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Original Article

Effectiveness of an ergonomic chair intervention in reducing low back pain among informal garment workers: A Quasi-Experimental Study

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ABSTRACT

Introduction: Garment workers experience low back pain (LBP), which impacts their productivity and health because they sit for prolonged periods and use non-ergonomic chairs. This study aimed to evaluate the effectiveness of ergonomic chairs in reducing LBP among small-scale garment workers.

Methods: A quasi-experimental pretest-posttest control group design was employed, and 102 sewing workers from micro and small-scale garment industries were recruited from Tuban Lor Village, Karanganyar Regency. The sample was divided into intervention (n= 51) and control (n= 51) groups. The intervention consisted of ergonomic chair designed according to the workers' anthropometric measurements. On days 0, 7, and 14, the Oswestry Disability Index (ODI) and Rapid Upper Limb Assessment (RULA) were used to measure LBP intensity and posture. Repeated measures ANCOVA and one-way ANCOVA were used to analyze the data after adjusting for age, gender, BMI, and years of service.

Results: LBP scores decreased significantly over time in the intervention group ($F=6.289$, $p=0.003$) with a significant linear trend ($p=0.002$), but not in the control group ($p=0.390$). Significant group differences were found on days 7 and 14 ($p=0.001$) and not at baseline ($p=0.731$). Covariates did not have a significant effect. There was also an improvement in posture, as evidenced by improved RULA scores.

Conclusion: Within 14 days, the ergonomic chair intervention was successful in reducing low back pain and improving posture among workers in the informal garment sector.

Keywords: Ergonomic chair, garment industry, informal sector, low back pain, working posture

Introduction

One of the most common occupational health issues in the world is work-related musculoskeletal disorders (MSDs), especially in the developing world, where informal sectors and small-scale industries are the major employers. MSDs significantly impact productivity, quality of life, and healthcare expenses.[1,2] MSDs have also been shown to negatively affect worker productivity and quality of life, while significantly increasing the overall burden of healthcare costs worldwide.[3–5] Low back pain (LBP) remains the leading cause of disability worldwide, affecting approximately 568 million people, and is strongly associated with static and non-ergonomic working postures.[6–8] Static, non-ergonomic working positions and the use of equipment that is not adjusted to the anthropometric characteristics of workers are among the leading risk factors for this condition.[9,10]

Workers in labor-intensive industries such as garment production spend extended hours in a sitting position. To prevent musculoskeletal disorders in such settings, it is important to apply the principles of ergonomics.[11,12] Nevertheless, ergonomic interventions in micro- and small-scale industries are not widespread due to limited resources and a lack of awareness.[13] Garment workers may experience lower back, neck, and shoulder pain due to the use of non-ergonomic chairs, which typically lack adequate back support, cushioning, or proper anthropometric adjustability.[14,15]

This study was motivated by observations from a case study conducted in micro, small and medium enterprises (MSMEs) within the garment industry in Tuban Lor Village, Gondangrejo Subdistrict, Karanganyar Regency, Central Java. An initial evaluation of 10 out of 22 garment workers (45.45%) on January 6, 2025, revealed poor working postures and high levels of subjective musculoskeletal complaints. The workers sat on wooden stools without cushions or a backrest, which were unsuitable for their anthropometric dimensions. Assessment using the Rapid Upper Limb Assessment (RULA) tool revealed a score of 5-6, indicating forward trunk flexion (20-60°), neck flexion (>20°), and elevated arm positions (up to 90°). Workers averaged 8 hours per day, engaging in repetitive tasks. According to the Oswestry Disability Index (ODI), 90% of the workers complained of low back pain.

Therefore, the purpose of this study was to evaluate the efficacy of an ergonomic chair intervention in preventing low back pain among informal garment workers. This study provides practical evidence and addresses the empirical data needed to improve ergonomic conditions in resource-constrained informal sectors. The results of this research can inform the development of simple yet effective ergonomic interventions in informal settings and provide empirical data to support the establishment of industrial hygiene practices grounded in sustainable work design.

