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ORIGINAL ARTICLE

Impact of Work-Fit Stretching on Occupational Fatigue among Industrial Sewing Operators in PT Mondy Garment, Sukoharjo, Indonesia

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ABSTRACT

Introduction: Sewing operators are vulnerable to fatigue caused by their inability to move and repetitive work that decreases their productivity and safety. Though it has been shown that Work-Fit Stretching (WFS) mitigates muscle fatigue, there is scant evidence among garment workers in developing nations. This paper discusses the impact of WFS on occupational fatigue among sewing operators at PT Mondy Garment in Sukoharjo, Indonesia. **Methods:** A randomized controlled trial was conducted involving 128 sewing operators in two groups: WFS and control. The intervention was a one-month program that was based on two sessions a day, five days a week. Fatigue was measured using a reaction timer in the Pre-Test, Post-Test 1, and Post-Test 2. Independent tests and Repeated Measures ANCOVA were used in data analysis, taking into account age and years of service. **Results:** WFS was an important contributor to the reduction of occupational fatigue. There was no baseline difference (p=0.475). The WFS group experienced reduced fatigue (425.7±107.1) compared to control (473.9±92.1; p= 0.007; Cohen d= 0.67). Four weeks later, the level of fatigue dropped to 354.3±101.1, and the control group did not change ($p < 0.001$; Cohen's d= 1.12). ANCOVA established a significant time effect ($p < 0.001$; $\eta2$= 0.218). **Conclusion:** The effects of ergonomically based stretching are moderate to large, with decreased fatigue. It is convenient, cheap, and can be used in daily garment work.

Keywords: ergonomic intervention, industrial sewing operators, occupational fatigue, work-fit stretching

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INTRODUCTION

The ergonomic risks facing workers in the garment industry are high in the sewing department due to the repetitive and stagnant nature of the tasks, as well as the demand to be precise even as the task extends over a prolonged duration (Das, Krishna Moorthy and Shanmugaraja, 2023; Arif et al., 2024; Gebrye et al., 2025). The well-known occupational fatigue happens due to inert, unbroken sitting poses, constant workloads, and the absence of active pauses, which lead to significant occupational fatigue (Halim and Aswin, 2022; Tianbo et al., 2022; Scoppolini Massini et al., 2024). Being tired not only reduces productivity but also increases the risk of making mistakes at work and of work accidents (Hidayatul Fitria et al., 2023; Nasution and Harahap, 2023; Sutherland et al., 2023). The International Labour Organization (ILO) estimates that about 340 million work-related accidents occur worldwide annually, with the vast majority related to fatigue and poor ergonomic working conditions (Mogensen, 2022; Hon, 2024).

Based on a report provided by the European Agency for Safety and Health at Work (EU-OSHA), in 2023, the prevalence of physical fatigue and musculoskeletal complaints of manufacturing workers was more than 60 percent, with the garment and textile industries being the most affected (Saha et al., 2023). More than 45 percent of sewing workers in developing countries experience moderate to severe fatigue daily, and every fifth of them suffers minor accidents due to fatigue-induced lack of concentration (Pabumbun, Russeng and Muis, 2022).

As part of the industrial hygiene implementation course, stretching interventions or Work-Fit Stretching have emerged as the ergonomic strategy

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that is effective in reducing muscular fatigue, circulation, and preparation to work (Suwartini, Tirtayasa and Adiputra, 2020; Putri, Masfuri and Nova, 2023). To address work-related fatigue, it is imperative to emphasize the industry-specific nature of a solution; one such solution is the Work-Fit Stretching paradigm, which has been shown to be highly effective in mitigating fatigue risks for employees (Wong and Swanson, 2022). Past research has revealed that consistent stretching training for two weeks can effectively mitigate fatigue among workers by 35 percent (Gasibat et al., 2023).

As a conceptual theory, this paper is based on occupational fatigue theory and industrial ergonomics theory, which reveal how repetitive work and the inability to take a break may cause musculoskeletal fatigue and how ergonomic solutions may mitigate these risks (Nur et al., 2023).

