# Ergonomic interventions based on stretching to relieve low back pain and work fatigue in nurses
## *Intervenciones ergonómicas basadas en estiramientos para aliviar el dolor lumbar y la fatiga laboral en enfermeras*

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## Abstract

Introduction: Low back pain (LBP) and work fatigue are common among nurses due to prolonged activity and poor posture. Effective interventions are needed to address these issues.
Objective**:** To evaluate the effect of stretching exercises on reducing LBP and work fatigue in inpatient nurses at Prof. Dr. W.Z. Yohannes Kupang Hospital.
Objective: This quasi-experimental study used a one-group pre-test and post-test design involving 20 nurses selected randomly. LBP was assessed using the Oswestry Disability Index (ODI), and fatigue was measured through reaction time. The intervention was 30–45 minutes of stretching exercises. Data were analyzed using a paired t-test with $\alpha = 0.05$.
Results: There was a significant reduction in LBP and fatigue after the intervention. ODI scores dropped from $11.775 \pm 3.952$ to $9.45 \pm 3.766$ (19.74% reduction, $p = 0.000$). Fatigue decreased from $421.525 \pm 50.466$ ms to $373.725 \pm 39.543$ ms (11.33% reduction, $p = 0.000$).
Conclusions: Stretching effectively reduces LBP and fatigue in nurses, likely by enhancing flexibility and circulation. Incorporating stretching into workplace health programs is recommended. Further research should explore long-term outcomes and ergonomic improvements.

## Keywords

Musculoskeletal disorders; nursing staff; flexibility exercises; physical fatigue; workplace ergonomics; health promotion.

## Resumen

Introducción: El dolor lumbar (DL) y la fatiga laboral son comunes entre las enfermeras debido a la actividad prolongada y las posturas no ergonómicas. Se necesitan intervenciones efectivas para abordar estos problemas
Objetivo: Evaluar el efecto de los ejercicios de estiramiento en la reducción del DL y la fatiga laboral en enfermeras hospitalarias del Hospital Prof. Dr. W.Z. Yohannes de Kupang.
Metodología: Estudio cuasi-experimental con diseño de pretest y postest en un solo grupo, con 20 enfermeras seleccionadas aleatoriamente. El DL se evaluó con el Índice de Discapacidad de Oswestry (ODI), y la fatiga mediante el tiempo de reacción. La intervención consistió en ejercicios de estiramiento de 30 a 45 minutos. Los datos se analizaron con la prueba t pareada con $\alpha = 0.05$.
Resultados: Se observó una reducción significativa en el DL y la fatiga después de la intervención. Los puntajes de ODI bajaron de $11.775 \pm 3.952$ a $9.45 \pm 3.766$ (reducción del 19.74%, $p = 0.000$). La fatiga disminuyó de $421.525 \pm 50.466$ ms a $373.725 \pm 39.543$ ms (reducción del 11.33%, $p = 0.000$).
Conclusiones: Los ejercicios de estiramiento son efectivos para reducir el DL y la fatiga en las enfermeras, probablemente al mejorar la flexibilidad muscular y la circulación. Se recomienda incorporar el estiramiento en los programas de salud laboral. Se sugiere realizar más investigaciones sobre los efectos a largo plazo y estrategias ergonómicas adicionales

## Palabras clave

Musculoesqueléticos; personal de enfermería; ejercicios de flexibilidad; fatiga física; ergonomía en el lugar de trabajo; promoción de la salud.

## Introduction

Hospitals, as providers of healthcare services to the community, must continuously improve service quality to ensure optimal health outcomes. The quality of healthcare services heavily depends on available resources, particularly healthcare professionals such as doctors, nurses, midwives, and physiotherapists. Among these professionals, nurses play a crucial role in patient care, often performing physically demanding tasks that require precision and endurance (Hassani et al., 2022).

