work fatigue at least between two groups of rice farmers. To find out which group has a difference, a post hoc analysis will be conducted.

The results showed that farmers who were given stretching and farmers who were given snacks and rest time had an average difference of -7.322. Farmers who were given stretching and farmers who were given simple education about the dangers of ergonomic work had an average difference of -20.322. Farmers who were given snacks and rest time and farmers who were given simple education about the dangers of ergonomic work had a mean difference of -13.00. The results of LSD (Least Significant Difference) post hoc analysis obtained a value of p = 0.042 in the stretching group with the group giving snacks and time management breaks, then p = <0.001 in the stretching group and the group providing simple education about the dangers of ergonomic work. and a value of p = 0.001 in the group giving snacks and time management breaks with a group that provides simple education about the dangers of ergonomic work. Thus it can be concluded that the groups that have differences in the incidence of occupational fatigue in farmers are the group that provides stretching with the group that provides snacks and time management breaks, the group that provides stretching and the group that provides simple education on work ergonomic hazards, and the group that provides snacks and time management breaks with the group that provides simple education on ergonomic work hazards. In other words, the difference in the incidence of occupational fatigue was significantly different in all groups of the innovative ergonomic model tested.

Table 2. Analysis of Differences in the Incidence of Work Fatigue among Farmers

Work Fatigue	n	Mean±sd	P
Stretching	24	52.04±9.99	
Providing snacks and arranging rest times	22	59.36±12.29	<0.001
Simple education about the dangers of ergonomic work	22	72.36±13.45	

Table 3. Post Hoc Analysis of Differences in the Occurrence of Work Fatigue among Farmers

Work Fatigue	Mean difference	IK 95% (min; max)	P
Stretching VS Providing snacks and setting rest times	-7,322	(-14.36 ; -0.28)	0.042
Stretching VS Simple education about the dangers of work ergonomics	-20,322	(-27.36 ; -13.28)	<0.001
Simple education about the dangers of ergonomic work	-13.00	(-20.19 ; -5.81)	0.001

DISCUSSION

Univariate Analysis

Resting and snacking to help reduce fatigue has been shown to provide an opportunity to release stress and restore energy. This will reduce the accumulated impact of fatigue and thus the level of fatigue that occurs will decrease. Optimal nutrition has a positive impact on individual work productivity. Conversely, if calorie intake does not match needs, workers will experience fatigue more quickly (Sensa, Susanto and Yohanan, 2022). In addition to snacks, rest practices can be a strategy to maintain physical health during monotonous work. This awareness of the importance of managing fatigue by taking short breaks can help improve productivity and quality of work, while maintaining a healthy life balance (Wurarah, 2020).

In a study conducted by Alshayji, Darwis and Alali (2022) entitled Optimal Production Output and Rest Frequency for Fatigued Workers showed that short breaks at work can overcome work fatigue and increase work productivity.

Eating and rest can help reduce fatigue, but if the food consumed before working and at rest is not balanced with the energy released and the work done

also has significant ergonomic problems, then the worker will remain vulnerable to fatigue (Farihatin, Subandriani and Setiadi, 2022).

Univariate tests showed differences in demographic characteristics and working conditions between the three groups of farmers. Group 1 had an average age of 53 with 27 years of service and worked for 7 hours a day. Farmers in this group scored an average of 2 for the use of personal protective equipment (PPE), indicating that they only wore hats and long clothes while working. Their average fatigue level was 52.04. In contrast, farmers in group 2 had an average age of 55 years, 23 years of service, and also worked for 7 hours a day. They also scored 2 for PPE use, but their average fatigue level was higher at 59.36.

Group 3 had farmers with an average age of 51 years and a working life of 28 years, as well as a slightly longer working period of 8 hours a day. Although they also scored 2 for PPE use indicating the wearing of hats and long clothes, their fatigue levels were much higher, with an average score of 72.36. This finding suggests that while there were similarities in PPE use across the three groups, differences in age, tenure, and length of work contributed to the variation in fatigue levels between them.

