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ORIGINAL ARTICLE

FREQUENCY AND RISK FACTORS ASSOCIATED WITH MUSCULOSKELETAL DISCOMFORT AMONG PROLONGED STANDING WORKERS AT THE UNIVERSITY

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ABSTRACT

Background: Due to the mobility of the legs and the high degree of freedom, standing can be regarded as a diverse position. Workplace musculoskeletal discomforts (MSDs) can have serious consequences for both the affected employees and their companies. From a personal standpoint, MSDs can cause pain, discomfort, and functional restrictions, which can impair a worker's capacity to effectively carry out their job duties.

Objective: To assess frequency of musculoskeletal discomfort and to evaluate the risk factors related to musculoskeletal discomfort, e.g. age, sex, body mass index (BMI), marital status, number of children, shoe preferences, profession, working experience, and standing hours. **Methodology:** An analytical cross-sectional study was conducted by administering a pre-designed questionnaire to two hundred and fifty-four prolonged standing workers (security guards n = 109, sweepers n = 80, messengers n = 37, and chefs n = 28) selected from The University of Lahore. The outcome variable, Musculoskeletal Disorder (MSD), was evaluated using the Cornell Musculoskeletal Discomfort Questionnaire (CMDQ), which categorized MSD scores into three levels of discomfort: mild, moderate, and severe. The data collected were analyzed by using Statistical Package for Social Sciences (SPSS) version 22. **Results:** MSD was most common in the foot 42.2%, lower legs 29.1%, lower back 11.4%, and hip 10.0%, according to the CMDQ tool. More than half (51.9%) of the participants reported no musculoskeletal discomfort, while the remaining participants reported varying levels of discomfort. The prevalence of discomfort was 25.5% mild, 11.9% moderate, and 10.7% severe. Gender, occupation, age, standing hours, daily working hours, weekly working hours, and shoe preference were directly associated with MSDs. Logistic regression analysis revealed that gender, age, profession, and break time were significant predictors of WRMSDs in workers. **Conclusion**: This study found a high prevalence of musculoskeletal disorders (MSDs) among prolonged standing workers, with lower back and foot pain being the most common complaints. Male workers, older workers, and those with less frequent breaks were more likely to experience MSDs. Implementing regular breaks and ergonomic training may help reduce the risk of MSDs among prolonged standing workers.

Key words: Cornell Musculoskeletal Discomfort Questionnaire (CMDQ), Cornell Musculoskeletal discomfort score, Musculoskeletal discomforts (MSDs), prolonged standing.

INTRODUCTION

Standing positions provide employees with a high degree of mobility and freedom to perform tasks effectively and efficiently. However, studies show that prolonged standing can cause lower extremity fatigue and discomfort if preventive measures are not taken as soon as physiological discomfort is detected. The lower back, foot, and muscles in the thighs and lower legs are especially impacted by prolonged standing. Numerous variables, including height, weight, age, and work environment, might affect how uncomfortable certain body regions are. Shorter individuals reported higher levels of overall discomfort and particularly in their upper back, lower legs, and knees after an 8-hour shift. Furthermore, older participants reported higher levels of hip and foot pain, lower back pain, and leg exhaustion, particularly when standing on wooden floors, suggesting that age is a major risk factor [1]. King stressed that as people age increased, their joints become more prone to discomfort [2].

Prolonged standing is a common requirement across various occupations, including industrial assembly line workers, hairdressers, salespeople, receptionists, traffic police, and security personnel. This practice can lead to numerous

musculoskeletal health issues and other complaints such as sore feet, leg swelling, varicose veins, and even coronary heart disease, underscoring the necessity of preventive practices to mitigate the adverse effects of prolonged standing [3]. While both men and women are required to stand and move frequently at work, a higher percentage of men (72%) stand for over a quarter of their workday compared to women (66%) [4]. It is crucial to differentiate between active movement and stationary standing, as movement is less fatiguing than static standing. Male-dominated fields like construction or warehousing typically involve more mobility than female-dominated professions such as hairdressing, retail, education, and healthcare, which often involve more static standing [5]. Additionally, women may face the challenges of prolonged standing in conjunction with other risks of musculoskeletal discomfort and they are more frequently found in low-paying roles with limited control over their work and break times, which can result in being "locked" into these positions for extended durations and encountering poor ergonomic conditions compared to men. Such circumstances are prevalent in sectors like manufacturing, financial transactions, transportation, cleaning, salon services, catering, retail, medical services, and agriculture. Furthermore, healthcare workers often perform repetitive tasks, carry heavy loads, and deal with complex tasks and frequent disruptions. They are often subjected to long standing periods and various physical and organizational risks that may contribute to musculoskeletal problems [5]. Workplace attire can exacerbate these issues, with women sometimes required to wear heels over 5 cm, which can alter posture and the functioning of leg muscles. Additionally, the restrictive nature of tight hosiery can constrain toes and pose additional challenges [3]. So workplace attire especially shoe preference among standing workers plays major role in performing their tasks more effectively.

