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FROM PRINTING PRESS TO STRESS: IDENTIFYING ERGONOMIC TRIGGERS IN THE WORKSTATION

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Abstract

This research identifies ergonomic factors that contribute to musculoskeletal discomfort, general body fatigue, and stress, particularly in printing workstation areas. Printing-machine operators are routinely exposed to physical demands, including prolonged static posture, awkward body positioning, repetitive actions, improper workstation height, and forceful exertion, all of which increase the likelihood of musculoskeletal discomfort and work-related stress. Implementing a quantitative research design with census sampling, data was collected from all 11 printing-machine operators at UiTM Shah Alam and UiTM Puncak Alam to ensure a thorough representation of ergonomic exposure in the printing environment. The findings show that although respondents demonstrate strong safety awareness, many report discomfort related to workstation layout, task repetition, lifting demands, and long working hours, reflecting the ergonomic issues documented. The research aims the need for better ergonomic solutions, such as redesigning workstations and promoting good posture, to reduce stress and improve worker health in printing environments.

Keywords: Printing Workstations, Ergonomic Risk Factors, Stress Triggers, Musculoskeletal Discomfort

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INTRODUCTION

Workstation design plays a crucial role in shaping workers' comfort, performance, and overall well-being, especially in printing environments where tasks are repetitive and physically demanding. Workers in these environments often remain in fixed positions for long periods while handling semi-automated machines. Therefore, this results in serious ergonomic issues, including musculoskeletal disorders, overall weariness, and stress (Greggi et al., 2024). According to Fikre et al. (2024), these

disorders may seem minor at first, but they usually grow gradually and become apparent only when pain starts to interfere with everyday activities. Over time, such physical strain may lead to greater emotional and mental stress, especially when workers perform duties under circumstances that do not adequately accommodate their physical needs (Demissie et al., 2024). This demonstrates that employees' stress levels may be directly affected by how workstations are designed and used regularly. According to data from the Ministry of Health's Planning Division and Health Informatics Centre, musculoskeletal disorders are a growing public health concern in Malaysia. Data in Figures 1 to 4 are from the Ministry of Health Malaysia, showing that diseases of the musculoskeletal system and connective tissue consistently ranked among the top ten causes of hospitalisation in private hospitals from 2019 to 2023. Specifically, as stated in Figure 1, musculoskeletal-related conditions accounted for 6.54% of hospitalisations in 2019; Figure 2 showed an increase to 7.11% in 2021. While the data in 2022 Figure 3 shown 6.68%, and the data in Figure 4 continued at 6.75% in 2023. The persistence of these figures over multiple years indicates an ongoing burden of musculoskeletal conditions within the Malaysian healthcare system. Given that work-related ergonomic exposure, such as awkward body positioning, prolonged static posture, repetitive tasks, and forceful exertion, is recognised as a contributor to musculoskeletal disorders. These data highlight the importance of addressing ergonomic risk factors at the workplace level.

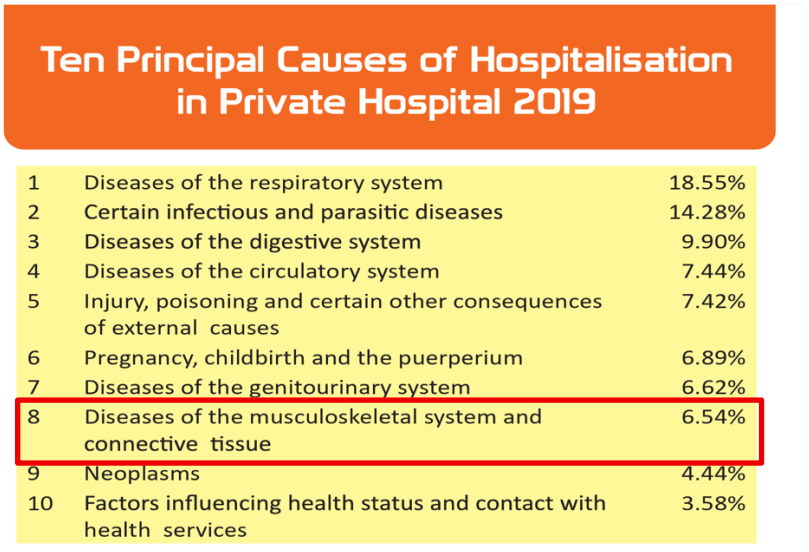

Figure 1: Data causes of hospitalisation in private hospital
(Ministry of Health Malaysia, 2020, references data for the year 2019)