According to the World Health Organization (WHO, 2022), the well-being of healthcare workers, particularly nurses, is essential to maintaining the quality and continuity of patient care services. Ensuring a safe and comfortable work environment is fundamental for enhancing nurses' performance and job satisfaction.

Workplace protection, therefore, is a critical aspect that must be provided by employers to prevent work-related injuries, reduce health risks, and improve service delivery. This necessity is also legally mandated under Article 86 of Law No. 13 of 2003 concerning Manpower (Indonesian Government, 2003). Despite existing regulations, various studies have shown that workplace accidents and occupational hazards among nurses remain prevalent, often caused by excessive workload, human negligence, unsafe practices, and inadequate decision-making (Dodoo & Al-Samarraie, 2019; Eskandari et al., 2017; Hafeez et al., 2020; Rostamabadi et al., 2019).

Nurses are exposed to numerous occupational hazards, ranging from infectious diseases to physical injuries caused by improper work postures and prolonged standing. These risks not only affect individual nurses but also compromise hospital efficiency and patient care quality. Among the most common occupational health issues faced by nurses is lower back pain (LBP), a condition affecting at least 70% of healthcare workers worldwide (Hassani et al., 2022; Hossian et al., 2022; Mekonnen, 2019; Rezaee & Ghasemi, 2014; Russo et al., 2021).

The theoretical framework of this study is grounded in ergonomic principles and occupational health theories. Ergonomics, as a multidisciplinary science, focuses on designing workplaces that align with the physical and cognitive capabilities of workers to promote health, safety, and productivity. Occupational health theory further emphasizes the prevention of work-related injuries and illnesses through systematic hazard identification and control measures (Jilcha & Kitaw, 2016).

Studies indicate that LBP is particularly prevalent among nurses working in inpatient wards due to the physically demanding nature of their tasks. These tasks include administering injections, inserting catheters, treating wounds, setting up IV lines, and transferring patients—activities that often involve bending, twisting, and lifting heavy loads (Belay et al., 2016; El-Haddad et al., 2018; Lin et al., 2012; Mijena et al., 2020; Samaei et al., 2017; Sanger et al., 2013). Frequent exposure to these biomechanical stressors significantly increases the risk of developing musculoskeletal disorders, particularly LBP, which can lead to long-term disability if left untreated (Stjernbrandt et al., 2024)

The impact of LBP extends beyond individual discomfort, The impact of LBP extends beyond individual discomfort, affecting productivity and well-being. Nurses experiencing LBP often report significant work fatigue, which refers to a state of physical and mental exhaustion resulting from prolonged work hours, repetitive tasks, and inadequate recovery, further exacerbating their physical discomfort and reducing job performance (Idrus, 2023). This fatigue is exacerbated by factors such as irregular sleep patterns, high workloads, and extended working hours. Additionally, prolonged standing, poor posture, repetitive movements, inadequate physical fitness, improper lighting, obesity, and aging further contribute to the deterioration of their health and efficiency (Baker et al., 2018).

Despite existing research on LBP and ergonomic interventions, a significant gap remains in understanding the effectiveness of structured ergonomic programs specifically tailored for inpatient nurses. Many studies focus on general workplace ergonomics without considering the unique challenges faced by hospital staff. This gap highlights the need for targeted interventions that can address the specific biomechanical and environmental stressors in hospital settings.

Healthcare institutions have a responsibility to ensure that their workforce remains in optimal condition to provide high-quality services. However, many nurses experiencing lLBP tend to neglect their symptoms, often relying on temporary remedies such as massages or pain relief patches rather than seeking appropriate medical intervention. Globally, scientific exploration on ergonomics has been extensive, particularly in identifying risk factors such as poor posture, excessive workload, long working hours, and age-related physical decline (Ezzatvar et al., 2020; Pillai Divya & Purti Haral, 2018). However,

a significant research gap remains concerning the comprehensive and systematic application of ergonomic principles in workplace design. While several studies have emphasized the importance of ergonomics in mitigating occupational hazards (Abareshi et al., 2022; Doshi et al., 2020; Gopinadh et al., 2013; Ketkar & Malaiappan, 2020; Prabata et al., 2019; SHAILEEN RIAZ et al., 2018), empirical evaluations of its real-world implementation are still limited. This gap highlights the need for further interdisciplinary research to examine how ergonomic optimization of work environments can contribute to enhanced safety, comfort, and productivity (Asmare & Hailemariam, 2025; ÖZBAKIR, 2024; Selamat & Wern, 2022).

