

Original Article

Musculoskeletal Disorders and Ergonomics Risk Assessment among Sewing Machine Operators and Tailors

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ABSTRACT

Background: Sewing machine operators and tailors in Faisalabad, Pakistan, frequently endure prolonged periods of sitting or standing, performing repetitive tasks that contribute to Musculoskeletal Disorders (MSDs). This study aims to fill the research gap in work-related musculoskeletal disorders (WRMSDs) and workstation evaluations within this group.

Objective: The purpose of this study was to assess the prevalence of MSDs and evaluate the ergonomic conditions of workstations among tailors and sewing machine operators in the local and textile sectors of Faisalabad.

Methods: A cross-sectional study design utilized non-probability sampling to include 810 participants from both local tailor shops and textile factories. Data collection involved a self-structured questionnaire focusing on demographic and job-related factors, the Cornell Musculoskeletal Discomfort Questionnaire (CMDQ), and the Rapid Upper Limb Assessment (RULA) to evaluate ergonomic risks.

Results: High levels of discomfort were reported in the upper limbs, particularly the right and left forearms (3.40 ± 0.97), and in the lower limbs, particularly the right knee (3.90 ± 0.47). The mean RULA scores were 4.8 ± 0.51 for textile workers and 4.9 ± 0.53 for local tailors, indicating poor workstation setups. Additionally, CMDQ results showed significant associations between musculoskeletal discomfort and variables such as age, residence, marital status, lifestyle, and smoking habits.

Conclusion: The study found a high prevalence of musculoskeletal disorders among textile workers and tailors, particularly affecting the left foot and left knee of local tailors. The RULA scores highlight a high risk of musculoskeletal disorders, necessitating further investigations and modifications in the working environment.

Keywords: Ergonomic Risk Assessment, Musculoskeletal Disorders, Sewing Machine Operators, Tailors, Workstation Evaluation, Work-Related Musculoskeletal Disorders, Workplace Ergonomics.

INTRODUCTION

Musculoskeletal disorders (MSDs) are conditions related to injuries affecting muscles, ligaments, joints, nerves, and discs. These disorders are a significant occupational health issue, with risk factors including prolonged stationary positions, repetitive motions, intense muscular exertion, awkward postures, and extended work hours without adequate breaks (1, 2). Among workers, the prevalence of MSD symptoms in the neck and shoulder regions is notably high, reaching a rate of 62% (2). Specifically, neck and shoulder disorders are prevalent among individuals performing tasks that require rapid, precise, and repetitive movements (3, 4). Previous research has identified sewing machine operators, along with meat cutters and office workers using visual display units, as particularly high-risk groups for developing MSDs (4, 5).

The maintenance of ergonomic standards in the workplace not only mitigates health risks but also enhances operational efficiency. To meet production deadlines and manage workloads effectively, workers are often required to synchronize their actions with machine operations, which may compromise their health due to neglected safety measures (6, 7). Despite technological advancements that have facilitated better ergonomic design in equipment—such as the introduction of tailoring machines with smart, adjustable components—many industries continue to fall short of adequate ergonomic practices (8, 9). These enhancements

in machinery design have proven to be beneficial, allowing for faster production, cost reduction, and improved deadline adherence while ensuring worker safety. Nevertheless, significant scientific efforts are still necessary to optimize workstations to minimize safety hazards and support the natural biomechanics of the human body (10).

In particular, sewing machine operators are susceptible to MSDs due to inadequate workstation setups, poor posture, prolonged work periods, and the repetitive use of arms and hands (11). The process of assembling various cut panels to produce a complete garment involves continual hand movements and trunk bending. Additional tasks, such as cleaning the machine, threading, adjusting thread tension, and handling materials, contribute further to the strain. Such continuous positioning and focus can lead to the development of MSD symptoms in the upper limbs, neck, and back (12). A study found that 65.45% of tailors suffered from MSDs, with the neck being the most commonly affected area, followed by the lower and upper back (13). The rise in MSD cases has been notable in recent years, with these disorders becoming a leading cause of worker absenteeism in the European Union, where approximately a quarter of industrial workers reported work-related MSDs affecting various body regions in the 4th European Working Conditions Survey (14).