Ten Principal Causes of Hospitalisation in Private Hospital, 2021

1	Diseases of the digestive system	12.09%
2	Pregnancy, childbirth and the puerperium	10.61%
3	Diseases of the circulatory system	9.49%
4	Diseases of the genitourinary system	8.41%
5	Injury, poisoning and certain other consequences of external causes	7.90%
6	Diseases of the respiratory system	7.61%
7	Certain infectious and parasitic diseases	7.44%
8	Diseases of the musculoskeletal system and connective tissue	7.11%
9	Factors influencing health status and contact with health services	6.24%
10	Neoplasms	5.58%

Figure 2: Data causes of hospitalisation in private hospital
(Ministry of Health Malaysia, 2022, references data for the year 2021)

Ten Principal Causes of Hospitalisation in Private Hospital, 2022

1	Diseases of the respiratory system	16.59%
2	Certain infectious and parasitic diseases	12.00%
3	Diseases of the digestive system	10.34%
4	Diseases of the circulatory system	8.06%
5	Injury, poisoning and certain other consequences of external causes	7.32%
6	Pregnancy, childbirth and the puerperium	7.30%
7	Diseases of the genitourinary system	6.89%
8	Diseases of the musculoskeletal system and connective tissue	6.68%
9	Factors influencing health status and contact with health services	4.84%
10	Neoplasms	4.33%

Figure 2: Data causes of hospitalisation in private hospital
(Ministry of Health Malaysia, 2023, references data for the year 2022)

Ten Principal Causes of Hospitalisation in Private Hospital, 2023

1.	Diseases of the respiratory system	19.74%
2.	Certain infectious and parasitic diseases	13.22%
3.	Diseases of the digestive system	10.02%
4.	Diseases of the circulatory system	7.55%
5.	Injury, poisoning and certain other consequences of external causes	7.33%
6.	Diseases of the musculoskeletal system and connective tissue	6.75%
7.	Diseases of the genitourinary system	6.49%
8.	Pregnancy, childbirth and the puerperium	5.99%
9.	Neoplasms	4.53%
10.	Factors influencing health status and contact with health services	4.35%

Figure 2: Data causes of hospitalisation in private hospital
(Ministry of Health Malaysia, 2024, references data for the year 2023)

Early signs of ergonomic strain are often overlooked in industrial environments, such as printing departments, due to high production demands and workers' habitual adaptation to pain. Research shows that workers in repetitive-task environments often underestimate early musculoskeletal symptoms until they develop into functional restrictions that impair job performance (Santos et al., 2025). According to Nevinia Narainsamy et al. (2025), extended exposure to poorly designed workstations has also been associated with greater fatigue, decreased focus, and increased vulnerability to workplace errors. These results highlight the need to assess the impact of workstation design on physical strain, which contributes to musculoskeletal issues, general body fatigue, and stress. Therefore, this research aims to identify the key ergonomic factors contributing to worker stress, with a particular focus on printing workstation areas.

Accordingly, the research asks which ergonomic aspects of workstation design and work activities contribute to stress among printing workstation workers. Under DOSH Act 514, Section 15(1), the employer must provide and maintain a working environment that is, as far as practicable, safe, free from health risks, and equipped with adequate facilities to support employees' welfare at work (Guidelines On Occupational Safety and Health Act 1994 (ACT 514) Department of Occupational Safety And Health Ministry of Human Resources Malaysia, 2006). Malaysian regulations emphasise safe and healthy workplaces, yet ergonomic triggers often receive less attention compared to more immediate physical risks (Selamat & Wern, 2022). Current research indicates human-centred workstation design, which includes suited seating, adequate posture support, and ergonomic risk

evaluation, serves as crucial for reducing musculoskeletal issues and improving overall occupational health (Alves et al., 2025). However, despite the availability of guidelines, many organisations struggle to implement consistent ergonomic practices, especially in heavy-duty sectors such as printing, where workflow demands overshadow ergonomic planning (View of Recent Advances in Ergonomic Posture Research: Assessing Innovations in Occupational Health and Musculoskeletal Disorder Prevention, 2025).