This study introduces a novel approach to addressing LBP and fatigue by emphasizing the role of targeted stretching exercises as an ergonomic intervention. Unlike conventional strategies that mainly focus on postural correction and workplace modifications, this research explores the direct impact of structured stretching routines on alleviating lumbar. By implementing a practical, low-cost, and easily adoptable solution, this study contributes to bridging the gap between theoretical ergonomics and real-world application in hospital environments.

In practical terms, ergonomic interventions can be implemented through posture correction, workplace redesign, and preventive strategies such as stretching and physical exercises (Adiga, 2023).

One particularly effective approach explored in this study is stretching exercises, which serve as an alternative intervention for reducing and work fatigue, as they help lengthen muscles, improve flexibility, and enhance overall functionality, thereby reducing the risk of musculoskeletal disorders (Hidayatullah et al., 2022). This simple yet effective practice alleviates muscle tension, mitigates stiffness, and accelerates recovery from physical strain caused by improper posture or prolonged inactivity. Empirical studies have demonstrated that stretching significantly reduces muscle tension, enhances blood circulation, and prevents chronic fatigue associated with prolonged strain (Castori et al., 2012)

Although ergonomic interventions have been proven beneficial in preventing and reducing LBP, no systematic ergonomic intervention has been implemented at Prof. Dr. W.Z. Yohanes Hospital to date. As a result, nurses continue to suffer from preventable LBP, which negatively affects their job performance and overall well-being. Therefore, this study carries a degree of novelty by evaluating the effectiveness of stretching exercises as a form of ergonomic intervention to reduce LBP and work-related fatigue among inpatient nurses. In addition, the study aims to provide evidence-based recommendations to optimize ergonomic strategies within the nursing work environment.

## Method

The research approach used in this study was a quantitative approach, which aims to examine the effect of one variable on another systematically, objectively, and through structured data analysis procedures (Choy, 1942; Kas et al., 2019; Murindangabo et al., 2023). A quantitative approach was chosen because it allows researchers to measure the magnitude of the effect of an intervention and to generalize findings within a certain degree of confidence. The specific quantitative method applied was the quasi-experimental method, particularly designed to evaluate causal relationships when random assignment to treatment groups is not feasible. In quasi-experimental research, although full control over all variables cannot be guaranteed as in a pure experimental design, the application of a structured intervention and the comparison of pretest and posttest data allow valid conclusions about the effects of the independent variable on the dependent variables.

### Population and Sample

In total, 20 nurses were included in the study as research participants. This study employed the total sampling technique, a type of non-probability sampling in which all members of the population who meet the inclusion criteria are selected as research participants. The population consisted of 20 nurses, all of whom were considered relevant and eligible based on the study objectives. This technique was chosen because the population size was relatively small and fully accessible to the researcher. According to (Sugiyono, 2010), total sampling is an appropriate method when the population is less than 30 individuals and when all members share homogeneous characteristics that are pertinent to the research problem. Furthermore, total sampling allows for comprehensive data collection without omitting potentially significant variations that may be lost when only a subset of the population is sampled. Therefore, in the context of this study, the use of total sampling is considered a rational and methodologically valid approach. The population in this study is every subject that meets the established criteria (Ahsan

et al., 2013). Population is defined as a generalization area consisting of objects/subjects that have certain qualities and characteristics determined by researchers to be studied and then conclusions drawn. The target population is the population that meets the sampling criteria and becomes the final target of the study. While the accessible population is the population that meets the criteria in the study and can be reached by researchers (Ahsan et al., 2013). In this study, the population is all nurses who work at Prof. Dr. WZ Yohannes Kupang Hospital. sample is a part of the population to be studied. In health research, samples can be divided into inclusion and exclusion criteria. Inclusion criteria are criteria where research subjects can represent the research sample that meets the requirements as a sample. While exclusion criteria are criteria where research subjects cannot represent the sample because they do not meet the requirements as a research sample (Hidayat, 2003). In this study, the inclusion criteria are:

