Original Article

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Workstation Risk Factors for Work-related Musculoskeletal Disorders Among IT Professionals in Indonesia

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Objectives: This study aimed to identify workstation factors influencing work-related musculoskeletal disorders (WMSDs) among information technology (IT) professionals in Indonesia.

Methods: A cross-sectional study was conducted among 150 IT workers at small-enterprise companies who were randomly selected across East Java, Indonesia. The data were modeled using multiple linear regression, with a 95% level of confidence for determining statistical significance.

Results: The respondents reported that the neck had the highest level of discomfort and was the most at risk of WMSDs, followed by the lower back, right shoulder, and upper back. Screen use duration ($p=0.040$) was associated with whole-body WMSDs, along with seat width ($p=0.059$), armrest ($p=0.027$), monitor ($p=0.046$), and a combined telephone and monitor score ($p=0.028$). Meanwhile, the factors significantly related to the risk of WMSDs in the hands and wrist were working period ($p=0.039$), night shift ($p=0.024$), backrest ($p=0.008$), and mouse score ($p=0.032$).

Conclusions: Occupational safety authorities, standards-setting departments, and policymakers should prioritize addressing the risk factors for WMSDs among IT professionals.

Key words: Musculoskeletal diseases, Occupational health, IT professionals, Ergonomics, Health risk, Computer users

INTRODUCTION

Musculoskeletal disorders (MSDs) are common health issues worldwide [1]. The problems posed by these conditions have become increasingly severe in recent years because of the potential for ergonomic hazards in all occupations and sectors. When the global burden of diseases and injuries was evaluated for 1990-2019 in 204 countries and territories, MSDs were among the top 10 [2]. Globally, 1.71 billion people experience MSDs [3]. The prevalence of MSDs exceeded 80% among specific types of workers, and a 90% threshold was reported in some countries [4]. A study in Thailand reported a 37% prevalence of MSDs among office workers, and the neck, shoulders, and back were the most commonly reported areas of discomfort [5].

MSDs may affect motor organs, muscles, tendons, bones, cartilage, ligaments, and nerves [6]. MSDs reduce workers' performance and productivity due to pain, mobility constraints, higher fall and fracture risks, and difficulty in daily

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tasks, notably those related to work [7]. Many workers currently use computers, which could be a main factor contributing to the rising prevalence of MSDs [8]. In a study in Iran, a developing nation, more than 60% of office workers reported physical issues relating to musculoskeletal illnesses [9]. Another study found that desk workers' complaints of MSDs were most strongly affected by the duration of computer use and seated position [10].

Several studies have reported the prevalence of work-related musculoskeletal disorders (WMSDs) among professional workers worldwide. A cross-sectional study conducted by Yizengaw et al. [11] among healthcare workers in Ethiopia who contributed to surgical procedures reported that the prevalence of WMSDs among the study participants was 64.2%. A study by Chiwaridzo et al. [12] among healthcare professionals in Zimbabwe reported that 82.1% of respondents had experienced WMSDs in the prior year, with low back pain being the most common problem. In Portugal, the spine was the healthcare providers' most affected body part [13]. Krishnan et al. [14] reported that about 44.3% of nurses faced mental and physical exhaustion in Malaysia. Another study found a high prevalence of WMSDs among office workers in Nigeria, with an overall rate of 71.9% in higher education institutions [15].

Workers with WMSDs experience declining health levels, absence, and many lost days, which could burden the health system, have economic effects, and lead to social costs [16]. The total annual cost of MSDs in Chile as of 2022 was US$943 413 490, which included therapeutic management, productivity losses, and sick days or absences [17]. Moreover, WMSDs may affect the national economy with huge losses, especially in underdeveloped and developing countries. In 2017, the Global Burden of Diseases reported that MSDs were the second most prevalent cause of years lost to injury in sub-Saharan Africa [18]. These conditions are also an issue of concern for the European Agency for Safety and Health at Work [11].

Several factors are associated with WMSDs globally, including ergonomic factors (awkward posture, repetitive movement, and working duration), psychosocial factors (relationships with others, workload, stress, satisfaction, and success), behavioral factors (substance abuse, physical activity, and other health conditions), and socio-demographic factors (sex, age, and income) [19]. Awkward or static postures, repetitive movements, and prolonged sitting are key factors that may lead to WMSD symptoms. Information technology (IT) professionals are vulnerable to developing WMSDs due to the nature of their jobs and their work environment, such as prolonged sitting, awkward postures, low levels of physical activity, psychological stress, long work duration, and insufficient breaks for physical and mental recovery [20].