Musculoskeletal discomforts, historically referred to as "occupational cramps" or "occupational myalgia," represent a significant source of job-related hindrances [6]. These ailments, associated with various professions and work-centric activities, affect countless workers globally. Over the past several decades, advancements in information technology have significantly transformed the daily tasks of office employees. Currently, over 50% of the workforce in western countries relies on personal computers for their duties, leading to extended periods of computer and mouse usage, which are believed to contribute to the rising rate of musculoskeletal discomforts (MSDs) [7]. MSDs encompass discomforts affecting the arms, neck, shoulders, knees, wrists, forearms, lower back, and upper back, not attributed to sudden traumatic injuries or overarching systemic illnesses. Initially defined in the Netherlands, MSDs can cause severe and sometimes terrible symptoms, including pain, numbness, and tingling, significantly affecting sufferers' quality of life [7]. Beyond the individual, MSDs have broader socioeconomic implications, leading to increased financial compensation for workers, reduced work productivity, and poorer job execution and effectiveness. Despite technological advancements that have alleviated some physical strain in many occupations, musculoskeletal problems remain a critical issue for worker health. These physical strains are often accompanied by consequential psychological impacts on employees. Psychosocial

risk factors emerge when workers lack sufficient rest periods, cope with excessive overtime, or feel general disinterest in their work [8]. On a personal level, risk factors for MSDs may include age-related physical deterioration, lifestyle choices such as smoking and alcohol consumption, body weight, and pre-existing medical conditions that predispose individuals to MSDs. Environmental risks are introduced by workplace settings with distracting or excessive noise, treacherous or slip-prone floor surfaces, and inadequate lighting, all of which compound the potential for musculoskeletal issues [9]. The significance of research lies in its potential to enhance worker health and well-being by identifying and addressing the root causes of musculoskeletal discomfort in standing jobs. This research can lead to improved occupational safety, reduced workplace injuries, and decreased healthcare costs for both employees and employers. Furthermore, it can inform policy and workplace design, promoting ergonomic practices that enhance job satisfaction and productivity. Overall, this topic is crucial for fostering healthier and more sustainable working conditions in standing workers.

MATERIALS AND METHODS

Study design: Analytical-cross sectional study

Setting: The University of Lahore

Duration: 9 month (December 2023 to August 2024)

Sampling technique

Two-stage cluster random sampling employed in which the junior staff of The University of Lahore was divided into 4 clusters i.e. security guards, sweepers, chefs and messengers. In the second stage, every individual was selected from each cluster with lottery method.

Sample size: The sample size for the study was statistically calculated using Yamane formula [10] with 5% marginal error and 95% confidence interval with 254 respondents from sample frame of 696 individuals given in

Table 1. The population of security guards, messengers, chefs and sweepers in The University of Lahore were 300, 100, 78 and 218 and the sample size of security guards, messengers, chefs and sweepers was 109, 37, 28 and 80.

Table 1: Total sample size of prolonged standing workers

Occupation	Population (N)	Percentage	Sample (n)
Security guards	300	43%	109
Messengers	100	14.3%	37
Chefs	78	11.2%	28
sweepers	218	31.3%	80
Total	696	100%	254

$$n = \frac{N}{1 + Ne^2}$$
$$\Longrightarrow n = 254$$

Sample selection criteria

Inclusion criteria: Age range of participants were between 24-60 years with working experience for more than 1 year in their professions and workers who had spent more than 4 hours of standing with either gender (male, female) were included in study.

Exclusion criteria: Individuals with any pre-existing musculoskeletal disorders like fractures, vitamin deficiency, trauma and systemic illness were excluded in this study.

Ethical Approval

Prior to data collection, ethical approval was secured from the Research Ethical Committee (REC) of The University of Lahore (approval number: REC-UOL-568-10-2023).

Data collection procedure

Data for this study was collected through face to face interviews. Individuals participating in the research was first informed about the study and consent obtained. They was then asked to fill the questionnaire.