1. Nurses in the inpatient room of Prof. Dr. WZ Yohannes Kupang Hospital who were willing to be studied, as evidenced by their willingness to sign an informed consent.
2. Inpatient nurses at Prof. Dr. WZ Yohannes Kupang Hospital who have experienced or are experiencing lower back pain for at least 1 month and have not received therapy.
3. An inpatient nurse at Prof. Dr. WZ Yohannes Kupang Hospital who experienced lower back pain without any other serious illness.
4. Inpatient nurses at Prof. Dr. WZ Yohanes Kupang Hospital aged 20-45 years.

The exclusion criteria in this study are:

1. Inpatient nurses at Prof. Dr. WZ Yohannes Kupang Hospital who experience lower back pain due to disease or aging factors (osteoporosis, kyphosis, lordosis, scoliosis, etc.).
2. Inpatient nurses at Prof. Dr. WZ Yohannes Kupang Hospital who took leave during the research.

The drop out criteria in this study are:

Nurses who were sick when the research was conducted.

The number of samples in this study can be determined by the following calculation:

$$n = \frac{NZ_{(1-a/2)}{}^2 P\,(1-P)}{Nd^2 + Z_{(1-a/2)}{}^2 P\,(1-P)}$$

$$N = \frac{21\ x\ 1.96^2 x\ 0.5\ x\ 0.5}{21\ x\ 0.05^2 + 1.96^2\ x\ 0.5\ x\ 0.5} = \frac{20.1684}{1.0104} = 19.95\mathord{\sim}20$$

### Intervention Protocol

The intervention carried out in this research involved the application of a structured stretching program aimed at reducing lower back pain and work fatigue among the participants. The type of stretching used in this study based on the classification proposed by Nieto et al., (2003), who reviewed various approaches and terminology inconsistencies and developed a unified framework for classifying stretching techniques in physiotherapy. According to their classification, the intervention in this study can be categorized as passive static stretching, where the target muscles are extended to the end range of motion and held without active contraction by the participant. The stretching protocol focused on the lumbar extensors and hamstrings, which are frequently strained in nursing tasks due to prolonged standing and improper posture. Each session lasted approximately 15 minutes and was conducted three times a week over a period of four weeks. The position was maintained for 20 to 30 seconds per stretch. This protocol aligns with kinesitherapy principles and supports musculoskeletal relief and flexibility improvement. The stretching intervention was implemented after the completion of each workday, performed twice a week for one month, and was classified as low-impact to prevent additional strain or injury to participants already experiencing musculoskeletal discomfort. The stretching sessions targeted key muscle groups associated with lower back stability and postural control. In the intervention for low back pain, the primary muscles targeted include the erector spinae, hamstrings, and gluteus medius, as these muscles play a crucial role in lumbar spine stability and movement. Tension or weakness in these specific muscle groups is commonly associated with low back pain, particularly.

# Results

## *Analisys Univariat*

The univariate analysis was conducted to provide an overview of low back pain (LBP) levels among nurses before and after performing their work, but prior to receiving stretching interventions. This analysis aims to assess the severity of LBP complaints and the distribution of pain levels among respondents, as shown in Table 1.

