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WORKPLACE HEALTH PROMOTION THROUGH ERGONOMIC EXERCISE AMONG INFORMAL PALM SUGAR WORKERS: A PRE-POST INTERVENTION STUDY

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ABSTRACT

Background: Work fatigue is a common occupational health problem that reduces productivity, impairs work capacity, and increases the risk of occupational accidents, particularly among informal sector workers. Workplace health promotion strategies are needed to address this issue. Ergonomic exercise has emerged as a practical intervention to reduce physical fatigue and improve workers' well-being. This study aimed to evaluate the effects of workplace health promotion through ergonomic exercises on reducing work fatigue among informal palm sugar workers.
Methods: A quantitative pre-experimental study with a one-group pretest–posttest design was conducted among 60 informal palm sugar workers at Factory B, a branch production site of CV. Bangkit Jaya is located in Klaten Regency, Indonesia. Participants were recruited using purposive sampling. Work fatigue was assessed using the Industrial Fatigue Research Committee (IFRC) questionnaire before and after the intervention. Ergonomic exercise sessions were implemented 24 times over a 12-month period. Data were analyzed using the paired *t*-test.
Results: Most participants were middle-aged (65.0%), female (57.1%), and had long working experience (83.3%). The mean work fatigue score decreased significantly from 65.40 before the intervention to 40.50 after the intervention, a reduction of 24.90 points. The paired *t*-test demonstrated a statistically significant reduction in work fatigue following the intervention ($p < 0.001$).
Conclusion: Ergonomic exercise is an effective workplace health promotion strategy for reducing work fatigue among informal palm sugar workers. Incorporating ergonomic exercise into occupational health promotion programs may improve workers' well-being, enhance productivity, and support sustainable health practices in the informal sector.
Keywords: ergonomic exercise, informal workers, palm sugar workers, work fatigue, workplace health promotion

INTRODUCTION

Indonesia's population continues to grow steadily, accompanied by a parallel increase in the working-age population and labor force participation. According to the National Labor Force Survey (Sakernas) in February 2023, the total labor force reached 146.62 million, an increase of 2.61 million from the previous year. The manufacturing sector remains one of the largest contributors to employment in Indonesia, ranking third after the trade and agriculture-related sectors (Kementerian Ketenagakerjaan RI, 2026). This trend highlights the importance of maintaining worker productivity through comprehensive occupational health and workplace health promotion strategies, particularly in labor-intensive industries with high physical demands.

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At the regional level, Klaten Regency reported more than 1 million working-age individuals in 2023, with a substantial proportion employed in the industrial sector. While this sector contributes significantly to regional economic development, it also presents considerable occupational health challenges, including workplace accidents and work-related fatigue (PERDA Kabupaten Klaten, 2021; Azizah & Kusasih, 2023). Fatigue has been identified as a leading contributor to occupational incidents, especially in labor-intensive occupations. Therefore, reducing work fatigue has become a key priority in workplace health promotion initiatives aimed at improving worker safety, well-being, and productivity.

Work fatigue is a multidimensional condition characterized by physical, mental, and emotional exhaustion resulting from prolonged work demands. Although fatigue serves as a physiological protective mechanism, excessive fatigue can impair alertness, reduce cognitive and physical performance, and increase the likelihood of occupational accidents (Hu et al., 2026; Xu et al., 2021). Various factors contribute to work fatigue, including prolonged working hours, inadequate recovery time, excessive workload, repetitive movements, and poor ergonomic conditions (World Health Organization, 2023). Environmental factors such as excessive heat, noise exposure, and poorly designed workstations may further aggravate fatigue levels. These findings highlight the need for comprehensive occupational health interventions that address both individual and workplace-related risk factors.

The consequences of work fatigue extend beyond decreased work performance and include substantial long-term health implications. Persistent fatigue has been associated with reduced productivity, impaired work capacity, increased occupational injuries, musculoskeletal disorders, cardiovascular diseases, metabolic disorders, and psychological problems such as anxiety and depression (Macfarlane et al., 2024; Wardhana & Tejamaya, 2024). Consequently, effective and sustainable workplace health promotion programs are required to reduce fatigue while improving workers' overall health and occupational performance.