A variety of tools are available to assess MSDs among IT professionals. One of these, the Rapid Office Strain Assessment (ROSA), is a risk-factor screening tool used to determine whether an office environment requires on-the-job intervention [21]. ROSA scores have been found to be strongly connected with musculoskeletal complaints and a user-friendly method for evaluating computer workstations. In addition, to assess office workers' pain levels in response to ergonomic changes and rest periods, the Cornell Musculoskeletal Discomfort Questionnaire (CMDQ) may be used [22]. The CMDQ is a valid and reliable method for collecting information on musculoskeletal discomfort, which is particularly useful for measuring the severity of pain among office workers [23].

In Indonesia, a major research and information gap exists regarding WMSDs and related risk factors among IT professionals. Occupational health and safety have become topics of concern, with the goal of reducing risks to employees from their work environments. Investigating the risk factors and prevalence of WMSDs is important for supporting occupational health and safety organizations in establishing policies and modifying workplace environments. Research results may also provide information to employers, organizations, therapists, and related health authorities. Additionally, this information could be useful for future investigations. Therefore, to address MSD complaints among IT workers who use computers for about 8 hr/day, this study investigated the musculoskeletal problems experienced by workers who use computers intensively and aimed to establish associations with psychosocial factors. The results may inform relevant strategies to limit the burden of WMSDs among workers, especially computer users.

METHODS

Study Design and Population

This cross-sectional study was conducted between December 2022 and February 2023. The participants were IT professionals from 10 different companies or organizations in East Java, Indonesia. The sample size was calculated by using the following formula: $n=(N \times (\frac{Z^2 \times p \times (1-p)}{e^2} \div (N-1+\frac{Z^2 \times p \times (1-p)}{e^2})))$. With a 5% precision level and a 95% level of confidence, our sample size was 150 IT professionals. The respondents were selected based on the following criteria: at least 23 years old, male or female, working as an IT professional, employed by their current company for at least 1 year, and using computers or tablets for more than 3 hr/day.

Data Collection Tool and Procedure

WMSDs refer to different health conditions and bodily injuries due to an individual's work environment or caused by the work itself. Therefore, participants' work tasks were evaluated using the CMDQ, which is a validated questionnaire, together with socio-demographic questions. The socio-demographic information included sex, age, body weight, and height, as well as type of work, educational level, marital status, income, work experience, working hours per day and week, break duration during work, and exercise.

On the CMDQ, the risk of body part exposure to MSDs is divided into 2 groups based on the dominant posture risk: whole-body MSDs based on seated posture and MSDs in the hands and wrists based on typing posture. We analyzed the factors directly related to these risks based on socio-demographic factors, including sex (male or female), age (years), working period (years), screen use duration (hr/day), weight (kg), exercise (never, infrequent, frequent, or intense), night shift (yes or no), employee status (permanent, temporary, or freelance), and educational level (high school, bachelor's degree, or master's degree).

The CMDQ was used to set standardized questions for investigating musculoskeletal complaints or symptoms. CMDQ scores are calculated by (1) counting the number of symptoms per individual, (2) adding up each person's rating values, (3) weighting the rating numbers to make it easier to identify serious problems, and (4) multiplying the frequency score (0.0, 1.5, 3.5, 5.0, 10.0), discomfort score (1, 2, 3), and interference score (1, 2, 3) [24].

The participants were assessed regarding the time they spent actively using desktop computers, laptops, and mobile devices, as well as breaks during work and sleep duration. The Job Content Questionnaire (JCQ) was used to evaluate psychosocial job domains. Physical exposure to musculoskeletal risks was assessed using an ergonomics assessment tool. The ROSA was used to assess the physical risks related to computer work and suggest actions appropriate for the risk level.

Data quality control

The questionnaire was initially prepared in English, and then it was translated into Indonesian. After data collection, the questionnaire responses in the local language were translated back into English. Moreover, the completeness of the questionnaire was checked regularly by the principal investigator.

Data management and analysis

All data from the questionnaire and risk assessments were analyzed using R Studio version: 2023.06.1+524 (R Foundation for Statistical Computing, Vienna, Austria), with a statistical significance threshold of $p=0.05$. Both descriptive and inferential statistics were used.