Table 1. Distribution of Respondents' LBP Levels in the Period 1

| LBP complaint level | Total | Percentage (%) |
|---|---|---|
| No pain (0-4) | 1 | 5 |
| Mild pain (5-14) | 14 | 70 |
| Moderate pain (15-24) | 5 | 25 |
| Average LBP | 11.775 | 100 |

The results indicate that the average LBP score in period 1 was 11.775, which falls within the mild pain category. Based on the distribution of pain levels, only 1 respondent (5%) reported no pain, indicating that nearly all nurses experienced some degree of LBP during their work. The majority of respondents, 14 individuals (70%), reported mild pain, suggesting that LBP was a common complaint among nurses, although not always severe. Additionally, 5 respondents (25%) experienced moderate pain, reflecting a higher level of discomfort that could potentially impact work performance and overall well-being.

These findings suggest that LBP is prevalent among nurses, with most experiencing at least mild pain during their work shifts. Given the physically demanding nature of nursing duties, including prolonged standing, frequent lifting, and repetitive movements, the high incidence of LBP may be associated with occupational factors. The data underscores the importance of preventive measures, such as stretching exercises, ergonomic interventions, and proper body mechanics training, to reduce the risk and severity of LBP.

Overall, the analysis highlights that LBP is a significant issue among nurses, with mild to moderate pain being commonly reported. The introduction of workplace interventions, including stretching programs and ergonomic improvements, may help alleviate discomfort and enhance the overall well-being of healthcare workers. Further analysis is needed to evaluate the effectiveness of stretching interventions in reducing LBP levels over time.

The univariate analysis was conducted to assess the level of work fatigue among nurses before and after performing their work in period 1, prior to the implementation of a stretching intervention. This analysis provides insight into the extent of fatigue experienced by nurses, which may be influenced by workload, shift duration, and physical exertion during work. The results are presented in Table 2.

Table 2. Distribution of Work Fatigue Levels in the Period 1

| Fatigue level | Total | Percentage (%) |
|---|---|---|
| Light work fatigue (> 240- < 410 milliseconds) | 9 | 45 |
| Moderate work fatigue (410- < 580 milliseconds) | 11 | 55 |
| Average work fatigue (milliseconds) | 421.525 | 100 |

Table 2, Indicate that the average work fatigue score was 421.525 milliseconds, placing it within the moderate fatigue range. In terms of distribution, 9 respondents (45%) experienced mild work fatigue, while the majority, 11 respondents (55%), reported moderate work fatigue. These results suggest that work-related fatigue is a common issue among nurses, with more than half of the participants experiencing moderate levels of fatigue after completing their work.

The presence of moderate work fatigue in most of the respondents may be attributed to the physically demanding nature of nursing tasks, such as prolonged standing, frequent patient handling, and the cognitive demands of patient care. Given that fatigue can impact concentration, reaction time, and overall job performance, these findings highlight the importance of fatigue management strategies in healthcare settings. Further investigation is required to evaluate the effectiveness of such interventions in reducing work fatigue over time. The differences in the level of LBP of nurses after work in period 2 are explained in the following table 3.

Table 3. Distribution of Respondents' LBP Levels in Period 2.

| LBP complaint level | Total | Percentage (%) |
|---|---|---|
| No pain (0-4) | 3 | 15 |
| Mild pain (5-14) | 16 | 80 |
| Moderate pain (15-24) | 1 | 5 |
| Average LBP complaint | 9.45 | 100 |

Table 3, The distribution of respondents' low LBP levels after receiving the stretching intervention in Period 2 is presented as follows: the average LBP score was 9.45. Specifically, 3 participants (15%) reported no pain, 16 participants (80%) experienced mild pain, and 1 participant (5%) reported moderate pain. These results were measured using a standardized pain scale instrument (e.g., Visual Analog Scale/ Numeric Rating Scale), which was administered before and after the workday. The sample consisted of 20 nurses who were selected using purposive sampling based on inclusion criteria such as active work status, no history of spinal surgery, and willingness to participate. All participants received the same stretching protocol over a four-week period. Further differences in the level of work fatigue before and after the intervention in Period 2 are presented in Table 4, using validated fatigue assessment tools and consistent observation timing.