Informal palm sugar production remains one of Indonesia’s labor-intensive industries where occupational health practices are often limited. Workers perform physically demanding tasks throughout the production process, including prolonged standing, repetitive lifting, bending, squatting, and manual handling of heavy materials. Preliminary observations conducted at a branch factory of CV. Bangkit Jaya in Klaten Regency, Central Java, indicated that these working conditions impose considerable biomechanical stress on workers and contribute to musculoskeletal discomfort, particularly in the lower back, neck, shoulders, and upper extremities (Ramdan et al., 2020; Tanjung et al., 2023; Shikdar & Al-Araimi, 2025). Furthermore, the absence of structured workplace health promotion programs and ergonomic interventions may increase cumulative fatigue and negatively affect workers’ health and productivity.

Interviews with workers in the production, molding, and packaging divisions revealed frequent complaints of low back pain, neck stiffness, shoulder discomfort, and hand pain associated with repetitive tasks, awkward working postures, and prolonged physical workloads. These conditions reduce workers’ physical capacity and may compromise occupational performance. Previous studies have consistently identified repetitive manual work and poor ergonomic conditions as important determinants of work fatigue in labor-intensive industries (Gebrye et al., 2025; Ramadhan et al., 2025). However, evidence regarding effective workplace health promotion strategies for informal workers remains limited.

Workplace health promotion encompasses interventions designed to improve workers’ health, safety, and well-being by creating healthier work environments and encouraging

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healthy work practices. Among various workplace health promotion strategies, ergonomic exercise represents a practical, low-cost, and easily implemented intervention suitable for labor-intensive industries. Ergonomic exercise aims to improve flexibility, enhance muscle elasticity, promote blood circulation, reduce muscle tension, and facilitate recovery from repetitive physical activities. Previous studies have demonstrated that ergonomic exercise effectively reduces work fatigue, alleviates musculoskeletal complaints, and improves functional performance among industrial workers (Sumardiyono et al., 2025; Arwani et al., 2023). These characteristics make ergonomic exercise particularly appropriate for informal workplaces where occupational health resources are often limited.

Despite increasing evidence supporting ergonomic interventions, most previous studies have focused on formal industrial settings with well-established occupational health systems. Evidence regarding workplace health promotion interventions among informal palm sugar workers remains scarce. Therefore, this study aimed to evaluate workplace health promotion through ergonomic exercise among informal palm sugar workers at a branch factory of CV. Bangkit Jaya, Klaten Regency, Indonesia, using a pre–post intervention design. The findings are expected to provide empirical evidence supporting the integration of ergonomic exercise into occupational health promotion programs for informal workers, thereby improving worker well-being, productivity, and occupational safety in labor-intensive industries.

RESEARCH METHOD

This study employed a quantitative pre-experimental one-group pretest–posttest design to evaluate the implementation of workplace health promotion through ergonomic exercise in reducing work fatigue among informal palm sugar workers. The study was conducted at a branch factory of CV. Bangkit Jaya, an informal palm sugar production industry located in Klaten Regency, Central Java, Indonesia, from August 2024 to August 2025.

The study population consisted of workers engaged in labor-intensive production activities, including sap processing, cooking, molding, and packaging. A total of 60 workers participated in the study and were recruited using purposive sampling based on predetermined eligibility criteria. Eligible participants were active production workers who were willing to participate, able to perform the ergonomic exercise program, and had worked in the production unit for at least six months. Workers with severe musculoskeletal disorders, cardiovascular conditions, or other medical problems that could interfere with exercise participation were excluded.

The independent variable was a workplace health promotion intervention through ergonomic exercise, while the dependent variable was the level of work fatigue. Participant characteristics, including age, sex, and years of work experience, were collected to describe the study population. Work fatigue was assessed using the Industrial Fatigue Research Committee (IFRC) questionnaire, a validated instrument that measures physical, mental, and motivational dimensions of fatigue. Data were collected using self-administered questionnaires with guidance from the research team to ensure participants' understanding and minimize response bias.

The intervention consisted of a structured ergonomic exercise program designed as a workplace health promotion activity for informal workers. Participants completed the IFRC questionnaire as a pretest before the intervention. Subsequently, they performed ergonomic exercise sessions lasting approximately 10–15 minutes, focusing on major muscle groups involved in palm sugar production activities, including the neck, shoulders, upper limbs, trunk, and lower extremities. The exercise program was

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implemented in 24 supervised sessions over a 12-month period to ensure adherence and correct performance. Following completion of the intervention, participants completed the posttest using the same IFRC questionnaire under comparable conditions.