However, the literature on the effectiveness of the Work-Fit Stretching towards sewing workers in the garment industry is quite scarce, especially in the developing markets, including Indonesia. The majority of the available research still targets the heavy manufacturing or office industry, and little targets high-risk workers like sewing machine operators. Furthermore, individual variables like age and longevity of service have been controlled very rarely in large-scale studies. The objectives of this study were to determine the outcome of Work-Fit Stretching on countering fatigue at the workplace of sewing operators at PT Mondy Garment, Sukoharjo, Indonesia.

The occupational fatigue theory and the industrial ergonomics principles are combined in the theoretical framework of the present study. It demonstrates that ergonomic stretching interventions can alleviate fatigue by enhancing muscular recovery, circulation, and work preparedness, especially in high-risk repetitive jobs in garment sewing (Ismayenti et al., 2021; Mothishwaran, Santhosh, and Pandian, 2023).

Hence, this research will be a study to understand the impact of the Work-Fit Stretching program on fatigue in the workplace of a sewing operator, in which an experimental methodological paradigm will be applied to the study to discuss major confounding factors. The original aspect of the given research is the use of an ergonomics-based stretching program as an industrial hygiene control measure in terms of a worker group that has been characterized by insufficient scientific attention, and the time-based experimental study design (pre-post intervention and control group) to assess the described measure.

The usefulness of this study goes beyond the enrichment of scientific knowledge on the effectiveness of active ergonomic programs; it also forms the basis of the formulation of evidence-based occupational safety and health policies, which can be utilized in the textile and garment sectors.

METHODS

Research Design

The study involved an experimental design and was randomized. Out of 128 sewing operators (sewing department), random sampling was conducted, with 64 assigned to the intervention group (who received ergonomic stretching) and 64 to the control group (who received no intervention). The measure of occupational fatigue was based on a reaction timer assessed at three points: the baseline (pre-test), one week later (post-test 1), and two weeks later (post-test 2), as presented in Table 1.

Table 1. Measurement Design of Occupational Fatigue in Intervention and Control Groups

End of Week	Time of Measurement	Intervention Group (Work-Fit Stretching)	Control Group (No Intervention)
First	Pre-test (Baseline)	Measurement of occupational fatigue	Measurement of occupational fatigue
Second	Post-test 1	Measurement of occupational fatigue after 1 week of WFS	Measurement of occupational fatigue at the end of the second week
Third	Post-test 2	Measurement of occupational fatigue after 2 weeks of WFS	Measurement of occupational fatigue at the end of the third week

The reaction timer was used to measure occupational fatigue at three time points: at baseline (pre-test, before the intervention), after the first week of the Work-Fit Stretching program (post-test 1), and after the second week of the intervention (post-test 2). The pre-test was conducted at the end of the first week, when the workers had been engaged in work activities, and the experimental and control groups had not yet been administered any intervention. This measurement was aimed at determining the amount of fatigue on the worker at the end of one week of work. The post-test 1 was done at the conclusion of week two, during which the experimental group had undergone the intervention, and the control group did not undergo any intervention. The purpose of this measurement was to observe the intervention's effectiveness following one week of implementation. Post-test 2 was done at the end of the third week, when the experimental group was still receiving the intervention, and the control group was still not receiving an intervention, in order to determine the effects of the intervention upon the second repetition.

In this study, the sewing operators were involved in high levels of accuracy, speed, and consistency of predominantly sedentary and repetitive activities. Their job was to prepare fabric fragments together with the use of the industrial sewing machine, overlocking, and folding, and to check the end stitches with the help of accurate checking. They usually spent between 6 and 8 hours in front of the machine with constant hand, arm, and foot movements as they operated the pedal. The work shifts took 30 to 45 minutes per shift, with a resting period, according to the production goals. This was a sustained static position with minimal trunk rotation, which often led to neck, shoulder, and lower back pain or exhaustion. The Work-Fit Stretching intervention was designed to address these ergonomic characteristics and the real physical demands of the job.