The tools selected for gathering data included:

1. Descriptive Form

Characteristics such as demographic information (like age, sex, marital status) along with professional details (such as years spent working, weekly working hours, length of time spent working in a standing position) and others like BMI, chronic disease and shoe preferences were considered.

2. Cornell Musculoskeletal Discomfort Questionnaire (CMDQ)

CMDQ is an MSD screening tool used to measure self-reported musculoskeletal discomfort for all body segments. The CMDQ was comprised of a body map and inquiries about the occurrence of musculoskeletal aches, pains, or discomfort in different body parts during the past week. [11]. CMDQ was developed by Professor Alan Hedge along with Ergonomics students from Cornell University, utilized to measure discomfort. The study on Turkish reliability-validity was conducted by Erdinc et al. in 2008 and the Cronbach's alpha for frequency, severity, and interference scales measured 0.876, 0.895, and 0.875 respectively [12]. The CMDQ questionnaire had taken into account each body region's frequency, degree of musculoskeletal discomfort, interference, and effect on work. This evaluation helped in determining how discomfort affects the efficiency of employees at work. Both male and female employees who worked in standing positions were given the CMDQ questionnaire form for this research. 12 different parts of body (neck, shoulder, upper back, forearm, upper arm, wrist, lower back, hip/buttock, thigh, knee, lower leg and foot) were evaluated. The evaluation of musculoskeletal discomfort was carried out in this manner: the frequency of discomfort reported by the workers during the study was quantified as follows - "Never" had scored as 0, "1 or 2 times/week" as 1.5, "3 or 4 times/week" as 3.5, "every day" as 5, and "several times every day" as 10. To calculate the weighted level of musculoskeletal discomfort, the previous results was multiplied by a rating that signified the severity of the discomfort. The scale for this was - "slightly uncomfortable" had counted as 1, "moderately uncomfortable" as 2, and "very uncomfortable" as 3. And interference rating ("Not at all = 1, slightly interfered = 2, substantially interfered = 3"). The scores achieved from the scale can vary from 0 to 90 for individual region discomfort, while the overall CMDQ score can range from 0 to 1080. A higher score served as an indicator of the heightened risk of Musculoskeletal Discomfort (MSD). Dependent Variable was MSD which is

categorized as mild, moderate and severe discomfort (when discomfort was reported) and no discomfort (when no discomfort was reported) in CMDQ screening tool. The CMDQ score 0 was considered as no discomfort. The CMDQ score 1.5 was considered as mild discomfort. The CMDQ score 1.6-10.5 was considered as moderate discomfort. The CMDQ score >10.5 was considered as severe discomfort.

1. Musculoskeletal discomfort: refers to a range of unpleasant sensations, including pain, stiffness, soreness, or tension, experienced in the muscles, bones, joints, ligaments, tendons, and other components of the musculoskeletal system. It can result from various causes, such as poor posture, overuse, injuries, medical conditions, and psychosocial factors [13].

2. Prolonged standing: Standing continuously for more than an hour, or standing in excess of four hours in a given day, qualifies as prolonged standing. Another way to describe this is static or constrained standing, characterized by standing in place (within a 20-cm range of movement) for lengthy periods without the chance to walk about or sit briefly for any rest [14].

Summarizing the information, possible thresholds of standing that may become a risk factor particularly are considered to be marked by these indicators:

- Low back complaints are noticeable when standing daily from 15 minutes onwards and are increasing from 30 minutes onwards.
- Exposure to standing at least 25% of the working time coincides with experiencing MSDs.
- Up to 2 to 2.5 hours a day of standing may be considered 'low risk' considering 'feeling burdened'.
- When standing 2 hours a day up to 4 hours a day low back complaints increase by 50%.
- When standing more than 4 hours a day low back complaints increase by 100% [2].

Analysis techniques

The independent variables were the potential risk factors in which age, gender, occupation, BMI, marital status, no. of children, shoe preference, standing hours/day, working experience (years), working hours/day. The dependent variables were the occurrence of Musculoskeletal Discomfort in different body regions (neck, shoulder, upper back, upper arm, forearm, wrist, hip lower back, knee, thigh, lower leg and feet). The analysis of the data was carried out utilizing the software SPSS (Statistical Package for Social Sciences) version 22.0. Descriptive Statistics: The presented data grouped and summarized in numerical form, using percentages to show the distribution of various independent variables. Pearson Chi-Square test was used to associate the risk factors with CMSD. Logistic regression analysis allowed for the assessment of the relationships between the predictor variables (e.g., age, gender, standing hours) and the outcome variable (musculoskeletal discomfort).