LITERATURE REVIEW

Recent research in Malaysia indicates an increased incidence of musculoskeletal disorders caused by ergonomic risk factors across various worker groups. A 2024 study of occupational therapy practitioners revealed that 82.5% reported shoulder concerns, 70.2% indicated lower back problems, and 64.9% encountered wrist pain at some stage (Majid, Abdul Zalif, & Murad, 2025). Similarly, research in a solvent-manufacturing factory revealed that 58.5% of workers experienced Work-Related Musculoskeletal Disorders (WMSD), with neck, lower back, and wrist regions most affected (Ali & Roslan, 2024). Thus, it is strongly linked to ergonomic risk factors such as awkward posture, repetitive motion, forceful exertion, and sustained static work (Ali & Roslan, 2024). Other findings across Malaysian industries indicate that the prevalence of WMSD among industrial workers may reach 93.1% when tasks involve repetitive or heavy handling (Nurhanisah et al., 2024). Altogether, these findings highlight the need to identify ergonomic factors that contribute to musculoskeletal discomfort, general body fatigue, and stress, especially in printing workstation areas.

When ergonomic principles are not properly implemented, employees might experience lack of motivation, greater tiredness, and a decline in productivity (Greggi et al., 2024). Poorly designed workstations have also been related to higher levels of workplace dissatisfaction and emotional tiredness, especially among workers who performing repetitive manual tasks (Guganesan Krishnanmoorthy et al., 2025). This research focuses on identifying the key ergonomic factors that contribute to worker stress, with particular emphasis on printing workstation areas. Improving ergonomic conditions not only reduces physical strain but also fosters a healthier and more positive working environment for all workers.

In printing environments, workstations often require workers to do the same thing repeatedly, stay in the same position for long periods of time, and use semi-automated machines. If the design isn't ergonomic, these conditions can cause musculoskeletal pain, general body fatigue, and stress (Santos et al., 2025). Despite these risks, ergonomic issues are frequently given lesser attention than other occupational hazards, which can result in early signs of strain leaving unrecognized until they effect daily work performance (Fikre et al., 2024). Ergonomic concerns are still not well addressed in many production workstations, especially printing departments, despite Malaysian rules emphasizing the significance of safe and healthy working environments (Selamat & Wern, 2022). If workstations aren't

designed properly and ergonomically, workers may become worn out, be less productive, and long-term health implications (Greggi et al., 2024).

METHODOLOGY

This research employed a quantitative research design, utilising a questionnaire to collect data on ergonomic aspects that may contribute to stress among printing workstation workers. A total of 11 respondents participated in the research, representing the whole workforce responsible for operating and managing the printing machines in the selected UiTM printing departments. This sample size is justified because the research specifically targets printing-machine operators, a highly specialised group within the organisation (Inoue et al., 2024). Few were assigned to this survey; the entire relevant workforce was included, making the sampling comprehensive rather than selective. In occupational and ergonomic research, such small but complete populations are appropriate when examining specific job functions, specialised tasks, or niche work environments where the number of qualified workers is naturally limited (Shidolo et al., 2025). This means that the results accurately show the real ergonomic stressors that people in this operational unit face, which improves internal validity and gets rid of sampling bias.

The questionnaire consisted of 20 structured questions and was distributed to printing staff from UiTM Shah Alam and UiTM Puncak Alam, Selangor. The instrument measured aspects of working hours, workstation conditions, and respondents' self-reported physical and psychological discomfort, providing insight into the ergonomic triggers encountered by printing machine operators. Responses were captured using a 3-point scale: (1) Yes, (2) No, and (3) Sometimes, allowing respondents to indicate the frequency or presence of discomfort or stress-related experiences.