Table 4. Distribution of Respondents' Work Fatigue Levels in Period 2

| Fatigue level | Total | Percentage (%) |
|---|---|---|
| Light work fatigue (> 240- < 410 milliseconds) | 16 | 80 |
| Moderate work fatigue (410- < 580 milliseconds) | 4 | 20 |
| Average work fatigue (milliseconds) | 373.725 | 100 |

Table 4 shows that the average work fatigue level was 373.725 milliseconds, which falls within the light fatigue category. In terms of distribution, 16 respondents (80%) experienced light work fatigue, while 4 respondents (20%) experienced moderate work fatigue. These findings suggest that most nurses experienced only light levels of work fatigue, indicating that while fatigue is present, it has not reached a critical level for the majority during this period.

The presence of moderate work fatigue in a majority of the respondents may be attributed to the physically demanding nature of nursing tasks, such as prolonged standing, frequent patient handling, and the cognitive demands of patient care (Trinkoff et al., 2011; Yıldız et al., 2018). Given that fatigue can impact concentration, reaction time, and overall job performance, these findings highlight the importance of fatigue management strategies in healthcare settings (Geiger-Brown & Lipscomb, 2010; Sagherian et al., 2017).

To mitigate the effects of work fatigue, interventions such as structured rest breaks, workload adjustments, ergonomically posture improvements, and stretching exercises could be implemented. Regular fatigue monitoring and workplace modifications may also help reduce the physiological strain on nurses, leading to improved occupational health and patient safety.

Overall, the study highlights a moderate level of work fatigue among nurses, with a nearly equal distribution between mild and moderate fatigue cases. The findings suggest that fatigue management interventions, including stretching and ergonomic strategies, should be considered to enhance nurses' endurance and reduce the risk of work-related exhaustion. Further investigation is required to evaluate the effectiveness of such interventions in reducing work fatigue over time

### Bivariate Analysis

The bivariate analysis aimed to evaluate the effectiveness of stretching exercises in reducing low back pain (LBP) among nurses. A paired T-test was conducted with a 95% confidence level ($\alpha = 0.05$) to determine whether the reduction in LBP levels from Period 1 to Period 2 was statistically significant. The results are presented in Table 5.

Table 5. Differences in LBP Levels in Period 1 and Period 2

| Variables | Period 1 | Period 2 | different | pvalue | Percentage decrease (%) |
|---|---|---|---|---|---|
| LBP nurse | 11.775 ± 3.952 | 9.45 ± 3.766 | 2.325 | 0.000[*] | 19.74 |

*= significant at 95% level ($\alpha = 0.05$)

Table 5, the findings indicate a significant decrease in LBP levels after the stretching intervention. The mean LBP score in Period 1 was 11.775 ± 3.952, which reduced to 9.45 ± 3.766 in Period 2, resulting in a mean difference of 2.325. This reduction corresponds to a 19.74% decrease in LBP levels, with a highly significant p-value of 0.000 (p < 0.05), confirming the effectiveness of stretching in alleviating LBP.. Overall, the study provides strong evidence that stretching interventions significantly alleviate LBP, emphasizing the importance of integrating structured stretching programs into workplace health management strategies to enhance nurses' musculoskeletal health and overall well-being.

The bivariate analysis aimed to evaluate the effectiveness of stretching exercises in reducing work fatigue among nurses. A paired T-test was conducted with a 95% confidence level ($\alpha = 0.05$) to determine

whether there was a statistically significant reduction in work fatigue levels from Period 1 to Period 2. The results are summarized in Table 6.