Ethics Statement

Before conducting the study, permission was obtained from the selected companies. Ethical approval was obtained from a public hospital in Ponorogo, Indonesia (005421350212124 20221206000/KEPK/X1I/2022), and the study was performed in accordance with relevant guidelines and regulations. The respondents were chosen at random and provided with a comprehensive explanation of the study's goal. Before the study commenced, informed consent was obtained from all participants. The respondents were assured of the confidentiality and anonymity of the details obtained from the questionnaires and assessments. The respondents were free to withdraw from the study at any stage. All information and data were stored and processed on a computer.

RESULTS

The data were collected from December 2022 to February 2023 in this cross-sectional study. Table 1 shows the distribution of demographic factors, including sex, age, working period, screen use duration, weight, exercise habit, night shift, employee status, and educational level.

Figure 1 shows the distribution of the participants' musculoskeletal discomfort by body part. Based on the CMDQ, 18 areas of the body were measured. The neck had the highest level of discomfort, with a score of 7.00. The lower back, right shoulder, and upper back were next, with scores of 6.75, 5.30, and 4.80, respectively. The right thigh was least frequently mentioned as an area of discomfort and had the lowest discomfort score.

WMSD risk was measured on a categorical scale based on

Table 1. Demographic characteristics of the participants (n=150)

Characteristics	n (%)
Sex	
Male	105 (70.0)
Female	45 (30.0)
Age, mean±SE [range; variance] (y)	26.39±0.40 [23-53; 23.67]
Working period (y)	
<5	126 (84.0)
5-10	19 (12.7)
>10	3 (2.0)
Screen use duration (hr)	
<4	42 (28.0)
≥4	108 (72.0)
Weight (kg)	
<50	22 (14.7)
50-70	96 (64.0)
>70	32 (21.3)
Exercise	
Never–infrequent	81 (54.0)
Frequent–intense	69 (46.0)
Night shift	
Yes	108 (72.0)
No	43 (28.7)
Employee status	
Permanent	46 (30.7)
Temporary	68 (45.3)
Freelancer	37 (24.7)
Educational level	
High school	19 (12.7)
Bachelor's degree	131 (87.3)
Marital status	
Unmarried	108 (72.0)
Married	41 (27.3)
No response	1 (0.7)

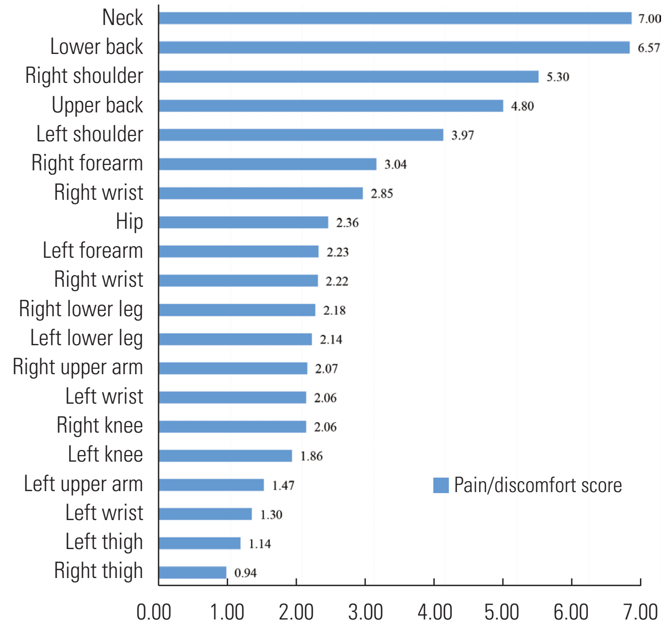

Figure 1. Pain and/or discomfort score in the body region.

the pain or discomfort reported by respondents for each body part. Table 2 shows individual factors related to WMSDs modeled with multinomial logistic regression. With α=0.05, the test showed that the model fit overall (Pearson $p>\alpha$; 0.911>0.05). Based on the model in Table 2, which shows that the p-value of the final model ($p=0.029$) was lower than α (0.05), at least 1 independent variable was statistically significantly related to the dependent variable in the model. The likelihood ratio test, with the significance of correlations indicated by *p*-values, was used to identify independent variables suitable for inclusion in the model. Table 2 shows that screen use duration was a significant predictor of whole-body WMSD risk among the participants ($\chi^2=1.278$; $p=0.040$). With longer screen use durations, the risk of WMSDs was higher. Most respondents selected the screen use duration options of >1 hour continuously or >4 hr/day.

