RESEARCH ARTICLE OPEN ACCESS
Website: http://ijte.americanjournal.us/index.php/ijte

International Journal of Technology & Energy
Volume 2, Number 1, 2026 | ISSN: 3066-6635

Embodied Experiences of Musculoskeletal Disorders Among Printing Workers: A Phenomenological Inquiry

Mahyudin[1]✉, Setiawan[2], Adi Rusdi Widya[3]

[1] *Fakultas Teknik, Universitas Pelita Bangsa, Indonesia (mahyu_d@mhs.pelitabangsa.ac.id)*
[2] *Universitas Pelita Bangsa, Indonesia (setiawan@pelitabangsa.ac.id)*
[3] *Universitas Pelita Bangsa, Indonesia (adirusdiw@pelitabangsa.ac.id)*

Abstract

Musculoskeletal Disorders (MSDs) remain one of the most prevalent occupational health problems in manufacturing industries, particularly in work environments characterized by repetitive tasks, manual material handling, and prolonged physical exertion. While previous studies have predominantly focused on biomechanical and quantitative assessments of ergonomic risks, limited attention has been given to workers' lived experiences of MSDs in daily production activities. This study aimed to explore the embodied experiences of MSDs among printing industry workers and to understand how these experiences influence work efficiency. A qualitative phenomenological approach was employed to capture workers' subjective experiences within their workplace context. Data were collected through semi-structured in-depth interviews, participant observation, and document review involving five warehouse workers at a printing manufacturing company in Indonesia. The data were analyzed using phenomenological procedures, including bracketing, horizontalization, thematic clustering, and synthesis of meaning. The findings revealed four major themes: (1) the body within production rhythms, (2) living with pain as a normal part of work, (3) adaptive strategies for maintaining work performance, and (4) the interrelationship between physical condition and work efficiency. Workers frequently experienced musculoskeletal discomfort, particularly in the lower back, shoulders, and neck, yet often normalized pain as an unavoidable consequence of their jobs. To sustain productivity, workers developed informal coping strategies such as changing work positions and taking short breaks. However, physical discomfort was consistently associated with reduced concentration, slower work performance, and increased work errors. The study highlights the importance of integrating workers' lived experiences into ergonomic interventions and supports the adoption of human-centered approaches to promote occupational health and sustainable productivity.

Keywords: Musculoskeletal Disorders (MSDs); Phenomenology; Embodied Experience; Human-Centered Ergonomics; Work Efficiency; Printing Industry.

INTRODUCTION

The printing industry remains an important component of manufacturing systems due to its strategic role in supporting packaging, consumer goods, and e-commerce supply chains. Increasing production demands have encouraged printing companies to optimize operational efficiency and productivity. However, the pursuit of higher productivity often places workers under repetitive physical demands, prolonged standing positions, manual material handling activities, and continuous production pressure. These working conditions have raised concerns regarding occupational health, particularly the prevalence of work-related Musculoskeletal Disorders (MSDs), which continue to represent one of the most significant occupational health challenges in manufacturing environments (Organization, 2024).

MSDs refer to injuries and disorders affecting muscles, tendons, ligaments, joints, nerves, and supporting structures caused or aggravated by work-related activities (Punnett & Wegman, 2004). Previous studies have consistently demonstrated that repetitive movements, awkward postures, excessive force exertion, and prolonged static positions contribute substantially to the development of MSDs among industrial workers (Choobineh & Daneshmandi, 2022; Marras, 2008). Within printing industries, workers frequently perform activities such as lifting materials, stacking products, packing finished goods, and operating machinery under demanding production schedules. These tasks expose workers to biomechanical loads that may accumulate over time and negatively affect both physical well-being and work performance (Kodle et al., 2022).

The relationship between ergonomics and productivity has been extensively discussed in occupational health and industrial engineering literature. Ergonomic interventions have been shown to reduce biomechanical stress, improve worker comfort, and enhance operational efficiency (Astuti et al., 2021; Kim & Lee, 2023). Human factors and ergonomics researchers emphasize that productive work systems cannot be separated from workers' physical capabilities and limitations (Dul et al., 2012; Karwowski & Marras, 1998). From this perspective, occupational health should not be viewed merely as a welfare issue but as a critical component of sustainable productivity. Consequently, understanding how workers experience and respond to physical strain becomes essential for designing effective and human-centered work systems.