Table 6. Differences in Work Fatigue Levels in Period 1 and Period 2

| Variables | Period 1 | Period 2 | Different | p-value | Percentage decrease (%) |
|---|---|---|---|---|---|
| Nurse burnout | 421.525 ±50.466 milliseconds | 373.725 ± 39.543 milliseconds | 47.8 milliseconds | 0.000* | 11.33 |

* significant at 95% level (α = 0.05)

Table 6, The findings reveal a significant decrease in work fatigue levels following the stretching intervention. The mean work fatigue score in Period 1 was 421.525 ± 50.466 milliseconds, which decreased to 373.725 ± 39.543 milliseconds in Period 2, resulting in a mean difference of 47.8 milliseconds. This reduction corresponds to an 11.33% decrease in work fatigue, with a highly significant p-value of 0.000 ($p < 0.05$), confirming the effectiveness of stretching in alleviating work fatigue.Overall, the study provides strong evidence that stretching interventions significantly reduce work fatigue, reinforcing the importance of integrating structured stretching programs into workplace health and wellness initiatives to improve nurses' endurance, productivity, and overall well-being

## Discussion

Low back pain (LBP) remains a significant occupational health issue among nurses, primarily due to prolonged physical activity and non-ergonomic working postures. The findings of this study confirm that nurses frequently adopt bent working positions during patient care, which strongly contributes to LBP complaints.

The univariate analysis in Period 1 revealed that the majority of nurses experienced LBP, with 70% reporting mild pain, 25% moderate pain, and only 5% reporting no pain. The average LBP score of 11.775 supports that musculoskeletal discomfort, particularly in the lower back, is widespread in daily nursing practice. This high incidence of LBP can be attributed primarily to non-ergonomic working postures. Nurses were frequently observed adopting bent or flexed positions when assisting patients, transferring individuals, or performing procedures. These repetitive and sustained postures apply continuous strain on the lumbar spine, leading to muscle fatigue and inflammation. Such findings are consistent with previous research identifying forward-flexed postures and awkward body mechanics as major risk factors for LBP in healthcare workers (Gonçalves et al., 2001; Goradia & Shimpi, 2023; Toh et al., 2017; Tzeng et al., 2019). Furthermore, inadequate use of assistive devices and lack of ergonomic awareness exacerbate the burden on the musculoskeletal system(Kharbat et al., 2023).

Although most nurses reported mild pain, it is clinically important to address even low-grade discomfort, as chronic exposure can escalate into moderate or severe conditions without timely intervention. Unaddressed LBP has been associated with declines in work efficiency, job satisfaction, and overall well-being (Ningsih et al., 2017).

In Period 2, after nurses completed a structured four-week stretching program, there was a marked improvement in LBP indicators. The average pain score dropped to 9.45, with 80% of participants reporting mild pain, 15% reporting no pain, and only one nurse (5%) remaining in the moderate pain category. This shift reflects a measurable improvement in musculoskeletal health, further substantiated by the bivariate analysis, which showed a 19.74% reduction in mean LBP scores between Period 1 and Period 2.

These outcomes confirm that stretching exercises are effective in alleviating LBP. Physiologically, stretching enhances muscle flexibility, corrects muscular imbalances, and promotes local circulation, all of which help reduce the discomfort associated with prolonged standing and repetitive motions (Kharbat et al., 2023; Lawand et al., 2015). Additionally, it limits lactic acid buildup and soft tissue strain, common contributors to pain in high-mobility jobs (Hossian et al., 2022; Putt et al., 2008).

Moreover, participants reported increased body awareness and posture consciousness following the intervention. This reinforces the dual role of stretching—not only as a physical recovery method but also as a behavioral and educational tool that fosters ergonomic mindfulness (Goradia & Shimpi, 2023). Considering the strong link between poor posture and LBP, implementing stretching programs within a broader ergonomic strategy is recommended. This could be integrated with patient-handling workshops, use of mechanical aids, and ergonomic workplace redesign to mitigate long-term health risks (Tzeng et al., 2019). The results of both univariate and bivariate analyses highlight that stretching is a

feasible, low-cost, and effective approach for reducing LBP in nursing personnel. The structured integration of stretching routines into shift transitions or breaks may serve as a sustainable occupational health initiative.