RESULTS

Of the total respondents, there was a greater frequency of male participants, who comprised 78.0% (198 individuals), while female participants made up 22.0% (56 individuals). These participants varied widely in age, from as young as 24 to 60 years, with the average age being 37.52 years, accompanied by a standard deviation of 11.893 years (37.52 ± 11.893). The marital status of these individuals also varied, but a significant majority, approximately three-quarters of the total

population surveyed, were married. Breaking down the occupational categories highlighted the job roles of these standing workers: 42.9% (109 individuals) of the respondents were security guards, 31.5% (80 individuals) were sweepers, 14.6% (37 individuals) were messengers, and chefs made up the smallest group at 11.0% (28 individuals).The study also explored the shoe preference of these workers, that almost all security guards wore close black boots. Messengers and chefs had a preference for close black shoes, while sweepers commonly opted for joggers during their working hours. All this detailed information, including the general and sociodemographic characteristics of the participants, was meticulously compiled and can be found outlined in Table 2 of the study. A comprehensive overview of the frequency and severity of musculoskeletal discomfort in various body parts and their impact on the ability to work was given in Figure 1. The data was derived from the Cornell Musculoskeletal Discomfort Musculoskeletal discomfort scores reflected a comprehensive method to quantify the impact of musculoskeletal pain on individuals, particularly in occupations involving prolonged standing. This kind of scoring system recognized the multifaceted nature of musculoskeletal discomfort by considering various factors such as frequency, severity, and interference with activities. By multiplying these three factors:

1. **Total Frequency Score**: Quantified how often the individual experienced musculoskeletal discomfort in a given time period, which could range from rarely to constantly.

Questionnaire, which evaluated discomfort experienced by individuals in different limbs and regions of the body. *Neck discomfort was reported by 55 individuals, with 36* experiencing slight to very uncomfortable pain. This discomfort was slightly substantially interfere with the work of 19 individuals. Shoulders had 66 individuals reporting discomfort, with around 51 individuals experiencing moderate to very uncomfortable pain. This affected the work of 25 individuals. 120 individuals had experienced upper back discomfort, with 37 reporting moderate to very uncomfortable pain. This affected the work of 27 individuals. The most affected area with 150 individuals was experiencing lower back discomfort. 68 individuals found the pain moderately to very uncomfortable, affecting the work of 41 individuals. 131 individuals reported hip/buttocks discomfort, with 96 experiencing moderate to very uncomfortable pain, and it interfered with the work of 29 individuals.

2. **Pain Severity Score (total)**: Measured the intensity of the pain experienced, which could vary from mild to very severe.
3. **Interference Score (total)**: Assessed the extent to which the discomfort interfered with the individual's ability to perform daily activities or job tasks, again ranging from not at all to extremely.

A total of 51.9% (132) reported no discomfort, while 25.5% (65) reported mild discomfort. 11.9% (30) and 10.7% (27) reported moderate and severe discomfort, respectively. The mean CMDQ score was 8.72 ± 4.67, with a median score of 9.00. Musculoskeletal Discomfort Questionnaire (MSDQ) scores, reflecting the

prevalence of musculoskeletal disorders (MSDs) across various socio-demographic variables. Questionnaire showed satisfactory internal consistency, with a Cronbach's alpha coefficient of $\alpha = 0.8$. A Chi-square test was used to determine if there were statistically significant associations between each variable and the presence of MSDs, with significant p-values (usually $p \leq 0.05$) indicating a strong association. Logistic regression was applied to model the relationship between predictor variables and binary outcome variables. The assumptions of linearity, independence, homoscedasticity, and lack of multicollinearity were checked. The goodness of fit was evaluated using the Hosmer-Lemeshow test. These checks ensured the validity of the logistic regression model. Logistic regression analysis revealed that gender, age, profession and break time were significant predictors of WRMSDs in workers. Male workers were 2.4 times more likely to experience WRMSDs. Older workers were 6.5 times more likely to experience WRMSDs. Workers who took more frequent breaks are 4 times less likely to experience work related musculoskeletal discomforts (WRMSDs).