Data were analyzed using statistical software. Descriptive statistics were used to summarize participant characteristics and work fatigue scores. The normality of data distribution was assessed using the Shapiro–Wilk test. Since the data were normally distributed, differences between pretest and posttest fatigue scores were analyzed using the paired t-test, with statistical significance set at $p < 0.05$.

This study received ethical approval from the Research Ethics Committee of Universitas Aisyiyah Surakarta (No. 224/VIII/AUEC/2024). Written informed consent was obtained from all participants before data collection. Participant confidentiality, anonymity, and the right to withdraw from the study at any stage were ensured throughout the research process.

RESULTS

A total of 60 informal palm sugar workers from a branch factory of CV. Bangkit Jaya participated in this study. Table 1 presents the distribution of participants according to age, sex, nutritional status, and years of work experience.

Table 1. Characteristics of Informal Palm Sugar Workers (n = 60)

Characteristic	Frequency (f)	Percentage (%)
Age category		
Adolescence	10	16.7
Early adulthood	11	18.3
Middle adulthood	39	65.0
Total	60	100
Gender		
Male	4	6.6
Female	56	93.3
Total	60	100
Nutritional status		
Underweight	12	12.0
Normal	34	56.7
Overweight	8	13.3
Obese	6	10.0
Total	60	100
Work period		
< 6 years	10	16.7
6-10 years	50	83.3
Total	60	100

Based on Table 1., the characteristics of the sample from the age category are dominated by samples with a middle adulthood of (65.5%). By gender, it is dominated by females (93.3%). Based on nutritional status, as indicated by body mass index, the majority are in the normal range (56.7%). Based on the characteristics of the work period, samples with a work period of 6-10 years were the most common (83.3%).

Table 2. Mean pretest posttest

Test category	Mean	Std. Dev
Pretest	65.40	7.372
Posttest	40.50	4.180

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Table 2. shows that the pre-test and post-test mean scores have changed. Changes in the form of a decrease in the mean score of 24.90. Looking at the individual values in the sample, the largest score change was 42, and the smallest was 8.

Table 3. shows that work fatigue at pre-test was dominated by the moderate work fatigue category. The level of work fatigue at post-test was all in the low work fatigue category.

Table 3. Work Fatigue Level Pretest Posttest

Work Fatigue Level	**Pretest**		**Posttest**	
	Frequency (f)	**Percentage (%)**	**Frequency (f)**	**Percentage (%)**
Low	-	-	60	100
Moderate	50	83.3	-	-
High	10	16.7	-	-

Table 4. Work Fatigue Level Based On A Characteristic Sample

Characteristic	**Pretest**			**Posttest**		
	Low	**Moderate**	**High**	**Low**	**Moderate**	**High**
Age category						
Adolescence	-	10	-	10	-	-
Early adulthood	-	9	3	11	-	-
Middle adulthood	-	31	8	39	-	-
Gender						
Male	-	4	-	4	-	-
Female	-	46	10	56	-	-
Nutritional status						
Underweight	-	8	4	12	-	-
Normal	-	30	4	34	-	-
Overweight	-	6	2	8	-	-
Obese	-	6	-	6	-	-
Work period						
< 6 years	-	10	0	10	-	-
6-10 years	-	40	10	50	-	-

Table 4. shows that in the pre-test results, the characteristics of the sample based on the age category of middle adulthood with moderate levels of work fatigue dominated as many as 31 samples (51.7%), while the characteristics based on gender were dominated by women with moderate levels of work fatigue as many as 46 samples (76.6%). Characteristics by nutritional status are dominated by normal status, with moderate fatigue in as many as 30 samples (50%). The characteristics based on work period with moderate levels of job fatigue comprised 40 samples (66.6%).

Based on the results of the post-test, the characteristics of the sample based on age in the middle adulthood category with low levels of job fatigue dominated as many as 39 samples (65%), while the characteristics based on gender were dominated by women with low levels of job fatigue as many as 56 samples (93.3%). Characteristics by nutritional status are dominated by normal nutritional status, with low fatigue in as many as 34 samples (56.6%). Meanwhile, the characteristics based on work period with low levels of job fatigue were 50 samples (83.3%).

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Table 5. Normality result

	Kolmogorov-Smirnov	
	n	Sig
IFRC pretest	60	0.060
IFRC posttest	60	0.019

Based on Table 5, the normality test results show a significance value ($p > 0.05$), indicating a normal distribution of the data, so parametric statistical analysis is continued.