This is an open access article under the CC BY License.

Despite growing attention to MSDs, existing studies have predominantly adopted quantitative and observational approaches. Ergonomic assessment tools such as Rapid Upper Limb Assessment (RULA), Rapid Entire Body Assessment (REBA), and Nordic Body Map (NBM) are frequently employed to identify postural risks and musculoskeletal symptoms (McAtamney & Corlett, 1993; Kuorinka et al., 1987). These methods provide valuable numerical indicators of ergonomic risk and facilitate workplace intervention planning. Several studies conducted in manufacturing and printing environments have successfully identified high-risk postures and areas of musculoskeletal discomfort through these instruments (Handayani & Ramdhan, 2020; Kurniawati & Nugraha, 2023; Widya et al., 2023). However, although such approaches effectively quantify risk exposure, they offer limited insight into how workers perceive, interpret, and adapt to these physical challenges in their daily work experiences.

This limitation highlights an important gap in contemporary ergonomics research. The majority of MSD studies focus on objective measurements while paying insufficient attention to workers' subjective experiences. Workers are often treated as objects of assessment rather than active subjects who continuously negotiate between productivity demands and bodily limitations. Consequently, little is known about how workers make sense of pain, fatigue, discomfort, and physical adaptation within the rhythm of industrial production. This gap becomes particularly relevant because workers' perceptions and experiences may influence their behavioral responses, coping strategies, and ultimately the effectiveness of ergonomic interventions (Kodle et al., 2022).

Phenomenology offers a valuable framework for addressing this gap by exploring lived experiences as perceived and interpreted by individuals themselves. Rather than focusing solely on observable behaviors or measurable outcomes, phenomenological inquiry seeks to understand the meanings individuals attach to their experiences (Creswell & Poth, 2017; Husserl, 2012; Moleong, 2019). Within occupational settings, phenomenology enables researchers to investigate how workers experience their bodies in relation to work demands, production pressures, fatigue, and physical discomfort. The body is not merely regarded as a biological entity but as a medium through which workers engage with and make sense of their working environment.

Recent developments in human-centered ergonomics further support the need for a more experiential understanding of occupational health. Human-centered approaches emphasize the integration of workers' physical, cognitive, and emotional experiences into workplace design and organizational decision-making (Dul et al., 2012; Karwowski & Marras, 1998). Emerging studies have begun to demonstrate the value of examining workers' embodied experiences in understanding workplace health and productivity outcomes (Rahmawati & Sutanto, 2023; Zhang et al., 2024). Nevertheless, phenomenological investigations of MSDs remain limited, particularly within the printing industry, where repetitive tasks, prolonged standing, and manual handling activities create unique ergonomic challenges.

The printing industry provides an especially relevant context for examining embodied experiences of MSDs. Workers are frequently exposed to repetitive operational cycles, demanding production targets, and physically intensive material handling processes. These conditions may shape not only the occurrence of musculoskeletal symptoms but also workers' perceptions of efficiency, performance, and occupational well-being. Understanding these experiences is therefore essential for developing ergonomic interventions that align with workers' actual needs and workplace realities.

Accordingly, this study aims to explore the embodied experiences of Musculoskeletal Disorders among printing workers through a phenomenological approach. Specifically, the study seeks to understand how workers experience bodily discomfort within production rhythms, how they interpret and respond to MSD-related risks, and how they negotiate the balance between productivity demands and physical well-being. By integrating workers' lived experiences with human-centered ergonomics perspectives, this research contributes to a deeper understanding of occupational health beyond biomechanical risk assessment and offers practical insights for developing more sustainable and worker-centered production systems.

METHOD

Research Design

This study employed a qualitative descriptive phenomenological approach to explore workers' embodied experiences of Musculoskeletal Disorders (MSDs) within the context of industrial production. Phenomenology was selected because it enables researchers to understand how individuals perceive, interpret, and assign meaning to their lived experiences rather than merely

examining observable behaviors or measurable outcomes (Creswell & Poth, 2017; Moleong, 2019). The approach is particularly relevant to ergonomics research because it places workers at the center of inquiry, allowing a deeper understanding of how physical strain, fatigue, discomfort, and workplace demands are experienced in everyday production activities.