Since most IT workers' activities occur in the typing posture, we specifically focused on the risks of developing WMSDs in a seated position, where the participants' hands and wrists experienced strain. Two models involved individual factors and typing factors related to hand and wrist complaints. Since WMSDs concerning wrists and hands were measured using a numerical scale, multiple linear regression analyses were conducted (Table 3). The 2 determinants that significantly affected the risk of wrist WMSDs were the working period and night shift, with *p*-values of 0.039 and 0.018 respectively. The β coefficient for the working period, which was measured in years, had a negative value, indicating that a longer working period was correlated to a lower risk of WMSDs. The night shift was scored as 0 for respondents with no night shift and 1 for respondents with a night shift. Working on the night shift was associated with a higher risk of wrist WMSDs caused by the typing posture ($\beta=1.802$).

Table 3 shows that the working period ($\beta=-0.015$; $p=0.039$), as an individual factor, was significantly associated with the participants' WMSD risk. The risk of developing WMSDs from a seated typing position was found to be related to the use of a

Table 2. Goodness-of-fit test, model fitting information, and likelihood ratio tests

		Chi-square	df	*p*-value
(A) Goodness-of-fit test				
Pearson		105.216	126	0.911
Deviance		75.121	126	1.000
Model	**Model fitting criteria -2 log likelihood**	**Likelihood ratio tests**		
		Chi-square	**df**	***p*-value**
(B) Model fitting information				
Intercept only	91.442			
Final	75.121	16.320	14	0.029
Effect	**Model fitting criteria -2 log likelihood of reduced model**	**Likelihood ratio tests**		
		Chi-square	**df**	**Sig.**
(C) Likelihood ratio tests				
Intercept	75.121	0.000	0	
Age	75.223	0.102	1	0.441
Working period	75.315	0.194	1	0.242
Screen use duration per day	76.399	1.278	1	0.040
Weight	78.245	3.124	1	0.423
Sex	75.154	0.033	1	0.724
Marital status	75.964	0.842	1	0.359
Educational level	77.537	2.416	3	0.856
Employee status	80.268	5.147	2	0.161
Night shift	75.503	0.381	1	0.681
Exercise	81.422	6.301	1	0.499
Smoking status	75.429	0.307	1	0.579

Sig., significant; df, degrees of freedom.

backrest ($\beta=0.226$; $p=0.008$) and mouse score ($\beta=0.072$; $p=0.032$). The β coefficient for both variables showed a positive relationship, meaning that a higher score was associated with a higher risk of WMSDs.

Figure 2 shows a chart comparing the predicted versus observed values of WMSDs for (A) the whole body and (B) the hand. To model WMSDs over the whole body, 5 determinants were selected, including screen use duration, seat width, armrest, monitor, and mouse and keyboard score. Visually, the distribution of points plotted on Figure 2A is not very linear, but they cluster in the value range 0.0-2.5, since the maximum predicted value is 2.5. This finding indicates the high accuracy of most predictions based on the testing data.

In Figure 2B, the 4 determinants selected to predict WMSD risk in the hands were working period, night shift, backrest, and mouse score. The distribution of plots is not linear due to several outliers, but the observed and predicted values are predominantly correlated in certain areas, indicating that most predictions are accurate.

DISCUSSION

In this study, to evaluate MSD discomfort based on seated and typing postures, the body parts affected by WMSDs were divided into 2 main areas according to the CMDQ instrument. Neck complaints were reported the most frequently by respondents, with an average pain level of 7 out of 10. This finding may be related to the habit of sitting uninterrupted during screen time, where the neck position is static. In an earlier study investigating musculoskeletal pain in office workers, the participants experienced upper back pain (69.6%), neck pain (65.2%), and lower back pain (64.1%) the most frequently during the prior 12 months [16]. The prevalence of neck pain and its contributing factors among office workers working in the Ministry of Health, Saudi Arabia, was 64% across a 12-month span [25]. According to Putra and Pristianto [26], neck pain is common among workers with longer sitting times. Because sitting places twice as much strain on intervertebral discs as standing does, the seated posture has an effect on neck pain. A proper

Table 3. Risk factors associated with MSDs in seated and typing positions, identified by multiple linear regression analysis

