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The Implementation of Ergo-SMEs to Reduce Musculoskeletal Complaints and Fatigue among Workers in Dodol Production

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ABSTRACT: Non-ergonomic working postures, repetitive movements in awkward positions for prolonged periods, and hot working environments are major contributors to the increase in musculoskeletal complaints and fatigue among dodol workers. This study aims to demonstrate that the implementation of ErgoSMEs can reduce musculoskeletal complaints and fatigue among dodol workers. This research employed an experimental design with a within-subjects approach. The study was conducted on 16 dodol workers in Penglatan Village who were selected based on inclusion and exclusion criteria, during the period from January to August 2024. Data collection was carried out in two phases: Phase 1 during conventional work practices and Phase 2 during work with the implementation of Ergo-SMEs. The collected data were statistically analyzed using SPSS Statistics 22. Normality was assessed using the Shapiro-Wilk test. Paired sample t-tests were used for normally distributed data, while the Wilcoxon Signed-Rank test was used for non-normally distributed data. The data analysis showed that improving working conditions through Ergo-SMEs led to a 23.8% reduction in musculoskeletal complaints (p=0.001) and a 24.4% reduction in worker fatigue (p=0.001). Based on the data analysis, it can be concluded that the implementation of Ergo-SMEs effectively reduces musculoskeletal complaints and fatigue among dodol production workers.

KEYWORDS: Ergo-SMEs, musculoskeletal complaints, fatigue.

I. INTRODUCTION

Small and Medium Enterprises (SMEs) serve as one of the fundamental pillars supporting Indonesia's national economy. However, many SMEs still rely on traditional working methods with minimal consideration for occupational health and safety. Such working conditions can compromise worker performance and, in severe cases, lead to fatalities due to workplace accidents or occupational diseases. According to the International Labour Organization (ILO), approximately 2.78 million workers die each year, with 13.7% due to occupational accidents and 86.3% due to work-related illnesses. Among the various SME products familiar to the Indonesian public, *dodol*—a traditional sweet confection—remains particularly popular and economically significant. Despite its contributions, several issues have been identified in the dodol production process based on field observations, assessments, and stakeholder discussions. Workers are required to manually stir the dodol mixture using a long-handled spatula while standing continuously for 3 to 4 hours until the mixture is fully cooked. This process increases physical workload, causes muscular tension, and leads to fatigue. Compared to sitting, standing for prolonged periods is more tiring and requires approximately 10–15% more energy (Fitriyani et al., 2019).

While standing can promote physical and mental readiness—thus enabling faster and more precise work (Tarwaka)—improper or prolonged standing postures may lead to musculoskeletal issues. For example, frequently elevated arms can cause shoulder strain, while excessive forward bending may result in lower back pain. Non-neutral working postures can trigger unnecessary muscle activity, which leads to energy inefficiency, fatigue, and increased risk of injury (Adiputra, 2004).

Environmental conditions also pose a challenge. The dodol is typically cooked over open flames, exposing workers to excessive heat. Continuous and dynamic interaction between the worker and the thermal environment can result in both physiological and psychological disturbances, which adversely affect comfort, health, and productivity (Parsons, 2000).

The human body is an active system that responds to thermal stress to maintain a core temperature of approximately 37°C. When body temperature rises, blood circulation to the skin increases (by 20–30 mL/min) along with sweat production, heart rate, and blood pressure. As more blood is directed to the skin, circulation to vital organs—such as the muscles, brain, and digestive

system—is reduced, impairing their functions (Grandjean, 2000). In hot and humid environments, heat cannot be efficiently dissipated via convection or conduction; instead, it relies on sweat evaporation. Excessive fluid loss through sweat can cause dehydration, which may have serious health consequences. At this stage, workers often feel overheated, sweat excessively, experience thirst and fatigue, and are compelled to pause their work for rest.