Multivariate Analysis

For work fatigue itself, based on the test results, the p value = 0.042 was obtained in the stretching group and the snack group and setting the break time, where the p value = 0.042 is smaller than alpha, namely 0.05, which means that there is a difference in the test in the stretching group and the snack group and setting the break time. This is in line with research, that providing short breaks with snacks provides an opportunity for the body to recover and feel refreshed after undergoing tiring work. Stretching is also effective in reducing the fatigue of farmers, this is in line with research (Fathonah, 2023). Stretching has an important role in reducing fatigue and can increase muscle strength and endurance. A 5-10 minute break provides time to stretch the legs, "in an effort to reduce fatigue-related incidents" (Dyall, 2023).

Based on the test results in the stretching group and the group that provides simple education about the dangers of work ergonomics, the p value = <0.001 which is still lower than alpha, namely 0.05, which means that there are differences in tests in the stretching group and the group that provides simple education about the dangers of ergonomic work. Stretching can also reduce fatigue in farmers, this is in line with the theory in research (Isnaeni and Gustriana, 2021). Stretching interventions carried out for 10-15 minutes in the middle of work, with each participant as many as 16 movements, are intended to restore worker freshness, increase concentration and stimulate creativity. This is expected to help prevent the risk of accidents due to fatigue. For the group, providing simple education about the dangers of effective work ergonomics is in line with research Aprilliani *et al*. (2022) that, in order for respondents to avoid the risk of work fatigue, it is hoped that they can increase efficiency in managing rest time and improve work attitudes, so that they are more comfortable in carrying out their work duties. Further research illustrates that work attitudes associated with unhealthy work systems can stimulate serious impacts on workers. Excessive workloads, unrealistic time limits, and work demands that are too intense can trigger significant levels of fatigue (Krisdiana *et al*., 2022).

Based on the test results in the group giving snacks and setting rest time with a group that provides simple education about the dangers of work ergonomics, the p value = 0.001 is still lower than alpha, namely 0.05, which means that there is a difference in tests in the group giving snacks and setting rest time with a group that provides simple education about the dangers of work ergonomics. This is in line with previous research. Based on research (Sagala, Sucipta and Tika, 2016), the study showed that farmers who were given snacks experienced a decrease in fatigue of about 24% compared to farmers who were not given snacks).

Multivariate test results using One Way ANOVA showed that there was a significant difference in the effectiveness of the innovative ergonomics model in preventing work fatigue between at least two groups of farmers. With a p-value of <0.001, which is less than alpha 0.05, this analysis indicated that there was a significant difference in the level of work fatigue between the groups that were given various ergonomic interventions, such as stretching, snacks and breaks, and education on ergonomic hazards. Therefore, further tests were required to determine which groups were significantly different.

LSD post hoc analysis showed that all comparisons between groups had significant differences. Specifically, there were significant differences between the group given stretching and the group given snacks and break time management

($p = 0.042$), between the stretching group and the group given simple education on ergonomic hazards ($p < 0.001$), and between the snacks and break time group and the simple education on ergonomic hazards group ($p = 0.001$). In other words, all tested groups had significant differences in work fatigue levels, confirming that each type of ergonomics intervention applied affected work fatigue levels differently.

The according to Qosim, Susanto and Setyaningsih (2021) reporting that the intervention of work attitude by providing snacks on the sidelines of working hours can reduce work fatigue because the provision of additional food for labor in the form of snacks will help workers in maintaining stamina and calorie capabilities until the next meal time. Based on research Pangaribuan *et al*.(2022). The purpose of applying Ergonomics in the work environment is to ensure that workers can carry out their duties in conditions of health, comfort, safety, productivity and welfare. Thus it can be concluded that providing snacks and setting break times and providing simple education about ergonomic work risks is effective in reducing fatigue in farmers.

CONCLUSION

There are differences in the effectiveness of innovative ergonomic models in preventing occupational fatigue between at least two groups of rice farmers. The results of LSD post hoc analysis showed that the groups that had differences in the incidence of occupational fatigue in farmers were the group given stretching with the group given snacks and regulated rest time, the group given stretching and the group given regulated rest time. Simple education on occupational ergonomic hazards, and the group given snacks and regulated rest time with the group giving simple education on occupational ergonomic hazards. In other words, the difference in the incidence of occupational fatigue was significantly different in all groups of innovative ergonomic models tested.

Providing stretching, providing snacks, setting breaks, and providing simple education about the dangers of work ergonomics are effective ways to prevent fatigue in rice farmers.

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CONFLICT OF INTEREST

All authors declare that they had no conflict of interest.

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