Research Setting and Participants

The study was conducted at PT Best Label Indonesia, a printing manufacturing company located in Bekasi, West Java, Indonesia. Data collection focused on the warehouse department, where workers routinely engage in physically demanding activities such as lifting, carrying, storing, and moving printing materials. This setting was selected because of its high exposure to repetitive tasks and manual material handling activities that may contribute to MSD-related symptoms.

Participants were selected using purposive sampling to ensure that informants possessed sufficient experience relevant to the phenomenon under investigation (Creswell & Creswell, 2017). The inclusion criteria required participants to: (1) be permanent employees, (2) have at least one year of work experience in warehouse operations, (3) regularly perform repetitive manual handling tasks, and (4) be willing to participate voluntarily in the study. Participant recruitment continued until data saturation was achieved, meaning that no substantially new themes emerged from subsequent interviews (Moleong, 2019).

Data Collection

Data were collected between October and November 2025 using three complementary techniques: in-depth interviews, participant observation, and document review.

Semi-structured in-depth interviews served as the primary source of data. Open-ended questions were used to encourage participants to describe their experiences related to physical workload, bodily discomfort, fatigue, work efficiency, and coping strategies. All interviews were conducted with participants' consent, audio-recorded, and transcribed verbatim to preserve the authenticity of participants' narratives.

Participant observation was conducted to obtain contextual understanding of workplace activities and to verify information obtained during interviews. During observations, the researcher examined work postures, material handling activities, worker interactions, and behavioral adaptations related to physical discomfort. Field notes and workplace documentation were used to support observational findings.

To strengthen contextual understanding, organizational documents such as attendance records, productivity reports, and occupational health records were reviewed. These documents provided supplementary information regarding workplace conditions and operational practices relevant to the phenomenon under investigation.

Data Analysis

Data were analyzed using a phenomenological procedure adapted from Creswell and Poth (2017). The analytical process began with verbatim transcription of interview recordings and compilation of field notes. Subsequently, the researcher conducted bracketing (epoche) to minimize personal assumptions and biases that might influence interpretation.

The analysis continued through horizontalization, in which all participant statements were initially treated as having equal value. Significant statements related to bodily experiences, fatigue, discomfort, productivity, and adaptation were then identified and coded. Similar meanings were grouped into thematic clusters representing recurring patterns across participants' experiences.

Thematic categories were subsequently interpreted to construct both textural descriptions (what participants experienced) and structural descriptions (how those experiences occurred within workplace contexts). Finally, these descriptions were synthesized to reveal the essential meaning of workers' lived experiences regarding MSDs and their relationship with work efficiency. The analytical process followed an inductive and reflective logic, allowing themes to emerge directly from participants' narratives rather than being imposed by predetermined theoretical assumptions.

Trustworthiness

Several strategies were employed to ensure the trustworthiness of the findings. Source triangulation was conducted by comparing information obtained from participants with different workplace roles and experiences. Method triangulation was achieved through

the integration of interview, observation, and documentary evidence. In addition, member checking was performed by sharing preliminary interpretations with selected participants to verify the accuracy of the researcher's understanding and representation of their experiences (Creswell & Poth, 2017).

To further enhance credibility and dependability, detailed documentation of the research process was maintained throughout data collection and analysis. Reflexive practices were also employed to minimize researcher bias and ensure transparency in the interpretation of findings.

Research Procedure

The study followed a systematic research procedure consisting of six stages: (1) identification of the research phenomenon and formulation of research questions, (2) literature review and theoretical framework development, (3) preparation of interview and observation instruments, (4) field data collection through interviews, observations, and document review, (5) phenomenological data analysis involving bracketing, horizontalization, thematic clustering, and synthesis of meaning, and (6) validation through triangulation and member checking before final reporting. This procedure ensured methodological rigor and alignment with phenomenological research principles.

RESULTS AND DISCUSSION

Participant Characteristics

Five warehouse workers participated in this study. Participants represented different operational roles, including material handling, packing, sorting, loading, and warehouse operations. Their work experience ranged from two to seven years, providing diverse perspectives on the physical demands and bodily consequences of warehouse activities. Most participants were involved in repetitive manual material handling tasks characterized by lifting, carrying, sorting, and storing materials throughout their work shifts.