These issues are rooted in working conditions that deviate from ergonomic principles. Therefore, solutions are needed to improve workplace conditions in SMEs. The Ergo-SMEs intervention offers an approach to enhancing work conditions in dodol production by incorporating short rest breaks, promoting natural working postures, and adding exhaust chimneys to improve traditional cooking environments. Rest is a critical physiological and psychological requirement that sustains work capacity. Grandjean (2000) describes bodily functions as a rhythmic balance between energy expenditure (work) and energy recovery (rest). Both processes are essential to muscular, cardiovascular, and overall biological functioning. Therefore, adequate rest should be provided both during and outside of working hours to maintain performance and efficiency.

Non-neutral postures when interacting with equipment can cause fatigue and musculoskeletal strain. If sustained and repetitive, these can lead to compression of the intervertebral discs, resulting in low back pain (Grandjean, 2000). Promoting neutral postures during dough mixing—based on proper body mechanics—can help minimize strain on the spinal column and other body segments. Poor ventilation further exacerbates heat stress in the work environment. Installing exhaust chimneys can be an effective solution, as they remove combustion smoke and excess heat, thus improving comfort and reducing health risks associated with heat exposure. This study aims to examine the effectiveness of the Ergo-SMEs approach in reducing musculoskeletal complaints and fatigue among workers involved in dodol production.

II. METHOD

This study employed an experimental design using a *treatment by subject* approach, also known as a within-subjects design (Bakta, 2021). The research was conducted at a *dodol* production enterprise located in Penglatan Village over a period of eight months, from January to August 2024. The accessible population consisted of *dodol* workers in Penglatan Village. The sample comprised workers who met the inclusion criteria: *dodol* production workers aged between 25 and 55 years, with a minimum of one year of work experience, who were willing to participate and able to complete the study. The exclusion criteria included workers currently experiencing illness (such as muscle or joint pain, shortness of breath/asthma), or obesity. The sample size was determined using Colton's sample size formula, as cited in Bakta (2021), resulting in a total of 16 participants.

Data analysis involved descriptive statistics to assess participant characteristics, musculoskeletal complaints, fatigue levels, and work environment conditions, including thermal climate, lighting, and noise levels. These data were presented as means and standard deviations. Data normality was assessed using the Shapiro–Wilk test. To test the research hypotheses, inferential statistical analyses were conducted to examine differences within and between conditions.

a. Period Effect Analysis

This analysis was used to determine whether the condition in Period 1 influenced the outcomes in Period 2. A paired *t*-test was used to assess differences across periods.

b. Paired Sample Comparison

If the normality test indicated that the data followed a normal distribution, a paired *t*-test was applied. If the data did not meet the assumption of normality, a non-parametric test—the Wilcoxon Signed-Rank Test—was employed.

III. RESULTS

The findings of this study indicate that the average age of the participants was 44.94 years. All participants were female and had an average Body Mass Index (BMI) of 24.94, which falls within the normal category—none were underweight or obese. All participants had more than one year of work experience, indicating that they had undergone a process of acclimatization to their jobs, thereby minimizing potential bias in the study.

1. Work Environment Conditions

The average scores for light intensity, noise levels, temperature, and humidity are presented in table below.

Table 1. Work Environment Conditions

No	Variable	Period 1				Period 2				p
		Mean	SD	*Min*	*Max*	Mean	SD	*Min*	*Max*	
1	Light intensity (Lux)	300,00	6,02	289,00	306,00	301,50	6,91	294,00	312,00	0,512
2	Noise (dB)	68,75	4,95	60,00	78,00	69,75	4,37	62,00	78,00	0,121
3	Dry Temperature (^{0}C)	35,53	1,78	34,40	38,70	32,82	0,50	32,20	33,43	0,043
4	Humidity (%)	47,68	4,07	44,22	52,70	60,52	1,85	58,01	62,76	0,002

There was a slight increase in light intensity between Period 1 and Period 2, amounting to 1.5 lux, and an increase in noise levels of 1 dB. However, statistical tests showed no significant differences between the two periods for either variable ($p > 0.05$). In contrast, temperature decreased by an average of 2.71°C, while humidity increased by 12.84%. These changes in the work climate variables were statistically significant ($p < 0.05$), indicating an improvement toward a more comfortable working environment.