Methods

A quasi-experimental pretest–posttest control group design was used in this study to determine the effectiveness of an ergonomic work chair intervention in alleviating subjective complaints of lower back pain in sewing workers in micro and small enterprises. Randomization was not feasible due to operational constraints in the informal workplace setting, which may have introduced selection bias. The study was conducted in Tuban Lor village, Gondangrejo Subdistrict, Karanganyar Regency, Central Java, which represents a typical informal garment production setting in the region; however, the findings may not be fully generalizable to other areas with different working conditions and ergonomic practices. Data collection took place from April to May 2025. The study population consisted of 155 sewing workers, from this population, 102 participants were selected via random sampling and assigned equally to the intervention group (n = 51) and the control group (n = 51). Although the sample size was sufficient to achieve adequate statistical power, the relatively small number of participants may limit the external validity of the findings. The minimum sample size was calculated using G*Power 3.1.9.7 with an effect size (d) of 0.5, α = 0.05, and power (1-β) = 0.80 and corresponded to n = 102 participants in total. The actual statistical power was 0.8059.

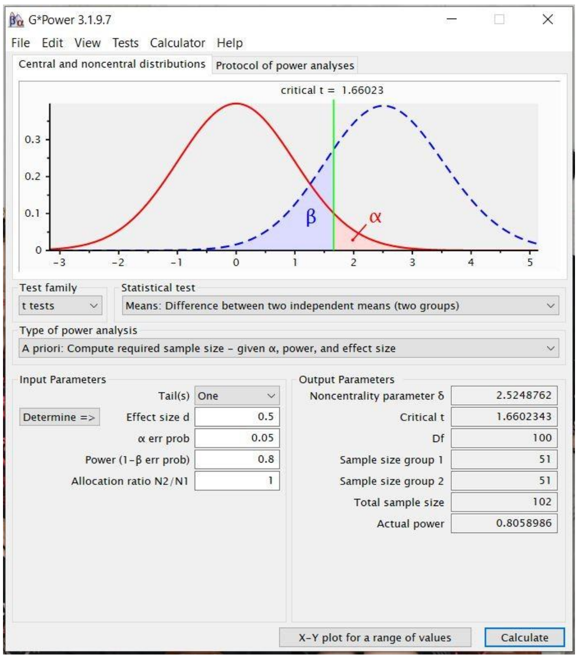

Figure 1: Sample size calculation result using G*Power

The independent variable was the ergonomic chair designed based on individual anthropometric measurements. The outcome was low back pain (LBP), measured with the Oswestry Disability Index (ODI). Workers' posture was measured using the Rapid Upper Limb Assessment (RULA). Data collection occurred at three points: before the intervention (baseline), one week after the intervention (posttest 1), and two weeks after the intervention (posttest 2). Blinding of participants and assessors was not implemented because the ergonomic chair intervention was visible, which may have contributed to observer or reporting bias.

The ergonomic chair intervention was designed based on the anthropometric measurements of the sewing workers. The main anthropometric measures taken were popliteal height, sitting elbow height, and buttock-popliteal length. These measurements were used to determine the appropriate chair size and its adjustments to achieve a neutral sitting position during the sewing process.

The ergonomic chair featured an adjustable seat height, a contoured backrest with lumbar support, and an appropriate seat depth. Seat height was adjusted to the workers' popliteal height to ensure complete foot contact with the floor, while the lumbar support was aligned with the natural lumbar curvature to minimize excessive flexion of the trunk. The backrest was adjusted to maintain an upright sitting position, as advised by ergonomic guidelines for prolonged seated work.

Participants in the intervention group used the ergonomic chair continuously during their working hours for a 14-day observation period, whereas the control group continued using their existing work chairs without ergonomic modification. The rationale for selecting a 14-day intervention period was based on evidence indicating that short-term ergonomic interventions are sufficient to observe early postural adaptations and initial reductions in musculoskeletal discomfort. Accordingly, this follow-up duration was designed to capture short-term postural adaptation and early musculoskeletal responses, rather than to assess the long-term sustainability of the ergonomic chair intervention.