Table 1. Participant Characteristics

Participant	Age	Years of Service	Work Role	Physical Intensity
I1	28	3	Material Handling	High
I2	32	5	Packing	High
I3	26	2	Sorting	Moderate
I4	35	7	Loading	High
I5	30	4	Warehouse Operations	Moderate

1. The Body Within Production Rhythms

The first theme reveals how workers experience their bodies as inseparable from production demands. Participants described daily work activities as highly repetitive and physically intensive. Lifting materials, arranging inventory, packing products, and loading goods required continuous bodily engagement throughout the workday.

One participant explained:

> "Almost all tasks are repeated every day."

Another participant stated:

> "During one shift, I constantly move and handle materials."

These accounts indicate that production rhythms are embodied experiences rather than merely organizational routines. Workers continuously adapt their movements, posture, and energy expenditure to meet operational targets. The body becomes the primary medium through which production requirements are fulfilled.

This finding aligns with the human-centered ergonomics perspective, which emphasizes that work systems should be designed according to human capabilities and limitations rather than solely focusing on productivity outcomes (Dul et al., 2012; Karwowski & Marras, 1998). The findings also support socio-technical perspectives suggesting that workers and production systems cannot be

understood as separate entities because organizational performance emerges from continuous interactions between human and technical components (Trist & Bamforth, 1951).

2. Living with Pain as a Normal Part of Work

A prominent finding across all interviews was the widespread experience of musculoskeletal discomfort. Participants frequently reported pain in the lower back, shoulders, neck, and wrists. These symptoms typically emerged after several hours of work and intensified during periods of increased production demand.

Table 2. Reported Areas of Musculoskeletal Discomfort

Body Region	Workers Reporting Symptoms
Lower Back	90%
Shoulders	80%
Neck	70%
Wrists	60%

Workers repeatedly associated discomfort with prolonged standing, repetitive movements, and awkward postures.

One participant reported:

"My back usually starts hurting after repeatedly lifting materials."

Another explained:

"My shoulders and neck become stiff when the workload increases."

Interestingly, workers rarely interpreted these symptoms as indicators of occupational health problems. Instead, pain was commonly viewed as an unavoidable consequence of employment.

One participant stated:

"Pain is normal; it is part of the job."

This finding reflects a process of risk normalization, whereby repeated exposure to discomfort leads workers to perceive health risks as ordinary aspects of work life. Such normalization may reduce workers' awareness of MSD-related risks and delay preventive actions. The phenomenon supports previous findings demonstrating that repetitive work and non-neutral postures substantially increase MSD prevalence among industrial workers (Choobineh & Daneshmandi, 2022; Punnett & Wegman, 2004).

From a phenomenological perspective, pain emerges not merely as a biomechanical outcome but as a lived bodily experience through which workers interpret their relationship with work. The body functions simultaneously as an instrument of production and a site where occupational pressures become physically manifested.

3. Adaptive Strategies for Maintaining Work Performance

Despite experiencing physical discomfort, participants developed various adaptive strategies to maintain productivity. Common coping mechanisms included stretching, changing work positions, temporarily slowing work pace, taking brief rest periods, and sharing physically demanding tasks with coworkers.

One participant explained:

"When the pain starts, I usually change my position for a while."

Another participant noted:

"Sometimes I reduce my working speed so I can continue working."

These adaptive behaviors demonstrate workers' active efforts to negotiate between production demands and bodily limitations. Rather than passively enduring discomfort, workers continuously adjust their behavior to preserve work capacity.

However, the findings indicate that these adaptations remain informal and individual rather than organizationally supported. Consequently, they may alleviate symptoms temporarily without addressing underlying ergonomic hazards.

This finding supports arguments that individual adaptation alone cannot eliminate ergonomic risks if workplace design remains unchanged (Robbins & Judge, 2020). Effective MSD prevention requires systematic interventions that integrate workers' experiences into ergonomic redesign efforts rather than relying solely on personal coping strategies.

4. The Interrelationship Between Physical Condition and Work Efficiency

The final theme concerns the relationship between workers' physical conditions and operational performance. Participants consistently reported that fatigue and pain affected concentration, working speed, and task accuracy.