Study Setting and Period

The research was conducted at a garment company, PT Mondy Garment, located in Sukoharjo Regency, Central Java, Indonesia. Intervention activities and data collection took place in June 2025.

Population and Sample Size

In this research the sample size (in G*Power software version 3.1.9.7) was calculated a priori based on an independent samples t-test. This was done to determine the minimum number of subjects that are necessary to detect a statistically significant difference between two groups. The significance level (z) was 0.05, statistical power (1-b) 0.80, and effect size (d) 0.5, a two-tailed test, and unequal sample group assignment (N2/N1 = 1).

The choice of an effect size of 0.5 is explained by the fact that, according to Cohen's classification, a medium effect is realistic and meaningful in intervention studies in public health and ergonomics, where large effects are not common.

The calculation indicated that a total of 128 subjects (or 64 per group) was needed; the degrees of freedom (df) = 126, and the actual power of the study was 0.801. The sample size determination process is shown in Figure 1, which confirms that the study contained an adequate number of subjects to test the hypothesis with an acceptable degree of confidence and statistical power.

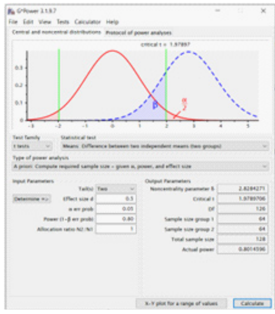


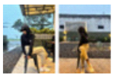
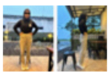
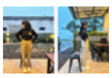
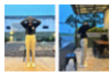
Figure 1. Sample size calculation result using G*Power for independent two-sample t-test

The sample was selected purposively, and the inclusion criteria included permanent sewing workers aged 21 to 50 years who had no history of musculoskeletal disorders or workplace injuries and were able to fully engage in the 2-week intervention programme. The workers who were on leave, unwell, or pregnant at the moment of the study were excluded from the exclusion criteria.

Intervention

The Work-Fit Stretching program, a group of ergonomics stretching activities, which would be intended to lessen strained muscles associated with stationary and repetitive working postures, was also provided to the experimental group. Intervention was carried out within 2 weeks with 5 working days a week and 2 sessions a day at 10.00 a.m. and 2.00 p.m. local time (WIB) and lasted 3-5 minutes. The program consisted of 10 flexion exercises in various parts of the body, such as the neck, shoulders, back, waist, and the lower extremities. A research assistant was present in each stretching session, which allowed the right and consistent execution of the stretching exercises. On the contrary, those in the control group would not be given any special treatment and thus could go and proceed with their normal activities. Table 2 presents the Work-Fit stretching movements designed to reduce musculoskeletal fatigue, improve flexibility, and enhance overall physical readiness during work. Each movement includes clear instructions and recommended repetitions to ensure proper execution.

Table 2. Description of Work-Fit Stretching Movements

No.	Figure	Stretching Movement	Instructions
1		Shoulders and Neck	Sit upright with your hands on your thighs. Slowly lift your shoulders toward your ears while inhaling, roll your shoulders backward, then lower them while exhaling. Repeat for a count of 1×8 on both sides.
2		Back, Waist, and Abdominal Muscles	Sit upright, place your right foot on your left thigh, twist your torso to the right while your right hand supports the chair for a count of 1×8, then repeat on the opposite side.
3		Hamstrings, Calves, and Lower Back	Sit upright with your eyes facing forward, straighten one leg, and reach for your toes with the hand on the same side. Return to the starting position and repeat alternately.
4		Calves and Ankles	Stand straight with your hands on your waist. Raise and lower your heels slowly (tiptoe movement) for 2×8 counts.
5		Neck and Shoulders	Slowly turn your head to the right and left while keeping your body upright and your hands on your waist to maintain balance.
6		Shoulders, Back, Calves, and Ankles	Stand straight while stretching both arms upward and tiptoe for 2×8 counts.
7		Shoulders, Chest, Arms, and Lower Legs	Stand upright with relaxed shoulders, clasp your fingers behind your back while extending one leg forward to feel the stretch, then switch to the other leg (2×8 counts).
8		Upper Back and Back of the Neck	Stand straight with your hands behind your head, then gently push your head downward for 2×8 counts.
9		Lower Back, Hips, and Thighs	Stand upright with one leg bent forward and the other leg straight behind, hands on the waist, then gently push your hips forward while arching your back slightly.
10		Lower Back, Hips, Hamstrings, and Calves	Stand upright with your legs crossed, bend your body forward with knees straight until your hands reach toward the floor, then repeat on the opposite side.