2. Mean Analysis of Musculoskeletal Complaints in Period 1 and Period 2

Musculoskeletal complaints among *dodol* workers were measured using the Nordic Body Map (NBM) questionnaire, administered both before and immediately after work in Periods 1 and 2. Results are presented in table below.

Table 2. Musculoskeletal complaints among *dodol* workers

No	Variable	Period 1		Period 2		Mean difference	P
		Mean	SD	Mean	SD		
1	Before work	28,13	0,22	28,22	0.41	0,09	0,083
2	After work	46,31	10,12	35,25	3.61	11,06	0.001

Data analysis showed no significant difference in the average musculoskeletal complaint scores before work between Period 1 and Period 2 ($p > 0.05$), indicating comparable baseline conditions. However, a significant difference was observed in post-work complaint scores between the two periods ($p = 0.001$; $p < 0.05$), indicating that workers reported significantly fewer complaints after working under the Ergo-SMEs intervention compared to the conventional method. The average score reduction was 11.06 points, yielding a percentage decrease of 23.8% (11.06 / 46.31 × 100). In other words, the Ergo-SMEs intervention reduced musculoskeletal complaints among *dodol* workers by 23.8%.

3. Mean Analysis of Fatigue in Period 1 and Period 2

Fatigue levels were assessed using a 30-item rating scale developed by the Japan Association of Industrial Health (JAIH), administered both before and immediately after work in Periods 1 and 2. Results are presented in table 3.

Table 3. Fatigue levels among *dodol* workers

No	Variable	Period 1		Period 2		Mean difference	P
		Mean	SD	Mean	SD		
1	Before work	30,34	0,30	30,28	0,26	0,06	0,317
2	After work	47,31	5,06	35,72	2,06	11,59	0,001

No significant difference was found in fatigue scores before work between the two periods ($p > 0.05$), indicating comparable starting conditions. However, a statistically significant difference was observed in post-work fatigue scores between Period 1 and Period 2 ($p = 0.001$; $p < 0.05$), demonstrating that workers experienced significantly lower fatigue levels under the Ergo-SMEs intervention compared to the conventional approach. The average score reduction was 11.53 points, corresponding to a 24.4% decrease (11.53 / 47.31 × 100). Thus, the Ergo-SMEs intervention was shown to reduce worker fatigue by 24.4%.

The fatigue questionnaire comprises three categories: activity-related fatigue (items 1–10), motivational fatigue (items 11–20), and physical fatigue (items 21–30). All three categories showed reductions from Period 1 to Period 2. Activity-related fatigue decreased by 11.52%, motivational fatigue by 3.16%, and physical fatigue by 14.3%. Among these, the greatest reduction was observed in the physical fatigue category.

IV. DISCUSSION

1) Respondent Characteristics

The characteristics of the workers involved in this study reflect the internal conditions of the participants during the research period. These attributes are closely related to individual work capacity. In ergonomic balance, task demands must align with a worker's capacity to achieve optimal performance without adverse effects on health and well-being.

The analysis of participant age revealed a range between 29 and 55 years, which is within the productive age group. According to the International Labour Organization (ILO), this range falls within the working-age population (15–64 years). Given their age and the physical nature of their work, these workers were considered to be within the optimal range for performing *dodol*-making tasks and capable of recovering quickly from fatigue or musculoskeletal discomfort.

Nutrition plays a vital role in supporting and enhancing metabolism and the performance of various organs in the human body. Proper nutrition helps maintain muscle function during work activities, supports recovery after physical exertion, and strengthens the immune system—thereby reducing the risk of illness and accelerating recovery. Electrolytes such as sodium, potassium, and magnesium are essential for muscle function and fluid balance. Deficiencies or imbalances in these electrolytes can impair physical performance and cause muscle cramps or fatigue. Overall, a balanced and nutritious diet enhances work capacity and promotes general well-being. Occupational nutrition not only improves health status but also significantly boosts work productivity. Previous research has shown that nutritional regulation can reduce fatigue and musculoskeletal complaints (Yuliani et al., 2021).