Demographic information was collected to contextualise the findings, including respondents' age groups categorised as: <25 years old, 31–35 years old, 36–40years old, 41–45 years old, and >46 years old. These demographic characteristics assist figure out whether age influences ergonomic-related stress or musculoskeletal problems in the printing environment. Overall, this quantitative technique makes it possible to systematically evaluate workers' experiences and helps to find the most important ergonomic factors that cause stress in printing workstation environments, which is exactly what the research aims.

Sampling

Census Sampling
This research used a census sampling approach, in which all workers were included as respondents. Census sampling is recognised as appropriate when the target group is small, specialised, and clearly

defined, allowing researchers to capture complete information from all individuals relevant to the research (Abbas Ziafati Bafarasat et al., 2023). In this case, only a few are responsible for operating and managing the printing machines in the selected UiTM printing departments. All 11 workers were surveyed to ensure complete coverage of those who directly experience the ergonomic triggers. This research consisted of printing-machine operators employed at the UiTM printing departments in Shah Alam and Puncak Alam, Selangor. These workers are directly involved in daily machine operation, paper handling, and workstation-based tasks, making them the most relevant group for examining ergonomic triggers and work-related stress in printing environments. At the time of the study, all were included as respondents. Before the respondents completed the questionnaire, the researcher explained the research purpose and provided instructions for responding in the chat to ensure that all operators, regardless of age, experience, or familiarity with online surveys, clearly understood the research purpose and the response instructions. The respondents were therefore small, specialised, and clearly defined, justifying the use of census sampling and ensuring that the findings accurately represent the ergonomic conditions experienced by printing workstation workers. This method is suggested because it reduces sample bias and makes results more accurate, especially when researching specialist jobs or situations where tasks are done repeatedly (Hossan et al., 2023). By gathering data from the whole operator population, the research improves internal validity and gives a more accurate representation of the ergonomic stresses faced in printing workstation situations.

Research Instrument

A structured questionnaire was used to collect data on workers' perceptions of ergonomic conditions, physical discomfort, and stress experienced at printing workstations. The questionnaire was developed based on findings from previous ergonomic and occupational health research and then converted into a Google Form. It was distributed through Telegram and WhatsApp, which are commonly used among staff for internal communication. Pilot testing was limited due to the small population; however, content validity was ensured through the adaptation of items from prior ergonomic studies and expert review. The instrument was divided into three sections to capture demographic information, workstation-related ergonomic factors, and self-reported stress indicators:

- **Section A**: The demographic profile collected in this research included age group, gender, employment status, working hours, and working period.
- **Section B**: Respondents provided answers related to workstation conditions, as well as their self-reported physical and emotional discomfort by using a 3-point scale, where (1) Yes, (2) No, and (3) Sometimes, allowing respondents to indicate the frequency or presence of discomfort or stress-related experiences.

Data Analysis and Findings

This presents the data analysis and findings derived from the census of 11 printing-machine operators at UiTM Shah Alam and UiTM Puncak Alam. Census sampling was selected because the research examines a small, highly specialised worker group, thereby enabling full representation of all individuals who directly experience ergonomic exposure in printing workstations (Abbas Ziafati Bafarasat et al., 2023). Collected data were used to analyse demographic information, workstation conditions, respondents' self-reported physical health, and physical discomfort. Focusing on ergonomic triggers from consistent evidence that poorly designed workstations contribute to musculoskeletal, general body fatigue, and stress among workers, particularly in environments involving repetitive and static tasks (Greggi et al., 2024). In line with Malaysian workplace safety expectations, which emphasise the importance of addressing ergonomic risks (Selamat & Wern, 2022), the data were examined to identify specific ergonomic aspects influencing operator well-being. The findings therefore provide a clearer understanding of how workstation design, posture demands, and daily work processes may contribute to stress among printing staff, supporting earlier research showing that human-centred ergonomic design significantly reduces occupational strain (Alves et al., 2025).