Operational Definition of Variables

Work-Fit Stretching is the independent variable in this study, characterized as a routine muscle-stretching program conducted twice daily, specifically after 2 hours of work at 10:00 a.m. and 2 hours before the end of the work shift at 2:00 p.m. This program implementation was documented through an attendance checklist and direct observation. The dependent variable is occupational fatigue, measured as visual reaction time using the Reaction Timer device (Lakassidaya brand). The reduction in the ability to respond physically to visual stimuli is described as occupational fatigue, which is proven by the increase in reaction time. The measures were in milliseconds (ms) on the ratio scale.

Research Instruments

The main research tool was Reaction Timer (Lakassidaya brand), which would be used to measure the visual reaction time of study participants. All the participants had 20 measurements each, and the middle 10 trials (trials 6 to 15) were analyzed to avoid adaptation and fatigue bias. Moreover, an observation checklist was used to record participants' attendance at each stretch, and the data recording sheet recorded the measurement results. Each respondent signed the informed consent form before the study started.

Research Procedure

The study process was split into three parts preparation, implementation, and evaluation. During the preparation phase, researchers quintessentially carried out an initial survey of the workspace environment and verified the stretching exercises with a source of professionals in ergonomics and physiotherapy. After getting the company and the ethics committee approval, the participants were selected in accordance with pre-planned criteria, and a presentation (pre-test) of the data was taken.

The implementation stage started with the assignment of participants into the experimental and control groups. The experimental group under the Work-Fit Stretching program took two weeks, and no intervention was given to the control group. On the last days of the first and second weeks, all participants were required to take follow-ups (post-tests) with a Reaction Timer. The research team supervised all the intervention activities at the workplace of each of the participants. The process of data collection, processing, and analysis was adopted as an evaluation.

Statistical Analysis

A dependent t-test was used in analyzing data to determine the difference in occupational fatigue between groups, and a Repeated Measures ANOVA was used to determine the difference in fatigue when pre-test (baseline), post-test 1, and post-test 2 were used. The SPSS software was used to do all the analyses. The value of p would run < 0.05 to be statistically significant.

Ethical Approval

Ethical approval was accorded to this research by the Moewardi General Hospital, as mentioned in the ethical approval letter No. 1.136/V/HERC/2025 dated May 28, 2025.

RESULT

Demographic Characteristics

Table 3 presents the demographic characteristics of participants in both the control and intervention groups. The mean age of participants was 31.88 ± 6.3 years in the control group and 31.48 ± 5.4 years in the intervention group (p = 0.747). The mean working duration was 2.91 ± 1.6 years in the control group and 3.56 ± 1.7 years in the intervention group (p = 0.080), indicating that there were no significant differences between the groups for these two variables.

Table 3. Demographic Characteristics of Participants

Variable	Control (n = 64)	Intervention (n = 64)	p-value*
	Mean ± SD	Mean ± SD	
Age (years)	31.88 ± 6.3	31.48 ± 5.4	0.747
Length of Service (years)	2.91 ± 1.6	3.56 ± 1.7	0.080

*Note: No significant differences were found between the control and intervention groups in age or length of service (p > 0.05), indicating comparable baseline characteristics.

Occupational Fatigue Scores

Table 4 presents the occupational fatigue scores of the control and intervention groups at three measurement points. At baseline (pre-test), there was no significant difference between the groups (p = 0.475, Cohen's d = -0.127). After one week of intervention (post-test 1), the intervention group showed a significant reduction in fatigue compared to the control group (p = 0.007, Cohen's d = 0.670), and this effect became even more pronounced at post-test 2 (p < 0.001, Cohen's d = 1.117), indicating a moderate to large effect of the Work-Fit Stretching program.