Table 2: Frequency and percentage of Socio-demographic and professional characteristics

		Frequency	Percentage			Frequency	Percentage
Gender	Male	198	78	**BMI**	Under-weight	30	11.8
	Female	56	22		Healthy	126	49.6
Occupations	Security guards	108	42.9		Over-weight	75	29.5
	Sweepers	80	31.5		Obese	23	9.1
	Messengers	37	14.6	**No. of children**	≤ 2 years	108	42.5
	Chefs	28	11		3 – 5 years	92	36.2
Age	≤ 30 years	82	32.2		6 + years	54	21.3
	31 – 45 years	115	45.3	**Standing hours/day**	≤ 5 years	68	26.8
	46 + years	57	22.4		6 – 8 years	98	38.6
Working experience	≤ 5 years	168	66.1		9 + years	88	34.6
	6 – 10 years	65	25.6	**Working hours/day**	≤ 8 hours	145	57.1
	11+ years	21	8.3		> 8 hours	109	42.9
Education	Illiterate	37	14.6	**Working hours/week**	48 hours	90	35.4
	Primary	38	15		56 hours	81	31.9
	Middle	62	24.4		84 hours	83	32.7
	Matric	70	27.6	**Break time/minute**	20 minutes	11	4.3
	Intermediate	41	16.1		30 minutes	115	45.3
	Graduate	6	2.4		60 minutes	128	50.8

Marital status	Unmarried	47	18.5	**Shoe preference at workplace**	Close shoe	171	67.3
	Married	207	81.5		Joggers	83	32.7

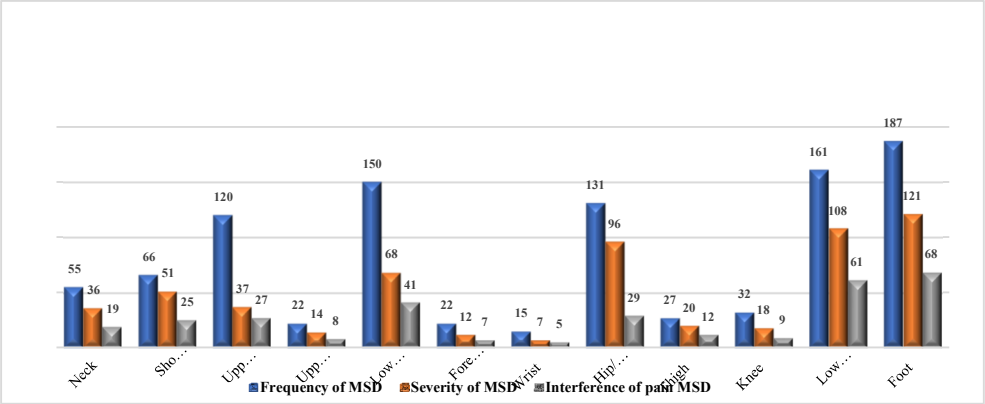

Figure 1: Graphical presentation of Cornell Musculoskeletal Discomfort Questionnaire

Table 3: Logistic regression analysis revealing significant predictors of WRMSDs in workers

Variables	B	S.E.	Wald	Sig.	Exp (B)	95% C.I for Exp (B) adjusted	
						Lower	Upper
Gender of workers	.893	.438	4.170	**.041***	2.444	1.037	5.761
Age of workers	1.873	.803	5.445	**.020***	6.508	1.350	31.382
Professions of workers	2.169	.903	5.765	**.016***	8.749	1.490	51.391
BMI	-.821	.850	.935	0.334	.440	.083	2.325
Education	.247	1.248	0.039	0.843	1.281	.111	14.775
Working experience	1.457	.1790	1.790	0.262	.465	0.71	1.648
Standing hours per day	-1.257	.711	3.123	0.07	.285	0.71	1.147
Working hours per day	-.202	.850	.067	0.795	.802	.152	4.24
Working hour per week	-.452	.844	.287	0.592	.636	.122	3.324
Break time (mins/day)	1.393	.492	8.011	**.005***	4.025	1.535	10.559
Shoe preference	.622	.654	.906	.341	1.863	.157	6.709
Constant	-4.999	1.086	21.182	0.00	0.007		