The nutritional status of the sample was assessed using Body Mass Index (BMI), with an average BMI of 24.94, which falls within the normal category. None of the participants were underweight or obese. Nutritional status is a critical factor influencing an individual's work capacity. It is one of the eight ergonomic factors affecting productivity and efficiency, and thus its inclusion in this study is warranted. A low BMI can indicate energy deficiency, leading to reduced productivity, while an excessive BMI (obesity) increases the risk of musculoskeletal disorders. According to Suma'mur (2014), individual work capacity varies depending on skill, physical fitness, nutritional status, sex, age, and body size. Nutritional status encompasses both the quantity and quality of nutrients consumed, which are crucial for physical health and performance. In this study, the nutritional intervention included fluid intake and *kue bali* (a traditional Balinese cake) containing essential nutrients to meet energy needs during work. Adequate and balanced caloric intake ensures that the body has sufficient energy for both physical and mental activities. Energy deficiency can lead to fatigue and reduced muscle strength, while excessive caloric intake may lead to obesity, both of which negatively impact work capacity.The analysis of work experience showed that participants had been engaged in *dodol* production for 2 to 8 years. Over time, the human body adapts to the physical demands of specific tasks. Longer work experience may have positive impacts, as it allows for physiological adaptation, improved task techniques, enhanced stress and workload management, and better regulation of work-rest cycles— thereby reducing muscle pain and fatigue. However, long work tenure can also have adverse effects. Prolonged muscle use and joint degeneration may increase the risk of musculoskeletal pain. The longer an individual is exposed to risk factors associated with musculoskeletal disorders, the greater the likelihood of developing such conditions (Darlis & Elyanovianti, 2023). Considering the 2 to 8 years of experience among participants, it can be concluded that the workers had undergone sufficient acclimatization. Nevertheless, regular health assessments remain essential to ensure sustained wellbeing.

2) Physical Environmental Conditions

The physical work environment is a critical factor in the production process of any organization. This environment encompasses workplace climate, noise levels, and lighting intensity. A wellmaintained physical environment promotes comfort and supports workers in performing their tasks efficiently. Conversely, an uncontrolled physical environment can negatively impact worker comfort and health, leading to increased workload, faster onset of fatigue, and other subjective complaints that ultimately reduce productivity.

Lighting is one of the essential components of the physical work environment. It plays a crucial role in enabling visual perception, which is vital for nerve function and visual processing in the brain. The eye's ability to clearly perceive objects heavily depends on the quality of lighting in the workplace. Adequate lighting allows workers to perform tasks more accurately, clearly, and quickly. In contrast, poor lighting can result in visual fatigue, which eventually contributes to overall physical fatigue (Ryadyani

& Herbawani, 2022). Visual fatigue arises from intense strain on a single visual function of the eye. In any type of work, visual strain-induced fatigue can lead to production losses, reduced work quality, increased errors, and a higher rate of accidents. According to a report by the United States National Safety Council, insufficient lighting is the sole cause of 5% of industrial accidents and a contributing factor in over 20% of eye-related injuries (Yusuf, 2015). After improving lighting to 200 lux in a welding department, one company reduced its accident rate by 32%. Later, by repainting the walls and ceiling with pale colors to reduce contrast and create more uniform illumination, the accident rate was further reduced by 16.5%.

Data analysis of workplace lighting showed that the average light intensity during Period 1 was 300 lux and 301.5 lux in Period Although there was a slight increase in lighting intensity from Period 1 to Period 2, statistical analysis revealed no significant difference ($p = 0.446$). Light intensity during both periods remained within the acceptable range of 300–500 lux, as stipulated in Indonesian Ministry of Health Regulation No. 70 of 2016 and the Threshold Limit Values (TLVs) of the American Conference of Governmental Industrial Hygienists (ACGIH). Therefore, lighting did not introduce bias into the research.