Table 4. Occupational Fatigue Scores at Three Time Points

Variable	Group	Mean ± SD	p-value	Cohen's d	Interpre-tation
Pre-Test	Control	445.2±102.4	0.475	-0.127	Not significant, very small effect
	Intervention	457.9±98.7			
Post-Test 1	Control	473.9±92.1	0.007	0.670	Significant, medium effect
	Intervention	425.7±107.1			
Post-Test 2	Control	463.9±95.1	<0.001	1.117	Significant, large effect
	Intervention	354.3±101.1			

Comparison of Fatigue Scores Between Groups Using ANCOVA

The findings of the One-Way ANCOVA test, which compared fatigue scores between the intervention and control groups and adjusted for age and length of service, are shown in Table 5. The result showed that the difference between groups is significant ($p < 0.001$), and neither covariate adds significant value to the model.

Table 5. Summary of One-Way ANCOVA Results on Fatigue Scores (Post-Test 2) with Age and Length of Service as Covariates

Group	Mean ± SD	N	F	p-value
Control	461.87 ± 105.95	64	22.026	0.000
Intervention	354.37 ± 101.03	64		
Total	391.66 ± 114.42	98		
Covariate Model				
- Age			2.452	0.121
- Length of service			2.074	0.153

Changes in Occupational Fatigue Over Time in the Intervention Group

Table 6 shows that, according to Repeated Measures ANCOVA, there is a significant change in occupational fatigue over time in the intervention group ($p < 0.001$), with a moderate effect size (Partial Eta2 = 0.218). The test on sphericity developed by Mauchly indicated that the assumption was satisfied ($p = 0.887$).

Table 6. Summary of Repeated Measures ANCOVA Results on Occupational Fatigue in the Intervention Group

Timestamp	Mean	SD	N	Mauchly's Test (p)	F (Time)	p-value	Partial Eta²
Pre-Test	457.95	98.70	64	0.887 (Sphericity assumed)	17.589	<0.001	0.218
Post-Test 1	425.74	107.28	64				
Post-Test 2	354.37	101.03	64				

Trend of Occupational Fatigue Changes Across Measurement Phases

Figure 2 shows a decreasing pattern of the mean occupational fatigue in the intervention group at all three time points of measurement. The second to third time points confidence intervals are not significantly overlapping, which shows that there is a significant effect of intervention.

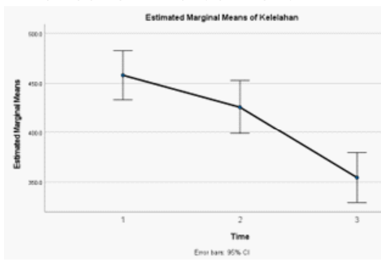


Figure 2. Changes in Mean Occupational Fatigue with 95% Confidence Intervals Across Three Measurement Phases

DISCUSSION

Physiological Mechanism of the release of Fatigue by Ergonomic stretching

Occupational fatigue is the physiological and psychological reaction caused by the concentration of the working load, lack of recovery, and the exhaustion of the muscular energy stores and the activity of the central nervous system (Fathonah, Nisa and Chahyadhi, 2023; Gembalska-Kwiecień, 2024; Ulandari et al., 2024). The ergonomic stretching exercises, as the intervention type, will stimulate local blood circulation, increase the oxygenation of muscle tissue, and decrease neuromuscular tension due to prolonged static postures (Bisconti et al., 2020; Zvetkova et al., 2023; Bhat and Nadzri, 2024).

Physiologically, repetitive stretching of large muscle groups (to say the least of the neck, shoulders, back and upper extremities) signals the muscle spindles and Golgi tendon organs which are intrinsic in reflexes of relaxation and the lowering of muscle tone (Trajano and Blazevich, 2021; Abbott et al., 2024; Cacciatore, Anderson and Cohen, 2024; Liu et al., 2024). Such activation also helps restore neuromuscular homeostasis and attenuate pain- and fatigue-inducing metabolites produced, such as lactic acid and hydrogen ions (Ducrocq et al., 2023; Dibaj and Windhorst, 2024; Richards et al., 2024). Such physiological effects could be the reason why the intervention group exhibited a significant reduction in the level of occupational fatigue as indicated by the results of the Repeated Measures ANCOVA test ($p < 0.001$; Partial Eta2 = 0.218).