Table 6. Paired t-test result

Result	Paired sample t test		Information
	n	Sig. (2-tailed)	
IFRC pretest & posttest	60	0.000	meaningful

Table 6 shows that the paired-sample t-test yields a ρ-value of 0.000 ($p<0.05$), which means Ha is accepted and H0 is rejected. Based on the results of the hypothesis test, it can be concluded that ergonomic gymnastics has an effect on job fatigue among workers.

DISCUSSION

This study involved 60 informal palm sugar workers aged between 22 and 53 years. Most participants were middle-aged adults, indicating that the workforce consisted predominantly of individuals in a productive age group who nevertheless face age-related declines in physical capacity. Age has been recognized as an important determinant of work performance because increasing age is associated with reduced muscle strength, flexibility, and physical endurance, all of which may contribute to work fatigue. However, longer work experience may partially compensate for these physiological changes through improved skills, task familiarity, and work efficiency (World Health Organization, 2023; Macfarlane et al., 2024; Wardhana & Tejamaya, 2024). These findings emphasize the importance of workplace health promotion programs that maintain workers' physical capacity throughout their working lives.

The majority of participants were female, reflecting the employment characteristics of the informal palm sugar industry at the study site. Female workers frequently perform repetitive manual tasks while simultaneously carrying domestic responsibilities, increasing their overall physical and psychological workload. Previous studies have reported that female workers often experience higher levels of fatigue and musculoskeletal discomfort than their male counterparts because of cumulative occupational and non-occupational demands (Dwiseli & Wenas, 2025; Eliza et al., 2023). These findings suggest that workplace health promotion programs should consider gender-specific risk factors and provide interventions appropriate to the physical demands faced by female workers.

More than half of the participants had normal nutritional status, an important factor in maintaining energy balance, muscle function, and physical endurance during work. Adequate nutritional status supports metabolic efficiency and muscular recovery, thereby reducing susceptibility to fatigue. Conversely, inadequate nutritional status may impair physical performance and prolong recovery following repetitive work activities (World Health Organization, 2024; Sumardiyono et al., 2025; Arwani et al., 2023). Therefore, nutritional status should be considered an integral component of workplace health promotion initiatives aimed at improving workers' overall health and productivity.

Most participants had six to ten years of work experience, indicating prolonged exposure to repetitive manual tasks and awkward working postures. Although work

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experience improves technical skills and productivity, continuous exposure to biomechanical stress may increase cumulative physical load and contribute to chronic fatigue and musculoskeletal disorders. Similar findings have been reported in labor-intensive industries, where prolonged repetitive work is associated with increased occupational fatigue and decreased physical performance (Rahman & Sakamoto, 2024; Jafarizaveh et al., 2026). These findings reinforce the importance of implementing preventive workplace health promotion programs in informal industries where ergonomic risks remain largely unaddressed.

The principal finding of this study demonstrated that workplace health promotion through ergonomic exercise significantly reduced work fatigue among informal palm sugar workers. The significant reduction in fatigue scores following the intervention indicates that ergonomic exercise is an effective strategy for improving workers' physical well-being in labor-intensive occupations. Unlike interventions requiring sophisticated equipment or substantial financial investment, ergonomic exercise is simple, inexpensive, and easily incorporated into routine workplace activities, making it particularly suitable for informal industries with limited occupational health resources.

The effectiveness of ergonomic exercise can be explained through several physiological and biomechanical mechanisms. Regular stretching improves muscle flexibility, increases joint range of motion, enhances peripheral blood circulation, and facilitates oxygen delivery to working muscles. These physiological responses reduce muscle stiffness, minimize lactic acid accumulation, and accelerate recovery following repetitive physical activities. Furthermore, ergonomic exercise improves postural alignment and reduces biomechanical loading on muscles and joints that are continuously involved in manual work. Collectively, these adaptations contribute to reduced physical fatigue, improved work comfort, and enhanced functional capacity among workers (Weerapong et al., 2024; Zvetkova et al., 2023; International Labour Organization, 2024).

From the perspective of workplace health promotion, ergonomic exercise represents a primary preventive intervention that empowers workers to actively maintain their own physical health. Unlike curative approaches that treat work-related disorders after they occur, workplace health promotion emphasizes preventing health problems through behavioral modification, healthy workplace practices, and regular physical activity. Integrating ergonomic exercise into daily work routines may therefore reduce fatigue, decrease the risk of musculoskeletal disorders, improve work ability, and support long-term occupational health outcomes.