Noise level measurements showed an average of 68.75 dB in Period 1 and 69.75 dB in Period 2. Although there was a slight increase in noise levels between the two periods, statistical analysis indicated no significant difference ($p = 0.121$). Both noise levels were within the permissible limit of 85 dB for continuous exposure over an 8-hour workday, as established by Indonesian Ministry of Health Regulation No. 48 of 2016 and ACGIH standards. Thus, noise exposure did not introduce bias into this study. However, noise levels above 85 dB may pose a long-term risk of hearing damage.

The analysis of the workplace climate showed an average humidity of 47.68% in Period 1 and 60.52% in Period 2, representing a 12.78% increase. The average dry temperature was 35.53°C in Period 1 and 32.82°C in Period 2, reflecting a 2.65°C decrease. Statistical analysis confirmed a significant difference ($p < 0.05$) in climate conditions between the two periods. This improvement in thermal comfort can contribute positively to workers' performance by creating a more favorable work environment.

Changes in environmental temperature can directly affect individuals' physiological conditions due to continuous interaction between human and environmental factors (Suma'mur, 2014). Under normal conditions, heat transfer from the body to the environment occurs via conduction, convection, or evaporation. However, elevated temperature and humidity levels hinder this heat dissipation, causing heat accumulation in the body. This may lead to reduced comfort and productivity. High temperatures also increase fluid loss through perspiration as the body attempts to regulate heat through evaporation, heightening the risk of dehydration. Additionally, heat exposure can accelerate fatigue and impair focus, as the body redirects blood flow to the skin for cooling, reducing circulation to vital organs. In extreme cases, prolonged heat exposure may lead to serious conditions such as heat exhaustion or heat stroke.

An uncomfortable physical environment can disrupt concentration, reduce work efficiency, and increase the likelihood of errors, thereby heightening the risk of occupational accidents. Furthermore, the work environment also significantly influences employee mood and motivation.

3) Ergo-SMEs Reduces Workers' Musculoskeletal Complaints

The musculoskeletal system consists of the skeletal muscles attached to bones. Musculoskeletal disorders (MSDs) refer to injuries or dysfunctions affecting muscles, nerves, tendons, joints, cartilage, and intervertebral discs, which may result in discomfort ranging from mild to severe across various parts of the body. Work-related musculoskeletal disorders are conditions in which the work environment and job demands contribute significantly to the development of such disorders and/or exacerbate or prolong their presence.

In this study, a 23.8% reduction in musculoskeletal complaints was observed. Statistical analysis of the average scores for musculoskeletal complaints after work during Period 1 (P1) and Period 2 (P2) showed a significant decrease ($p = 0.001$; $p < 0.05$). This indicates a meaningful reduction in musculoskeletal complaints in Period 2 compared to Period 1. This reduction is likely attributed to the implementation of the Ergo-SMEs intervention, which helps minimize non-ergonomic working conditions.

In Period 1 (conventional work conditions), musculoskeletal complaints among workers were primarily caused by excessive muscular strain, particularly in the hands, lower back, shoulders, and legs due to awkward working postures. In addition, repetitive tasks such as prolonged dough mixing and the presence of heat in the work environment exacerbated poor postures, increasing muscle tension and complaints. Prolonged excessive muscle contractions under hot working conditions reduce blood circulation to the muscles, leading to diminished oxygen supply. This impairs carbohydrate metabolism, causing lactic acid accumulation, which in turn results in pain (Dewi et al., 2019). The intervention involving improvements in working posture and workflow through Ergo-SMEs resulted in a notable decrease in musculoskeletal complaints during Period 2. Improved working conditions provide workers with increased comfort and relaxation, reducing physical complaints. Short rest breaks and fluid intake improve blood circulation in the muscles by enhancing the supply of nutrients for muscle cell metabolism and facilitating the removal of metabolic

waste products. This can alleviate ischemia in spasmodic or tense muscles, reducing pain. Furthermore, rest and hydration give muscles the opportunity to return to their resting length, disrupt the pain-spasm-pain cycle, improve physical fitness, increase range of motion (ROM), and reduce muscle fatigue. Muscle pain typically results from prolonged, excessive muscle contractions. Such discomfort is unlikely to occur if the muscle contraction remains between 15–20% of maximum strength. However, when contractions exceed 20%, blood flow to the muscles decreases, oxygen supply drops, metabolism slows, and lactic acid builds up, leading to muscle soreness. These findings are consistent with a study by Damantalm et al. (2018), which found that the provision of bananas, short rest breaks, and stretching exercises reduced musculoskeletal complaints by 31.77%.