Demographic Characteristics

In Table 1, demographic data reveal that the respondents represent a diverse working population within the printing units, with most individuals falling into the age groups below 25 years (36.4%) and between 31 and 40 years (54.6%). This distribution indicates that both younger and mid-career workers are actively involved in printing-machine operations, suggesting varying levels of physical capacity and ergonomic adaptability across age ranges. The predominance of male respondents (72.7%) reflects the gendered nature of printing operations, which often involve physically demanding and repetitive tasks known to contribute to musculoskeletal strain (Greggi et al., 2024). Most respondents in Table 1 are permanently employed (81.8%), strengthening the relevance of the findings, as these workers experience continuous exposure to the same workstation conditions, a factor associated with the gradual development of ergonomic-related discomfort (Fikre et al., 2024). As shown in Table 1, the working hours data reveal that nearly half of the respondents (45.5%) operate printing machines for more than 5 hours per day, indicating prolonged static and repetitive activity, which has been linked to an increased risk of stress and WMSD (Demissie et al., 2024). This pattern is reinforced by the working-period distribution, as stated in Table 1, 45.5% of respondents have over 20 years of experience, suggesting long-term exposure that may heighten cumulative ergonomic risks. These findings align with the literature, which notes that inadequate ergonomic conditions can exacerbate physical fatigue and stress over time (Alves et al.,2025). Overall, these demographic characteristics justify examining ergonomic triggers, in line with Malaysian workplace expectations that emphasise identifying and managing ergonomic hazards (Selamat & Wern, 2022).

Table 1: Demographic Characteristics of Respondents

Demographics Characteristics	Values	Frequency	Percentage
Age Group	<25 years old	4	36.4
	31 – 35 years old	3	27.3
	36 – 40 years old	3	27.3
	41 – 45 years old	0	0
	>46 years old	1	9.1
Gender	Female	3	27.3
	Male	8	72.7
Employment Status	Employed	9	81.8
	Currently Internship	0	0
	Retired, Pensioneer	0	0
	Student	2	18.2
Working hours	<1 hour	3	27.3
	3 – 4 hours	3	27.3
	>5 hours	5	45.5
Working period	<5 years	3	27.3
	10 – 15 years	3	27.3
	20 – 25 years	5	45.5
	>30 years	0	0

As shown in Table 2, all respondents (100%) are aware of their own safety while working, indicating strong safety consciousness in the printing environment. However, almost half of the workers (45.5%) reported discomfort from prolonged static postures, and a similar proportion (45.5%) reported back pain from improper table or chair height, highlighting limitations in workstation design that may contribute to musculoskeletal strain. This finding is consistent with research indicating that repetitive and static postures can lead to physical discomfort and musculoskeletal disorders when ergonomic conditions are inadequate (Fikre et al., 2024; Demissie et al., 2024).

Additionally, as shown in Table 2, 45.5% of respondents sometimes experience muscular strain while lifting objects, reflecting physical load issues like those identified as ergonomic risk factors in past research (Greggi et al., 2024). Although 81.8% take short breaks to reduce fatigue, 72.7% reported needing to stop work when discomfort arises, suggesting that early symptoms of physical strain may already be interfering with work routines. An effect previously linked to poorly designed work processes and workstation layouts (Alves et al., 2025). Most respondents in Table 2 (90.9%) were satisfied with machine positioning, yet an equally large proportion (90.9%) believed that ergonomics training would be helpful. This aligns with Malaysian regulatory guidance, which emphasises proactive management of ergonomic hazards and worker education to reduce long-term risks (Selamat & Wern, 2022). Overall, the responses in Table 2 indicate that workers exhibit strong safety awareness, yet still experience discomfort related to posture, lifting demands, and furniture height. These ergonomic issues may contribute to stress, indicating a need for improved ergonomic interventions.