Factors	Unstandardized coefficients		Standardized coefficients	*t*-value	Sig.	Partial R^2	Model		
	β	SE	β				R^2	SE of the estimate	*p*-value
Individual factor							0.068	4.214	0.049
(Constant)	2.245	3.835	-	0.585	0.559	-			
Age	-0.123	0.064	-0.069	-0.602	0.513	0.013			
Marital status	-0.203	0.940	-0.022	-0.216	0.829	0.004			
Educational level	0.128	0.489	0.017	0.192	0.876	0.001			
Working period	-0.001	0.009	-0.015	-0.157	0.039	0.001			
Employee status	-0.151	0.348	-0.013	-0.120	0.904	0.000			
Weekly duration	-0.014	0.032	-0.053	-0.429	0.669	0.001			
Screen use duration per day	0.010	0.107	0.016	0.143	0.947	-0.006			
Night shift	1.802	0.471	0.216	2.401	0.018	0.030			
Weight	-0.007	0.004	-0.107	-1.176	0.302	0.005			
Exercise	-0.899	0.482	-0.098	-1.051	0.243	0.006			
Typing factor							0.118	3.980	0.021
(Constant)	-2.402	2.009	-	-1.195	0.234	-			
Chair height	-0.552	0.442	-0.113	-1.249	0.924	0.001			
Seat width	0.528	0.611	0.075	0.864	0.264	0.009			
Armrests	-0.113	0.458	-0.021	-0.246	0.734	0.000			
Backrest	1.318	0.489	0.226	2.694	0.008	0.067			
Chair score (section A)	-0.042	0.329	0.943	0.604	0.943	0.040			
Monitor score	-0.188	0.429	-0.042	-0.438	0.556	0.005			
Telephone score	-0.153	0.441	-0.030	-0.347	0.285	0.000			
Mouse score	0.344	0.419	0.072	0.822	0.032	0.009			
Keyboard score	0.962	0.444	0.196	2.166	0.201	0.053			
Telephone and monitor (section B)	0.401	0.330	0.301	1.706	0.227	0.120			
Mouse and keyboard (section C)	0.174	0.327	0.411	1.216	0.596	0.031			

MSDs, musculoskeletal disorders; SE, standard error; Sig., significant.

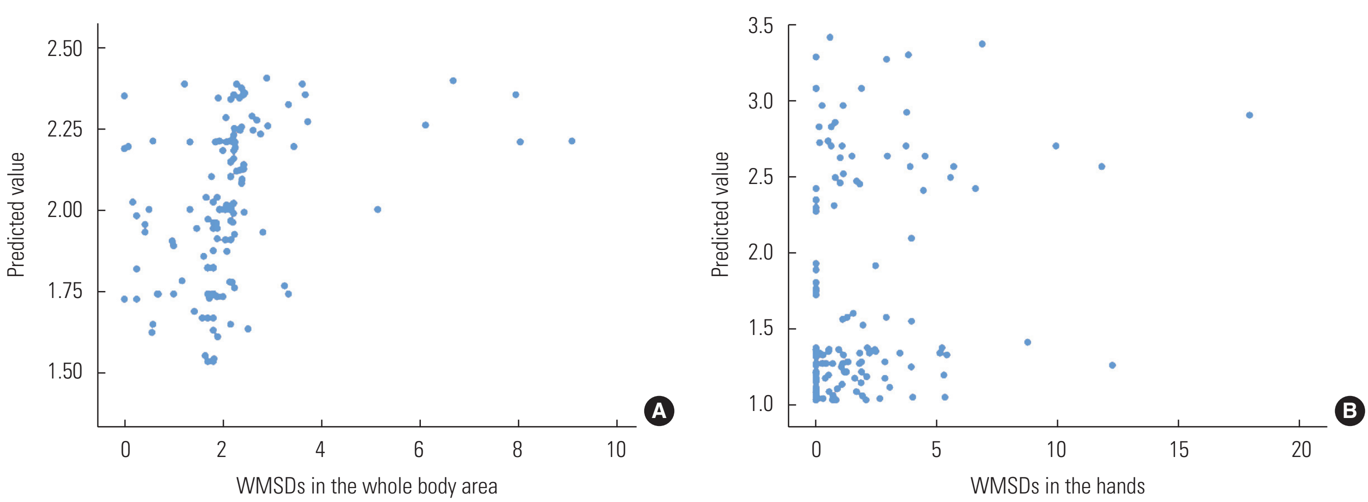

Figure 2. Work-related musculoskeletal disorders (WMSDs) in the whole body area by screen duration, seat width, armrest, monitor and mouse and keyboard score (A) and WMSDs in the hands and wrist area by working period, night shift, backrest and mouse score (B).

seated position involves a brief moment of relaxation of tense muscles to help relieve neck pain [27].