Additionally, improving working posture reduces forced positions and allows workers to adopt more natural and ergonomic postures during tasks. Short rest breaks for hydration can help alleviate ischemia in spasmodic muscles by enhancing circulation and nutrient renewal. Stretching exercises improve muscle flexibility, enable muscles to return to their resting length, disrupt the pain-spasmpain cycle, enhance physical fitness, increase ROM, and reduce muscular fatigue. Research by Dewi et al. (2018) demonstrated that workplace stretching exercises and modifications to working conditions decreased musculoskeletal complaints by 18.3%. Similarly, the application of short rest periods was found to reduce physical workload by 18.15% and musculoskeletal complaints by 32.75% (Sutapa et al., 2017).

Empirical evidence suggests that ergonomic working postures significantly reduce musculoskeletal complaints while improving worker productivity. A study involving construction workers showed that adopting more ergonomic postures reduced spinal compression forces by over 60%, decreased musculoskeletal complaints by 4.92%, and improved productivity by 5.97% (Dewi et al., 2019). Another study reported a strong correlation between standing work postures and musculoskeletal complaints among welding mechanics at Company X (Anggrianti et al., 2017). Similarly, research involving office workers revealed a high prevalence of musculoskeletal complaints and high-risk postures, although no significant association was found between them (Salsabila, 2020). A study at CV Sada Wahyu in Bantul Regency identified statistically significant relationships between work posture, age, and length of service with musculoskeletal complaints (Wildasari & Nurcahyo, 2023). These findings highlight the importance of applying ergonomic working postures to reduce musculoskeletal complaints and enhance both worker well-being and productivity.

4) Ergo-SMEs Reduces Worker Fatigue

Fatigue is a condition manifested through psychological changes such as slowed motor and respiratory activity, feelings of pain, heaviness in the eyes, reduced motivation, and decreased physical activity, all of which can affect both physical and mental performance (Grandjean, 2000). Fatigue serves as a protective mechanism of the body to prevent further damage, functioning as a biological alarm that signals the need for rest (Tarwaka et al., 2004). A decline in physical capacity and endurance can reduce work efficiency and performance. If left unaddressed, such conditions may lead to increased error rates, elevate the risk of occupational accidents, and reduce worker productivity. This study found a 24.4% reduction in fatigue levels. Analysis of mean fatigue scores before and after the intervention across Period 1 and Period 2 showed a statistically significant difference, with a p-value of 0.001 ($p < 0.05$). These findings indicate a meaningful reduction in fatigue during Period 2, attributed to the implementation of Ergo-SMEs, which helped mitigate non-ergonomic working conditions.

Fatigue experienced during Period 1 (control group, with conventional working conditions) may be influenced by several factors, such as energy expenditure during tasks and environmental conditions including temperature, humidity, airflow, and air pollution. Physical activity increases energy requirements, and when these demands are unmet, workers are likely to experience fatigue. Conditions such as anemia and micronutrient deficiencies can exacerbate work-related fatigue, particularly among female workers (Ambarwati & Wirjatmadi, 2022). In hot environments, the body tends to lose more fluid through sweat. If fluid loss is not promptly replaced through adequate hydration, workers are at risk of dehydration, which can impair performance, cause fatigue, or lead to more severe health issues such as fainting or heatstroke. Additionally, elevated temperatures may require greater physical exertion to maintain the same level of performance, which increases internal heat production, accelerates muscle fatigue, and elevates the risk of injury. Eka et al. (2019) found that 92.9% of workers exposed to substandard thermal conditions (approximately 30.8°C) reported high levels of fatigue, whereas only 8% of workers in thermally adequate conditions reported normal fatigue levels.