Table 2: Respondents provided answers related to workstation conditions, respondents' self-reported physical, and physical discomfort (Section B)

No	Questions	Yes		No		Sometimes	
		Frequency	**%**	**Frequency**	**%**	**Frequency**	**%**
1.	Are you aware of your own safety while working?	11	100	0	0	0	0
2	Do you feel any discomfort due to static body posture for a long time?	5	45.5	2	18.2	4	36.4
3.	Do you make it a point to rest your feet on ground while working?	5	45.5	2	18.2	4	36.4
4.	Do you feel any difficulties or muscular strain when lifting object/ while working?	3	27.3	3	27.3	5	45.5
5.	Do you have back pain due to improper table/chair height?	5	45.5	2	18.2	4	36.4
6.	Do you use PPE just in case of annoying noise from machines?	4	36.4	5	45.5	2	18.2
7.	Do you take short breaks between procedures?	9	81.8	1	9.1	1	9.1
8.	Do you stop working for a while when the pain/discomfort arises?	8	72.7	1	9.1	2	18.2
9.	Do you stretch a lot during working?	5	45.5	2	18.2	4	36.4

10.	Are you satisfied with the positions of the machines?	10	90.9	1	9.1	0	0
11.	Do you think information and training about ergonomics will be useful?	10	90.9	1	9.1	0	0

Ergonomic Risk Factors

The ergonomic risk factors identified in the printing workstation environment are closely influenced by workspace design and the nature of the tasks performed. Repetitive actions, such as cleaning print blanket machines, operating cutting equipment, or stacking paper, place continuous stress on the upper limbs and back, increasing the likelihood of musculoskeletal disorders. This is consistent with findings that repetitive motions are a major contributor to WMSD development in industrial environments (Greggi et al., 2024). Forceful exertions present a considerable risk, as activities demanding excessive effort may result in muscular fatigue or strain on tendons and ligaments, supported by previous research that identifies physical overexertion as a major source of discomfort and chronic musculoskeletal issues (Fikre et al., 2024). Additionally, awkward postures associated with prolonged standing, restricted body movement, or sitting in improperly adjusted workstations can create sustained pressure on the joints and muscles, thereby increasing the risk of WMSD. This aligns with research showing that non-neutral postures maintained for extended periods significantly elevate ergonomic stress and cumulative physical strain (Demissie et al., 2024). Collectively, these factors demonstrate how the physical demands and workstation layouts in printing operations can create substantial ergonomic challenges for employees.

Prolonged static posture becomes a significant ergonomic issue. Figure 6 shows that operators often stood or sat in the same place for a long time. Table 2 stated that some workers took brief breaks or stopped working for a short time when they felt discomfort. However, these actions don't seem to be enough to make up for the physical strain that comes from being in the same position for a long time. Staying in one posture for a long time can make muscles tired and slow down blood flow, which explains why many respondents said they were uncomfortable.

Employees also reported uncomfortable positions while doing things like checking machines, getting to interior parts, and handling paper. Figures 5 and 7 depict operators bending forward, reaching inside equipment, or working in tight places. These positions are not neutral and put too much stress on joints and muscles. The arrangement of the machines and the height of the workstations typically determine these postural requirements. This shows that design limitations are an important aspect of how ergonomic risk exposure is developed. Table 2 points out that even when workers know how to operate safely, the way the workstation is set up may make it hard for them to maintain neutral postures while they work.

Forceful exertion represents another significant ergonomic risk, particularly during manual handling activities such as lifting and carrying heavy paper stacks, as shown in Figure 8. These tasks require substantial physical effort and may lead to muscular fatigue or strain, primarily when performed repeatedly or without mechanical assistance. When combined with awkward postures or prolonged standing, forceful exertion can further intensify physical stress and increase the likelihood of cumulative musculoskeletal strain. This combination of risk factors may explain why workers continue to experience discomfort despite adopting coping strategies.

Figure 5: Operator inspecting print quality in a forward-bending posture.
(Source: Author's Collection, 2022)

Figure 6: Statistic posture in standing and seating for too long, UiTM Shah Alam.