Given the repetitive and inert nature of most IT workers' tasks, professional computer users were selected as our study's target group. Since our investigation found that the neck, lower back, and shoulder were the areas most affected by WMSDs, we referred to these parts collectively as back pain. Sitting for long periods in awkward postures with unadjusted monitor heights is a prominent risk factor for neck, shoulder, back, and arm pain among office workers [28].

Working with a computer (screen use duration) was also found to be a significant factor for shoulder pain because employees working with a computer for >4 hr/day complained frequently about pain in this area [29]. A study has demonstrated that those who worked night shifts had lower bone density than those who worked day shifts. The researchers speculated that the low bone density in night shift workers may have been due to an increase in cortisol and altered vitamin D status from sleep disturbances [30]. The monitor height was adjusted so that the viewing level was on the upper third of the screen. The monitor was positioned in front of the worker, 40 cm to 75 cm from their view [31].

The study also found that working periods and night shifts were associated with WMSDs in the hands and wrists. The negative β coefficient for working period indicated an inverse relation to WMSD risk for hands and wrists. Longer work periods were associated with lower risks. The working period might be related to a participant's ability to adapt to their workplace's psychological load. Several studies have indicated a significant correlation between psychological factors and the risk of WMSDs [14,32]. Rigó et al. [33] found that a longer working period was related to a lower risk of psychological issues, such as work stress and depression. According to a World Health Organization report, exposure to workplace demands can cause, worsen, accelerate, or intensify work-related disorders and impair one's ability to work. However, the risk factors include individual traits as well as socio-cultural and environmental factors [34]. Undoubtedly, the development and progression of MSDs are linked to physical stressors encountered in the workplace, an imbalance between an individual's capacity and the demands of their job, inadequate recovery time, and the impact of workplace interventions in preventing these disorders or lessening their pathological effects [35].

The findings regarding the night shift variable could have been related to the disruption in circadian rhythms, which may have increased the participants' work-related stress. Furthermore, several studies have found a higher incidence of MSDs or pain at night [36-38], and sleep deprivation may have a role in the link between night work and MSDs. Multiple prospective studies have demonstrated that sleep disorders are associated with a higher likelihood of musculoskeletal complaints. A lack of workload recovery and inadequate sleep may be the cause of musculoskeletal complaints following night work [36].

However, WMSDs tend to have multifactorial causes that lead to the symptoms described as a disorder. While investigating WMSDs, it is appropriate to include occupational and demographic characteristics, but psychological elements should also be assessed in future studies for a clearer understanding of WMSD issues.

The age distribution and relatively short working period of our study's participants are potential limitations. Our findings indicate that long-term work experience may reduce the risk of wrist injuries, although an additional review of the literature would be necessary to comprehensively explore the role of adaptability in this context. Though our study cohort had a mean age of 26.39 years and a majority had <5 years of working experience, these demographic characteristics were reflective of the IT workforce profile in our study region. Despite the statistical insignificance observed, variations in age and working experience could have influenced our findings if the demographic composition had been different. Future studies could benefit from broader distributions of age and experience to further elucidate the impact of these variables on WMSD risk among IT professionals.

In addition, because this study focused on identifying workstation-related risk factors for WMSDs among IT professionals in Indonesia, it was not designed to investigate the variables, although stress and depression are recognized as significant factors in musculoskeletal health. Therefore, our analysis did not include related outcomes or statistical findings concerning stress and depression. We acknowledge that these psychosocial factors may influence the manifestation and severity of WMSDs [39]. Future investigations incorporating comprehensive assessments of both ergonomic and psychosocial factors could provide a more holistic understanding of the factors that contribute to WMSDs among IT professionals.

Based on the study findings, among IT workers, the neck had the highest level of discomfort and was the most exposed to the risk of developing WMSDs, followed by the lower back, right shoulder, and upper back. Screen use duration, seat width, armrest, monitor, and section B (telephone and monitor score) were significantly related to the risk of whole-body WMSDs. Meanwhile, the factors significantly related to the risk of WMSDs in the hands and wrists were the working period, night shift, backrest, and mouse score. Our findings could be applied to guide the establishment of preventive measures, such as performing ergonomic training, improving how work is organized, and adjusting the working environment to ensure occupational health and safety.

NOTES

Conflict of Interest

The authors have no conflicts of interest associated with the material presented in this paper.

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