The 24.4% reduction in fatigue between Period 1 and Period 2 can be attributed to ergonomic interventions including improved working conditions, scheduled short breaks involving walking to rest areas for hydration, and regulated breathing patterns. These measures helped prevent prolonged static postures and facilitated muscular relaxation. Fatigue results from energy depletion and the accumulation of metabolic waste products, particularly lactic acid and carbon dioxide. Prolonged highintensity muscle contractions deplete glycogen reserves and induce ischemia due to reduced blood flow to the muscles,

limiting oxygen supply and impairing energy metabolism. Short breaks were effective in reducing muscle tension, improving blood circulation, and enhancing metabolic activity. Additionally, fluid intake during breaks helped maintain hydration, preventing one of the primary contributors to fatigue.

Workplace modifications also included installing smoke exhaust chimneys to improve ventilation and reduce ambient temperatures. Heat stress increases fatigue by diverting blood flow to the skin, reducing circulation to internal organs and muscles, thereby limiting energy production and promoting the accumulation of metabolic waste. Improved ventilation lowers ambient temperatures, restores blood circulation, and decreases lactic acid buildup, reducing fatigue. The Ergo-SMEs intervention—including scheduled short breaks with light walking and breathing regulation, water and Balinese snacks ("jaje Bali") intake, and improved ventilation—has been proven to reduce fatigue by 24.4%. The fatigue questionnaire used in the study categorized fatigue into three domains: activity-related fatigue (items 1–10), motivational fatigue (items 11–20), and physical fatigue (items 21–30). Data analysis revealed reductions across all domains from Period 1 to Period 2: activity-related fatigue decreased by 11.52%, motivational fatigue by 3.16%, and physical fatigue by 14.3%. Among these, physical fatigue showed the most substantial decline, likely due to continuous high-intensity muscular contractions that deplete energy reserves and lead to ischemia. The implemented short rest breaks alleviated muscle tension, enhanced blood flow, and supported energy metabolism.

These findings are consistent with Suarjana et al. (2023), who reported that short rest intervals and adequate nutritional intake effectively reduce worker fatigue and enhance productivity. Short breaks of 5–15 minutes, when strategically scheduled, significantly reduce subjective fatigue and help maintain cardiovascular workload within moderate limits. Recommended break patterns included a 15-minute rest at 9:30 AM and a 10-minute break at 2:00 PM. The intervention led to a 3% reduction in average working heart rate (from 107.35 bpm to 104.13 bpm), a 9.94% reduction in %CVL (from 29.97% to 26.99%), and a 10.03% reduction in energy consumption (from 3.19 kcal/min to 2.87 kcal/min) (Prastawa et al., 2021). These results demonstrate that structured rest and energy intake can significantly reduce workload and enhance productivity.

Dewi et al. (2018) also found that workplace stretching exercises combined with improved working conditions reduced fatigue by 18.5%. Other studies have established a strong correlation between hot working environments and increased worker fatigue. For instance, 93.3% of workers operating at temperatures around 30.8°C reported high fatigue levels (Eka et al., 2019). Additionally, anemia and micronutrient deficiencies further exacerbate fatigue, particularly in female employees (Ambarwati & Wirjatmadi, 2022). To mitigate such risks, researchers recommend improving workplace ventilation, installing air conditioning systems, ensuring adequate rest periods, promoting hydration, and providing regular health screenings and education on proper personal protective equipment usage.

V. CONCLUSION

Based on the results and discussion presented above, the following conclusions can be drawn:

1. Workplace improvements implemented through the Ergo-SMEs intervention resulted in a 23.8% reduction in musculoskeletal complaints among dodol production workers.
2. Workplace improvements implemented through the Ergo-SMEs intervention led to a 24.4% reduction in worker fatigue among dodol production workers.

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