In Period 1, nurses experienced work fatigue at a moderate level, with an average reaction time of 421.525 milliseconds. Most participants reported moderate fatigue (55%), while the remaining 45% experienced mild fatigue. This level of exhaustion reflects the physical and emotional toll of nursing duties, including prolonged standing, repetitive lifting, and intensive mental engagement.

The observed fatigue is consistent with earlier findings that show a direct association between workload intensity and nurse fatigue. As the number of patients increases, so does the physical burden and emotional strain, leading to fatigue-related outcomes such as reduced alertness and increased risk of clinical errors (Marti et al., 2019). Contributing factors also include limited break periods, poor shift rotation, and inadequate staffing, which restrict the opportunity for proper recovery (Geiger-Brown & Lipscomb, 2010; Trinkoff et al., 2011; Yildirim & Aycan, 2008).

In Period 2, after implementing the four-week stretching intervention, fatigue levels shifted notably. The average reaction time dropped to 373.725 milliseconds. A majority of participants (80%) fell within the light fatigue category, while only 20% remained in the moderate range. This reflects improved physical endurance and a reduction in fatigue symptoms across the workforce.

Bivariate analysis supported these observations, showing an 11.33% decrease in average fatigue scores. These changes demonstrate that stretching contributes to faster energy recovery, enhanced circulation, and decreased neuromuscular tension. These effects work together to improve overall resilience and reduce burnout (Gasibat et al., 2017; Mols et al., 2012). In addition to physical recovery, stretching was reported to improve mental focus and psychological relief. This benefit is attributed to parasympathetic nervous system activation, which is essential in promoting relaxation and lowering occupational stress levels (Dupuy et al., 2018; Hossian et al., 2022).

Another influential factor in fatigue response was body weight. Nurses with either overweight or underweight conditions tended to fatigue more rapidly, which aligns with previous studies linking poor nutritional balance and metabolic strain with decreased stamina (Kumari et al., 2024; Sunaryo & Ratriwardhani, 2022; Uzogara, 2016).

The absence of structured rest periods was also correlated with higher fatigue levels. Nurses who lacked adequate breaks reported more persistent exhaustion, suggesting that the quality—not just the quantity—of rest plays a critical role in fatigue management (Balk & de Jonge, 2021; Demerouti et al., 2012). Participants also reported subjective improvements in work comfort and alertness after stretching sessions. Many found that a short stretching break before or during shifts helped restore energy and concentration. These active rest periods appear to support cognitive functioning and emotional regulation during physically demanding tasks.

Importantly, implementing fatigue reduction strategies such as stretching should not be viewed in isolation, but rather as part of a broader occupational health system. Research by ÖZBAKIR (2024) emphasizes that enhancing healthcare worker well-being through structured risk assessments and targeted interventions is essential not only for staff health but also for patient safety outcomes. In high-pressure environments like emergency departments or inpatient units, minimizing fatigue directly contributes to better clinical performance and safer care delivery. The integration of stretching into daily nursing routines has been shown to reduce fatigue effectively. When paired with structured rest, improved nutrition, and equitable workload distribution, stretching serves as a powerful component of comprehensive fatigue management strategies in healthcare environments.


## Conclusions

The findings of this study showed that the implementation of stretching exercises effectively reduced the intensity of low back pain (lbp) and work fatigue among inpatient nurses. the lbp score decreased by 19.74 percent, while work fatigue decreased by 11.33 percent after the intervention, indicating the positive impact of stretching on musculoskeletal health this study contributed to the existing body of knowledge by demonstrating that simple ergonomic interventions, such as stretching exercises, could measurably improve nurses' occupational health. the findings emphasized the importance of integrating regular stretching sessions into workplace health programs to prevent musculoskeletal disorders and enhance work performance. although stretching exercises led to significant improvements, lbp and fatigue levels remained within mild and moderate categories, suggesting that additional ergonomic

measures are necessary to achieve optimal results. Future workplace interventions should include posture correction training, ergonomic improvements to facilities, and better workload management strategies to complement stretching exercises.

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