The data collection instruments included anthropometric tools, the ergonomic chair, the RULA and ODI questionnaires, a demographic questionnaire, a posture documentation camera, and Angulus software for measuring sitting angles. Data were analyzed with SPSS version 27. A repeated-measures ANCOVA was employed to compare groups over time on ODI scores with age, sex, BMI, and years of service as control variables. Statistical significance was set at $p < 0.05$.

Results

Repeated-measures ANCOVA was used to evaluate the impact of ergonomic seat usage on low back pain complaints among garment workers by taking three measurements: before the intervention (LBP_Pre), after the first intervention (LBP_Post1), and after the second intervention (LBP_Post2). Moreover, a one-way ANCOVA was conducted to assess differences in low back pain scores between the groups at each time point. Age, years of service, body mass index (BMI), and gender were used as covariates in both analyses to control for potential confounding factors and ensure that the observed effects could be attributed to the ergonomic chair intervention. Table 1 shows the descriptive statistics for the variables studied.

Table 1: Demographic Characteristics of Respondents (N = 102)

Characteristic	Description
Group 1: Intervention Group (n = 51)	
Gender	
Male (Number, %)	25 (49.0)
Female (Number, %)	26 (51.0)
Age (mean ± SD)	38.49 ± 8.1
Years of Service (mean ± SD)	12.69 ± 4.9
BMI (mean ± SD)	22.9 ± 3.5
LBP (mean ± SD)	
Pretest (Baseline)	19.16 ± 4.5
Posttest1 (1 week)	14.73 ± 3.3
Posttest2 (2 weeks)	8.24 ± 6.7
Group 2: Control Group (n = 51)	
Gender	
Male (Number, %)	26 (51.0)
Female (Number, %)	25 (49.0)
Age (mean ± SD)	39.06 ± 8.9
Years of Service (mean ± SD)	12.00 ± 4.8
BMI (mean ± SD)	22.71 ± 3.4
LBP (mean ± SD)	
Pretest (Baseline)	19.35 ± 3.5
Posttest1 (1 week)	19.61 ± 3.4
Posttest2 (2 weeks)	19.92 ± 3.5

Work posture improved, consistent with the RULA questionnaire results, and the score improved from 5 to 4. The changes in the posture are described in detail in Figures 2, 3, and 4.

Figure 2: RULA Score Before the Intervention (Score 5)

Figure 3: RULA Score After 7 Days of Intervention (Score 4)

Figure 4: RULA Score After 14 Days of Intervention (Score 4)

Repeated-measures ANCOVA was employed to assess differences in low back pain (LBP) scores across three measurement points (baseline/pretest, posttest 1, and posttest 2), controlling for covariates such as age, years of service, body mass index (BMI), and gender. The Mauchly's test indicated that the assumption of sphericity was met for both the intervention group ($W = 0.968$, $p = 0.478$) and the control group ($W = 0.987$, $p = 0.747$), as both p-values exceeded 0.05. Thus, the repeated-measures ANCOVA output was interpreted using the F-statistic with the assumption of sphericity. The findings indicated that low back pain scores decreased significantly across time points in the intervention group ($F = 6.289$, $p = 0.003$), whereas the covariates had no significant effect ($p > 0.05$). Conversely, the control group did not exhibit any significant difference across measurement times ($F = 0.951$, $p = 0.390$). Table 2 shows the detailed results of the analysis.