*Statistically significant at P≤0.05

DISCUSSION

Prolonged standing at work has been linked to musculoskeletal disorders, with this research indicating high prevalence rates among workers. This study conducted at the University of Lahore found that 73.6% of participants experienced MSDs, with areas such as the feet, lower legs, hips, lower back, and thighs being most affected. These rates surpassed 64.9% among teachers reported in Turkey [15], yet were lower than the 89.3% found among occupational drivers in Ibadan, Nigeria [16]. Another study by Thangaraj and Shireen in Bangalore identified a 62% prevalence of MSDs among automobile workers [17]. The occurrence of MSDs was notably prominent in workers with long standing hours, such as those in Malaysia's manufacturing sector, who often worked without

breaks and with inadequate workstation design, leading to both physical and psychosocial strain [18]. Previous findings suggested that physical hazards pose a greater risk for MSDs than psychosocial hazards in the Malaysian context [19]. To mitigate this, ergonomic strategies that tailor the work environment to the needs of employees are advisable [20]. Such interventions, along with reducing the duration of exposure to risky conditions, can decrease muscle fatigue, enhance productivity, and lessen the expenses related to MSD treatment and lost working time [18]. Research has highlighted that various ergonomic measures can significantly alleviate the hardship workers experience during periods of extended standing, particularly in terms of discomfort and pain affecting the lower limbs. Anti-fatigue mats, shoe insoles, structured surfaces designed for reduced strain, and footrests are among the recommended interventions [21]. A study by King in 2002 demonstrated that the type of flooring significantly influenced the level of discomfort workers felt. Softer surfaces provided a more comfortable working platform and helped to reduce the fatigue felt from standing on harder surfaces. This reduction in fatigue can have a direct impact on the wellbeing of workers engaging in tasks that require them to stand for long durations [2]. Moreover, other findings suggest that supportive footwear plays a crucial role. Insoles are found to increase comfort, and Gregory & Callaghan underlined the benefit of mats and insoles in aiding workers during prolonged periods of standing. This can help to lessen the physical strain and potential for long-term injury [22]. Sousa et al. added that wearing shoes that offer stability can improve the performance of a worker's postural control system and can be more beneficial than standing barefoot, which can be challenging over extended periods and may affect posture and cause discomfort [23]. Another element that can contribute positively is the angle of the standing surface. Wong and Callaghan in 2010 investigated the effects of a sloping surface on workers and discovered a significant decrease in lower back pain when these surfaces were used during long-standing work sessions. Lastly, anti-fatigue mats have been recognized in several studies, such as one by Cham and Redfern, as effective in reducing muscle soreness, especially in the feet which are a common area of discomfort for individuals who stand for extended periods. These ergonomic interventions collectively can enhance worker satisfaction, decrease the risk of musculoskeletal disorders, and potentially increase productivity due to better comfort and reduced pain [24].

Researchers Arun and Vijayalakshmi unearthed that a significant number of individuals often report lower back and knee pain, along with stiffness in the early hours of the morning. These primary issues were closely followed by discomfort in the hips, shoulders, ankles, feet, and neck [25]. Another study conducted by Joseph et al. echoes this finding, particularly noting the prevalence of lower back pain and linking it to the lengthy hours and extensive duration of employment individuals endure [26]. The study conducted by Martarello and Benatti shed light on a similar trend among hospital cleaning and sanitation staff, with a distinct pattern of musculoskeletal symptoms manifesting in the shoulders (50%), upper back (43%), and the neck and lower back (37.2%) [27]. Such high instances of musculoskeletal discomfort among hospital housekeepers can be traced back to several ergonomic factors that these workers face regularly. These can include repetitive movements of the upper and lower limbs, maintaining body postures that are not ergonomically recommended, along with recurrent bending and twisting of the back [28].

These actions, necessary for the completion of their daily tasks, may not seem harmful in the short term but gradually can lead to muscle fatigue, alterations in tissue density, and strain on the tissues. Eventually, and often inevitably over time, these physiological stresses converge to result in musculoskeletal disorders [29]. The accumulation of stress and strain from these smaller or larger forces exerted during work-related activities has been pinpointed as a significant risk factor in the development of MSDs, showcasing the need for attention to the continual physical toll on these workers' bodies [30 31].

CONCLUSION

Lower back and foot pain were the most common complaints. Male workers, older workers, and those with less frequent breaks were more likely to experience MSDs. The study highlights the need for targeted interventions to prevent MSDs among prolonged standing workers. Implementing regular breaks and ergonomic training may help reduce the risk of MSDs. Employers should prioritize providing a safe and healthy work environment to mitigate the risk of MSDs.

Author's Contribution
ZY: Developed the methodology and wrote the original draft of the manuscript, integrating data and findings into a cohesive narrative. **IHK:** Provided supervision of whole research. **IY:** Conducted formal analysis and investigation to gather and analyze data, contributing to the interpretation of results.

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