Table 3. Perceived Impact of Physical Conditions on Work Performance

Physical Condition	Impact on Work Performance
Fatigue	Reduced work speed
Pain	Reduced concentration
Muscle tension	Reduced accuracy
Physical discomfort	Increased work errors

Workers described experiencing slower task completion and greater difficulty maintaining focus during periods of physical discomfort.

One participant stated:

"When I am tired, my work becomes slower."

Another reported:

"Pain makes it harder to stay focused."

These findings suggest that MSDs should not be viewed solely as occupational health concerns but also as factors directly influencing organizational efficiency. The results support ergonomic research demonstrating that physical strain negatively affects worker performance, productivity, and operational effectiveness (Kim & Lee, 2023; Li & Buckle, 2020).

The findings further reinforce the principle that worker well-being and productivity are mutually reinforcing rather than competing objectives. Organizations that fail to address ergonomic risks may experience hidden productivity losses through reduced efficiency, decreased concentration, and increased work errors.

Discussion

This study contributes to the MSD literature by extending the focus beyond biomechanical assessment toward workers' lived experiences. Previous research has largely relied on quantitative instruments such as RULA, REBA, and Nordic Body Map to identify ergonomic risks (McAtamney & Corlett, 1993; Kuorinka et al., 1987). While these approaches successfully quantify risk exposure, they provide limited insight into how workers experience, interpret, and respond to physical discomfort in everyday work settings.

The findings reveal that workers experience MSDs as embodied consequences of production rhythms characterized by repetitive activities, prolonged standing, and manual material handling. Rather than perceiving pain as a warning sign of potential injury, participants frequently normalized discomfort as a routine aspect of work. This normalization process demonstrates how organizational cultures and production demands shape workers' perceptions of occupational health risks.

Another important contribution of this study is the identification of adaptive strategies developed by workers to sustain productivity despite physical discomfort. Although these adaptations demonstrate resilience and agency, they should not substitute for systematic ergonomic interventions. Human-centered ergonomics emphasizes that responsibility for workplace health should not rest solely on individual workers but should be integrated into organizational design and management practices (Dul et al., 2012; Karwowski & Marras, 1998).

Finally, the findings highlight the inseparable relationship between physical well-being and operational efficiency. Workers' bodily experiences directly influence concentration, work pace, accuracy, and overall productivity. Consequently, ergonomic improvements should be viewed not merely as occupational health initiatives but as strategic investments that support sustainable organizational performance.

Taken together, these findings suggest that MSDs in industrial production environments should be understood as both physical and experiential phenomena. A human-centered approach that incorporates workers' lived experiences into workplace design may provide a more comprehensive foundation for improving occupational health, productivity, and long-term organizational sustainability.

CONCLUSION

This study explored the embodied experiences of Musculoskeletal Disorders (MSDs) among printing industry workers through a phenomenological perspective. The findings demonstrate that warehouse workers routinely perform repetitive and physically demanding tasks, including lifting, carrying, sorting, and handling materials, which expose them to substantial biomechanical stress. These work conditions shape workers' bodily experiences and contribute to the development of musculoskeletal discomfort, particularly in the lower back, shoulders, neck, and wrists.

A key finding of this study is that workers tend to perceive pain and physical discomfort as normal and unavoidable consequences of their jobs. This normalization of risk reflects a workplace culture in which musculoskeletal symptoms are accepted as part of everyday work rather than recognized as potential occupational health concerns. Consequently, workers often continue performing physically demanding tasks despite experiencing pain and fatigue, increasing the likelihood of prolonged exposure to ergonomic hazards.

The study also reveals that workers actively develop adaptive strategies to maintain work performance under physically challenging conditions. These strategies include changing work positions, taking informal rest breaks, reducing work pace, and sharing physically demanding tasks with coworkers. While such adaptations help workers cope with immediate discomfort, they remain temporary responses that do not address the underlying ergonomic risks embedded within the work system.

Furthermore, the findings highlight a strong relationship between physical condition and work efficiency. Fatigue, pain, and muscle tension were consistently associated with reduced concentration, slower work performance, lower task accuracy, and a greater likelihood of operational errors. These results suggest that worker well-being and productivity should not be viewed as competing objectives but rather as mutually reinforcing dimensions of sustainable organizational performance.