Table 2: Repeated Measures ANCOVA Results on Low Back Pain Scores across Time Points, Controlling for Age, Years of Service, BMI, and Gender

Source of Variation	Differences across time		Covariates							
			Age		Years of Service		BMI		Gender	
	F	p-value	F	p-value	F	p-value	F	p-value	F	p-value
Group 1: Intervention Group (n = 51)	6.289	0.003	0.011	0.917	0.210	0.649	0.303	0.584	0.345	0.560
Pre-test Post-test1 Post-test2										
Group 2: Control Group (n = 51)	0.951	0.390	0.005	0.945	0.008	0.930	0.227	0.636	0.155	0.695
Pre-test Post-test1 Post-test2										

A trend analysis was then performed to investigate the direction of change in low back pain (LBP) scores over time and to establish whether the trend was linear or quadratic. The within-subjects effects test showed that the linear trend was statistically significant in the intervention group ($p = 0.002$), whereas the quadratic trend was not significant ($p = 0.534$). In the control group, however, there was no statistically significant pattern of change, as neither the linear trend ($p = 0.840$) nor the quadratic trend ($p = 0.160$) was significant. These results suggest that the change in LBP scores in the intervention group showed a strong linear pattern ($p < 0.05$); specifically, the scores declined steadily over time.

The differences in low back pain (LBP) scores between the control and intervention groups at each measurement time point—baseline (pretest), posttest 1 (day 7), and posttest 2 (day 14)—were analyzed using a one-way ANCOVA. This comparison was conducted while controlling for potential confounding factors, including age, years of service, body mass index (BMI), and gender, to ensure that the identified differences could be attributed to the ergonomic chair intervention. The findings showed no significant difference in LBP levels between the intervention and control groups at baseline ($p = 0.731$), suggesting the two groups had similar LBP levels before the intervention. Nevertheless, on day 7 (posttest 1) and day 14 (posttest 2), statistically significant differences were observed between the two groups ($p = 0.001$ for both), with LBP scores showing a sharp decrease in the intervention group but no significant changes in the control group.

Moreover, the results of the analyses showed that covariates, including age, years of service, BMI, and gender, did not significantly affect changes in low back pain scores at any time point. This supports the observation that the decrease in pain complaints was mainly attributable to the ergonomic chair itself. Table 3 presents the results of the one-way ANCOVA analysis at each measurement time point in detail.

Table 3: Results of One-Way ANCOVA of Low Back Pain Scores in Intervention and Control Groups at Three Time Points, Adjusting for Age, Years of Service, BMI, and Gender

Source of Variation	MSDs Baseline pre-test ($\bar{x} \pm SD$)	MSDs Day 7 post-test1 ($\bar{x} \pm SD$)	MSDs Day 14 post-test2 ($\bar{x} \pm SD$)
Group			
Intervention	19.16 ± 4.5	14.73 ± 3.3	8.24 ± 6.7
Control	19.35 ± 3.5	19.61 ± 3.4	19.92 ± 3.5
F	0.119	49.377	263.519
p-value	0.731	0.001	0.001
Covariates			
Age			
F	1.719	0.514	1.344
p-value	0.193	0.475	0.249
Years of Service			
F	0.541	0.481	0.208
p-value	0.464	0.490	0.649
BMI			
F	0.168	0.075	0.789
p-value	0.683	0.785	0.377
Gender			
F	0.119	0.361	0.038
p-value	0.512	0.549	0.846

Discussion

The findings of this research indicate that the ergonomic chair intervention approach provided substantial value in reducing low back pain (LBP) complaints among workers in the informal garment sector. The repeated-measures ANCOVA confirmed this reduction, demonstrating a significant linear trend in pain scores across time points in the intervention group (p = 0.002) but no significant difference in the control group. This indicates that consistent use of the ergonomic chairs led to a positive change in alleviating low back pain in only two weeks. In addition, the One-Way ANCOVA findings also supported these results, revealing that the difference in LBP scores between intervention and control groups became significant after the first week (p = 0.001) and even more pronounced in the second week (p = 0.001), whereas the difference at baseline was not significant (p = 0.731). That is, the group using ergonomic chairs had a significantly larger reduction in pain than the group receiving no intervention.