(Source: Author's Collection, 2022)

Figure 7: Operator adopting an awkward posture while accessing internal machine components and during paper handling, UiTM Shah Alam.
(Source: Author's Collection, 2022)

Figure 8: Operator lifting and carrying heavy paper stacks, demonstrating forceful exertion, UiTM Shah Alam.
(Source: Author's Collection, 2022)

DISCUSSION

This research indicates that printing workstation operators are exposed to multiple ergonomic risk

factors that contribute to musculoskeletal discomfort, work-related stress, and general body fatigue. Repetitive tasks, awkward body positioning, prolonged static postures, and forceful exertion were consistently observed during daily printing operations and reported by respondents, reflecting ergonomic risk patterns widely documented in occupational settings (Demissie et al., 2024; Fikre et al., 2024; Nurhanisah et al., 2024). Even though workers were very aware of safety and used coping strategies like taking short breaks or stopping work when they felt uncomfortable, these steps didn't seem to be enough to make up for the physical demands of the workstation design and task structure. Observations of non-neutral postures during machine inspection and paper handling, along with forceful exertion during manual lifting, provide additional evidence that these ergonomic exposures are significantly linked to the onset of work-related musculoskeletal disorders (WMSDs) (Greggi et al., 2024; Ali & Roslan, 2024). These findings imply that ergonomic hazards are incorporated in the operational workflow of printing facilities and may build over time, particularly among individuals who work long hours and have been in the industry for many years.

The significance of these findings is reinforced by national health data from the Ministry of Health Malaysia, which consistently identifies diseases of the musculoskeletal system and connective tissue as one of the leading causes of hospitalisation in private hospitals between 2019 and 2023 (Ministry of Health Malaysia, 2020 - 2024). This ongoing pattern draws attention to the wider health consequences of extended physical strain, including exposure to ergonomics at work. Unaddressed ergonomic hazards can cause early-stage discomfort to develop into chronic musculoskeletal conditions, which can have a serious impact on work performance and quality of life, according to evidence from systematic reviews (Santos et al., 2025; Alves et al., 2025). In line with the Occupational Safety and Health Act 1994 (Act 514) and DOSH ergonomic guidelines, the results emphasise the significance of ergonomics training, workstation redesign, and systematic ergonomic risk assessment in reducing stress and preventing chronic musculoskeletal disorders (Selamat & Wern, 2022; DOSH, 2006). In addition, the targeted ergonomic interventions are essential for promoting worker well-being and supporting sustainable occupational health in printing workstation environments.

CONCLUSION

The findings of this research highlight the significant ergonomic challenges faced by printing machine operators at UiTM Shah Alam and UiTM Puncak Alam. Although workers demonstrated strong safety awareness and adopted coping strategies such as taking short breaks and stopping work when discomfort arises, the data indicate that several workstation-related factors continue to contribute to physical strain. Discomfort from prolonged static posture, improper table or chair height, awkward body positions, and occasional muscular strain are consistent with established ergonomic risks that increase the likelihood of musculoskeletal disorders. These results align with previous research, which shows that repetitive actions, forceful exertions, and non-neutral postures are significant contributors to work-related physical stress. The demographic patterns further reinforce these findings, as many

operators work long hours and have spent more than two decades in the printing environment, increasing the cumulative impact of ergonomic exposures.

Overall, this research underscores the importance of identifying specific ergonomic aspects within printing workstations that contribute to worker stress. The use of census sampling ensured that all machine operators were represented, providing a complete and accurate depiction of ergonomic conditions in the workplace. From a practical perspective, the findings imply that organisations should prioritise ergonomic improvements such as workstation redesign, adjustable furniture, proper posture support, safe lifting techniques, and regular ergonomics training to reduce physical strain and stress among workers. At the organisational level, these measures may enhance employee well-being, improve productivity, and reduce the risk of work-related musculoskeletal disorders. For future researchers, this research could expand the sample to include multiple printing facilities or industries, adopt longitudinal designs to examine long-term ergonomic effects, or integrate objective ergonomic assessment tools to complement self-reported data. Such approaches would provide deeper insights into ergonomic risk management and support the development of more effective and sustainable ergonomic interventions in printing environments.

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

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AUTHOR CONTRIBUTIONS STATEMENT

Aminudin, A.S (Conceptualisation, Methodology; Data curation; Formal analysis; Visualisation;

Writing-original draft, Writing-review & editing; Supervision)

AVAILABILITY OF DATA AND MATERIALS

The data supporting research's findings are available on request from the corresponding author.

ETHICS STATEMENT

Not applicable.

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