This study contributes to the occupational ergonomics literature by extending the understanding of MSDs beyond biomechanical assessment toward workers' lived experiences. By integrating phenomenology with a human-centered ergonomics perspective, the study demonstrates that the body functions not only as an instrument of production but also as a site where organizational demands, physical strain, and adaptive responses are continuously experienced and negotiated. Therefore, ergonomic improvement initiatives should prioritize workers' experiences and perceptions alongside technical risk assessments to create healthier, safer, and more sustainable work environments.

From a practical perspective, organizations should consider implementing ergonomic workplace redesign, structured rest schedules, material-handling assistance, and ergonomics training programs to reduce physical strain and improve long-term productivity. Future research may benefit from combining phenomenological approaches with quantitative ergonomic assessment tools, such as RULA or Nordic Body Map, to generate a more comprehensive understanding of the relationship between work conditions, MSD risks, and organizational performance.

BIBLIOGRAPHY

Choobineh, A., & Daneshmandi, H. (2022). Ergonomic assessment of posture and risk factors for MSDs among industrial workers. BMC Public Health, 22(1), 233.

Creswell, J. W., & Creswell, J. D. (2017). Research design: Qualitative, quantitative, and mixed methods approaches. Sage publications.

Creswell, J. W., & Poth, C. N. (2017). Qualitative Inquiry and Research Design: Choosing Among Five Approaches. SAGE Publications. https://books.google.co.id/books?id=gX1ZDwAAQBAJ

Dul, J., Bruder, R., Buckle, P., Carayon, P., Falzon, P., Marras, W., Wilson, J., & van der Doelen, B. (2012). A Strategy for Human Factors/Ergonomics: Developing the Discipline and Profession. Ergonomics, 55, 377–395. https://doi.org/10.1080/00140139.2012.661087

Husserl, E. (2012). Ideas: General Introduction to Pure Phenomenology. Taylor & Francis. https://books.google.co.id/books?id=MJ43SiNok4cC

Karwowski, W., & Marras, W. S. (1998). The occupational ergonomics handbook. Crc Press.

Kim, J., & Lee, S. (2023). Impact of ergonomic redesign using RULA on worker efficiency and MSD prevention. International Journal of Occupational Safety and Ergonomics, 29(4), 671–683. https://doi.org/10.1080/10803548.2023.2173984

Kodle, N., Bhosle, S., & Pansare, V. (2022). Work-Related Musculoskeletal Disorders and Ergonomic Intervention in Marble and Granite Industries: International Journal of Social Ecology and Sustainable Development, 13, 1–12. https://doi.org/10.4018/IJSESD.292038

Kuorinka, I., Jonsson, B., Kilbom, Å., Vinterberg, H., Biering-Sørensen, F., Andersson, G., & Jørgensen, K. (1987). Standardised Nordic questionnaires for the analysis of musculoskeletal symptoms. Applied Ergonomics, 18(3), 233–237. https://doi.org/10.1016/0003-6870(87)90010-X

Marras, W. S. (2008). The working back: A systems view. Wiley-Interscience.

McAtamney, L., & Corlett, E. N. (1993). RULA: A survey method for the investigation of work-related upper limb disorders. Applied Ergonomics, 24(2), 91–99. https://doi.org/10.1016/0003-6870(93)90080-S

Moleong, L. J. (2019). Moleong," Metodologi Penelitian Kualitatif Edisi Revisi". Bandung: Remaja Rosdakarya. PT. Remaja Rosda Karya, 58.

Organization, I. L. (2024). Global Wage Report 2024–25: Is Wage Inequality Decreasing Globally? International Labour Office. https://www.ilo.org/publications/flagship-reports/global-wage-report-2024-25-wage-inequality-decreasing-globally

Punnett, L., & Wegman, D. H. (2004). Work-related musculoskeletal disorders: The epidemiologic evidence and the debate. Journal of Electromyography and Kinesiology, 14(1), 13–23.

Robbins, S. P., & Judge, T. A. (2020). Organizational behavior (18th ed.). Pearson Education.

Trist, E., & Bamforth, K. (1951). Some social and psychological consequences of the longwall method of coal-getting. Human Relations, 4(1), 3–38.