Age, length of service, body mass index (BMI), and gender were not statistically significant, indicating that the reduction in pain complaints was more likely attributable to the ergonomic intervention itself than to the participants' demographic or anthropometric characteristics. The positive impact of ergonomic chairs on working ergonomics, as evidenced by a reduction in RULA scores from 5 (high risk) to 4 (medium risk), indicates an improvement in working posture, though the RULA score of 4 corresponds to a medium risk level, suggesting a need for further ergonomic modifications or supplementary interventions. Overall, these findings suggest that anthropometrically designed ergonomic chairs are effective in the short term in reducing low back pain and improving posture, although they may not be sufficient on their own to achieve an acceptable postural risk level.

The reduction in low back pain can be attributed to the ergonomic chair's design, which enhances postural support. In this study, the chair was designed to optimally accommodate the lumbar curve, discourage excessive slouching, and enable height adjustments to align it with the worktable.[16,17] This aligns with established principles of static ergonomics, whereby maintaining a neutral posture and using adequate lumbar support helps decrease pressure on the intervertebral discs and reduce muscular load on the lower back on the lower back.[18,19]

These findings are consistent with previous research indicating that modified work chairs, as an ergonomic intervention, can potentially reduce the prevalence of low back pain among garment workers.[20–22] Adjustable lumbar support chairs were shown in a longitudinal study to reduce musculoskeletal complaints by half after the second week of intervention.[23]

Moreover, the posture rating score based on RULA (Rapid Upper Limb Assessment) also improved, decreasing to 4 (from an earlier score of 5). Although the difference was not significant, it shows that working postures can be corrected with an ergonomic chair, particularly by reducing excessive lumbar flexion.[24,25] More favorable working conditions are reflected by a lower RULA score. This is supported by studies that revealed a positive correlation between the risk of musculoskeletal disorders and RULA scores.[26–28]

As indicated by the between-subjects analysis, the covariates did not significantly affect LBP scores. This confirms that changes in pain were more attributable to the ergonomic chair intervention than on individual factors.[29–31] However, the influence of these factors cannot be dismissed entirely, as several studies have shown that age and BMI may increase the risk of LBP, especially among manual laborers.[32,33]

From a scientific perspective, this study expands the body of empirical evidence that even simple ergonomic interventions—like adopting suitable ergonomic chairs—can make a considerable difference in a very short time, even in an informal industry like garment workshops.[34–36] It should be noted that most prior research was conducted in formal industrial or office environments, whereas garment workers have received little to no attention regarding ergonomic measures.[37]

Although the current research makes significant contributions to the overall knowledge of how ergonomic interventions with chairs can be used to alleviate low back pain among garment industry workers, a number of limitations must be noted. First, the intervention is relatively short (14 days), which could limit the assessment of long-term outcomes of using ergonomic chairs. To evaluate the long-term sustainability of the intervention's effects, longer-term follow-up studies are warranted. Second, self-reported pain scores are prone to subjective bias, such as intentional or unintentional over- or underreporting.[38,39] Third, the geographic location of the study site, limited to one garment industry in Indonesia, might also limit the generalizability of the results to other populations that have different conditions in the workplace and different ergonomic cultures.

Future research should address the limitations identified in this study. Specifically, longitudinal or longer follow-up designs would be more effective for evaluating the long-term effects of ergonomic interventions, as suggested by Konradt and Wiben.[40,41] Additionally, the validity and robustness of the findings could be strengthened by incorporating objective measurements, such as spinal load analysis, muscle activity (EMG), or sitting duration. Applying these methods to other industries and geographic locations, especially in Southeast Asia, would provide a broader perspective and enhance the generalizability of ergonomic interventions in high-risk work environments.

Conclusion

The ergonomic chair intervention showed improvements in working posture and a consistent decrease in low back pain over 14 days among informal garment workers. These results are novel and contextually appropriate for this industry in Southeast Asia, where ergonomic research is limited. The findings illustrate the need for even simple ergonomic interventions, especially when incorporating chair designs that fit the anthropometric characteristics of the intended users, to mitigate the risk of developing MSDs in occupations with high ergonomic stress.

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