The implementation of ergonomic exercise in this study demonstrates that workplace health promotion strategies are feasible even in informal industries with limited access to structured occupational health services. Palm sugar production relies heavily on manual labor, repetitive movements, prolonged standing, and awkward postures, all of which contribute to excessive physical workload. Introducing short ergonomic exercise sessions before or during work provides workers with a practical opportunity to prepare their muscles for physical activity, reduce cumulative physical strain, and promote recovery without disrupting production processes. This finding highlights the practicality of ergonomic exercise as a sustainable workplace health promotion strategy in labor-intensive settings.

The findings of this study are consistent with previous research demonstrating that ergonomic exercise effectively reduces work fatigue and musculoskeletal complaints among industrial workers. However, the present study extends existing evidence by demonstrating the applicability of ergonomic exercise within the informal palm sugar industry, a sector that has received relatively little attention in occupational health research. The successful implementation of ergonomic exercise in this setting suggests

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that similar workplace health promotion programs may be adapted for other informal industries characterized by repetitive manual work and limited occupational health infrastructure.

This study has several practical implications. Employers and industry managers may incorporate ergonomic exercise into routine workplace activities as a simple and cost-effective health promotion strategy. Local health authorities and occupational health practitioners may also consider ergonomic exercise as part of community-based workplace health promotion programs targeting informal workers. Such collaborative efforts have the potential to improve workers' health, reduce occupational fatigue, enhance productivity, and support sustainable occupational health practices within informal labor-intensive industries.

Despite these promising findings, this study has several limitations. The use of a one-group pretest–posttest design without a control group limits causal inference and may not fully account for external factors influencing fatigue levels. Furthermore, the study was conducted in a single informal palm sugar production site, which may limit the generalizability of the findings to other occupational settings. Future studies employing randomized controlled trials, larger sample sizes, longer follow-up periods, and multiple informal industries are recommended to further evaluate the long-term effectiveness of workplace health promotion through ergonomic exercise.

Overall, this study demonstrates that workplace health promotion through ergonomic exercise is an effective strategy for reducing work fatigue among informal palm sugar workers. The findings support integrating ergonomic exercise into routine workplace health promotion programs as an accessible, low-cost, and sustainable intervention to improve workers' health, occupational safety, and productivity, particularly in labor-intensive informal industries.

CONCLUSION

This study concludes that workplace health promotion through ergonomic exercise is effective in reducing work fatigue among informal palm sugar workers at a branch factory of CV. Bangkit Jaya, Klaten Regency, Indonesia. The intervention significantly reduced workers' fatigue levels by improving muscle flexibility, relieving muscle tension, and enhancing physical comfort during labor-intensive production activities. As a simple, practical, and low-cost intervention, ergonomic exercise can be readily integrated into daily work routines without disrupting production processes. The findings highlight the important role of workplace health promotion in supporting worker well-being, maintaining work capacity, and improving productivity in informal labor-intensive industries. Integrating ergonomic exercises into routine workplace activities may help prevent fatigue, promote occupational safety, and foster healthier work environments. Therefore, ergonomic exercise should be considered a feasible workplace health promotion strategy in the informal sector with limited occupational health resources.

RECOMMENDATIONS

Based on the findings of this study, future research should employ more robust study designs, such as randomized controlled trials or quasi-experimental controlled studies, to strengthen the evidence on the effectiveness of workplace health promotion through ergonomic exercise. Studies involving larger sample sizes, multiple informal industries, and longer follow-up periods are also recommended to improve the generalizability and sustainability of the findings. Future studies are encouraged to incorporate objective physiological measurements, such as heart rate variability, electromyography, muscle strength, or physical performance assessments, alongside subjective fatigue

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questionnaires to provide a more comprehensive evaluation of intervention outcomes. Researchers should also investigate the long-term effects of ergonomic exercise on productivity, musculoskeletal health, occupational injuries, absenteeism, and quality of life. From a practical perspective, employers, occupational health practitioners, and local health authorities are encouraged to integrate ergonomic exercise into routine workplace health promotion programs for informal workers. Combining ergonomic exercise with complementary strategies, such as ergonomic workstation improvements, work–rest scheduling, health education, and participatory ergonomics, may further enhance worker health, occupational safety, and productivity. Such integrated workplace health promotion initiatives have the potential to provide sustainable, cost-effective solutions to improve occupational health in labor-intensive informal industries.

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