Theoretically, ergonomic stretching also helps prevent occupational fatigue (Suwartini, Tirtayasa, and Adiputra, 2020); hence, in light of the Job Demands-Resources (JD-R) model. According to this model, job demands (i.e., monotonous tasks, stationary work positions) lead to fatigue due to physical and mental exhaustion among workers, whereas job resources alleviate the adverse consequences, namely through the introduction of rest breaks, ergonomic interventions, or exercises (Salawati and Abbas, 2023). Stretching exercises serve as resources due to their effect of improving musculoskeletal resilience, enhancing circulation, and micro-recovery time that limits the buildup of physical stress (Putri, Masfuri and Nova, 2023). The JD-R approach provides a supplementary interpretation compared with a pure physiological explanation because it can relate the physical impact of stretching to broader organizational and psychosocial issues.

In this work, it was observed that sewing machine operators showed signs of exhaustion before the intervention, including slumped postures, irregular hand movements, and shoulder rubbing during the final two-hour shifts. Nevertheless, two weeks of the ergonomics stretching intervention led to a reduced occurrence of stiff necks and lower back pain among the workers, who also maintained better posture and enhanced coordination during sewing. Also, the changes in staff behavior were positively correlated with the significant differences in the fatigue scores recorded in post-test 1 and post-test 2 (mean difference = 5.2 points). The supervisors also indicated that production output has been more stable during the shifts, and this indicator indicates that less fatigue correlates with enhanced concentration and dedication to the task. The same results in respect to the working stretching provisions were documented in other studies (Milyavskaya et al., 2021). These behavioral observations, coupled with the statistical results, demonstrate that stretching ergonomics, besides physiological gains, does yield pragmatic, behavioral soft-tissue changes that ease the worker's work and make them more visible.

Comparisons to the Previous Studies

The results of the current research prove that Work-Fit Stretching can be effective in alleviating work-related fatigue in sewing machine operators. This finding aligns with many past research studies that have demonstrated the effectiveness of stretch intervention in reducing work-related fatigue, especially in repetitive and static work.

Six-week or eight-week stretching programs have been noted to have a significant effect and lead to a significant decline in fatigue and tension in the muscles of industrial workers (Shahrjerdi and Mondalizadeh, 2024), employees in offices (Holzgreve et al., 2020), and health care professionals (Almuhaidb et al., 2023; Alqhtani et al., 2023). The same results were observed during daily stretching within a period of two weeks and, as a result, lowered the work fatigue and enhanced productivity in manufacturing workers (Abas and Kalir, 2003), office employees (Putri, Masfuri and Nova, 2023), and members of the informal sector workforce (Luik, Ratu and Setyobudi, 2021; Ismayenti and Wardani, 2022). Regular workplace stretching exercises have also been shown to increase work capacity and reduce physical fatigue (Mänttäri et al., 2021; Moreira et al., 2021; Martinez, Rouhani and Nazarahari, 2023).

The results of the present study align with the expansion of the comparative body of literature supporting the success of workplace stretching in alleviating job-related tiredness. As an example, manual handling workers demonstrated that having small breaks or undertaking stretching exercises during work shifts can substantially mitigate muscle fatigue and may even decrease the risk of work-related musculoskeletal disorders, provided that such interventions do not interfere with the productivity of the workers (Beltran Martinez, Nazarahari and Rouhani, 2023). The integration of short stretching interventions during working hours for industrial workers has also led to significant negative changes in fatigue levels at the end of shifts and positive changes in perceived ability to work (Latipah and Ahmad, 2024). Moreover, activities to stretch muscles incorporated into micro-breaks (8-15 min long, 16 exercises in total) have demonstrated their effectiveness in reducing fatigue during work. The practice enhances freshness, concentration, and creativity, and reduces the risk of work accidents caused by exhaustion (Mufti Azzahri Isnaeni and Gustriana, 2021). These data validate the current study's findings: that ergonomic stretching, as a regular intervention, can be an effective yet simple way to prevent fatigue on the job when the work is physically taxing.

It has also been shown that the short-ergo activities at the workplace help to greatly reduce fatigue and make the work more comfortable, in the case of a working population employed in textile industries (Mänttäri et al., 2021; Chaiklieng, 2023). Another study conducted in Pakistan showed that garment workers experienced benefits regarding fatigue and myalgia through daily stretching exercises lasting over 10 minutes (Siddiqui et al., 2023). In Indonesia, stretching has also been found to play a significant role in minimizing fatigue in the physically demanding sewing machine operator at the garment industry during the day (Ismayenti et al., 2021).

In addition to the high level of significance indicated by the independent t-test and One-Way ANCOVA (Tables 5 and 6), the results of the present study were supported by moderate to large effect sizes (Cohen's d = 0.670 to 1.117), which contributed to the finding that the intervention produced statistically and practically significant effects.

Nevertheless, not every research has led to similar results. Stretching did not cause a substantial effect in the shift workers' fatigue, yet indicated the significance of sufficient rest time (Djupedal et al., 2024). Moreover, the physiological benefits of stretching may be suboptimal when not embedded in organizational support and a positive work culture that sustains such a long-term practice (Santos and Miragaia, 2023). The workload and unresolved psychosocial stress can also increase the perceived meaninglessness of stretching interventions in mitigating occupational fatigue (Demerouti, 2024).

The differences in the studies can be explained by differences in methodology, the gauge of the stretching programs, and the personal traits of the workers —age, health, and motivational level. However, to a large extent, the literature also indicates that ergonomic stretching programs are very promising as promotional and preventative measures of occupational fatigue management, especially in work of a repetitive and static nature in industry.

Implications of the Study Findings

The results of this research give a good guarantee that ergonomic stretching exercises can be an effective intervention (introduced systematically) to reduce work-related fatigue in industrial sewing workers; it is cheap and safe to employ. This intervention is easily incorporated into the industrial workplace health promotion initiatives.

The fact that they are moderate to large effects (Cohen d = 0.670 to 1.117) means that the intervention has not only been proven significant statistically but is also significant in practice. The dramatic drop in the fatigue scores on the post-test measures 1 and 2, and the trend going down shown in Figure 2, demonstrates the power of the cumulative effects of regularly exerting stretching exercises.

Study Limitations

Although the results show some promising findings, this study has several limitations. The intervention lasted only two weeks, and it was not easy to determine its long-term effects. The motivation, commitment, and work habits could be other factors that influence individual responses towards stretching, which were also not completely controlled in this study.

Recommendations for Future Research

It is suggested that future research areas should include long-term tests and add more complementary factors, like work-related stress, sleep quality, or objective measurements of the physiological parameters. It was also possible to test the synergistic effects of integrating it with other ergonomic interventions (e.g., ergonomic chairs or workload manipulation).

CONCLUSION

The results of this study show that occupational fatigue of sewing machine operators was greatly reduced after the ergonomic stretching intervention. This intervention demonstrated moderate to large effects, as fatigue scores decreased after the post-test at both post-intervention measurements. Controlling for age and years of service, the ergonomic stretching program remained effective, which provided evidence for an easy, low-cost, and feasible intervention for improving occupational health in industrial settings characterized by static and repetitive work tasks. This provides preliminary evidence for the use of ergonomic stretching in worksite health promotion programs to improve both worker well-being and performance.

CONFLICT OF INTEREST

The authors state that there was no financial, professional, or personal conflict of interest that could affect the performance or the results of this study.

AUTHORS' CONTRIBUTION

All would certify their involvement in the study and drafting of this article and would take equal responsibility in its contents. S: conceptualization, methodology, supervision, writing- review and editing; YAP: data collection, data analysis, writing-original draft; WYR: investigation, visualization, validation.

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