In developing countries, including Pakistan, there is a notable deficiency in the awareness and application of proper ergonomic principles among sewing machine operators and tailors. This gap in knowledge and practice has led to an increased incidence of work-related musculoskeletal disorders (WRMSDs) among this workforce. The objective of this study was to assess the prevalence of WRMSDs and to identify ergonomic risk factors among sewing machine and tailor operators in Faisalabad, Pakistan, aiming to propose informed interventions that could alleviate these health issues.

MATERIAL AND METHODS

Between March and August 2019, a cross-sectional study was conducted among male textile workers from COZY Textiles, Image Garments, and local tailor shops in Faisalabad, Pakistan. The study aimed to determine the prevalence of musculoskeletal (MSK) discomfort and evaluate ergonomic risk factors in the workplace. A total of 810 participants, including sewing machine operators and local tailors who voluntarily consented to participate, were enrolled after approval from the Research and Ethics Committee at XXXXXX University. Individuals with a history of upper limb fractures, cumulative trauma disorders, recent severe trauma, neurological impairments, or persistent musculoskeletal injuries were excluded from the study.

Data collection was carried out using the Cornell Musculoskeletal Discomfort Questionnaire (CMDQ), which assesses the frequency, severity, and interference of MSK discomfort across 20 body parts. Developed by Professor Alan Hedge and his team at Cornell University, CMDQ has been effectively utilized in various occupational groups, including nursing staff (17), computer operators (18), and telecommunication data entry workers. For ergonomic evaluation, the Rapid Upper Limb Assessment (RULA) was employed. This survey method focuses on biomechanical and postural loads, particularly affecting the neck, trunk, and upper limbs, and is known for its reliability in studies involving Visual Display Users and sewing machine operators.

The study protocol required that each participant be observed while working at their station to capture the most representative postures during an 8–10 minute period. Following this, participants were asked to complete the CMDQ, which was distributed along with a consent form. Each participant was given guidance and approximately 10 minutes to fill out the questionnaire. Concurrently, ergonomic assessments were performed using RULA. The assessors selected the most critical postures for evaluation, either choosing the most frequently adopted or the most severe postures, based on the nature of the tasks. Scores were then assigned to various elements of the workstation, including chairs, machines, and the positioning of sewed cloth boxes.

All data were managed and analyzed using SPSS version 20 for Windows. The association between ergonomic risk factors and MSK discomfort was examined using the Chi-square test. The results of this study are intended to provide insights into the prevalence of MSK issues among tailors and sewing machine operators and to inform potential ergonomic interventions aimed at reducing these occupational hazards.

RESULTS

The study involved 810 participants, comprising 373 sewing machine operators and 397 local tailors, selected based on pre-defined criteria from the textile industry and various local settings. The age distribution showed a majority in the 20-23 year range, with 6.7% of participants aged 19 or younger and 1.2% over 55 years. Lifestyle habits indicated that 79.5% of participants led a sedentary lifestyle, while 20.5% were considered active. Hand dominance was predominantly right-handed at 91.2%, with the remaining 8.4% being left-handed.

The evaluation of musculoskeletal discomfort revealed that the body parts most affected were the forearms, with right and left forearm discomfort scores averaging 3.40 ± 0.97 . In the lower limbs, the right knee was notably affected, showing a discomfort score of 3.90 ± 0.47 .

Ergonomic risk was assessed using the Rapid Upper Limb Assessment (RULA). For sewing machine operators in the textile industry, the mean RULA score for arms and wrists was 4.55 ± 0.54 , while local tailors scored slightly lower at 4.11 ± 0.8 . The scores for neck, trunk, and legs were 3.21 ± 0.43 for sewing machine operators and 2.8 ± 0.54 for local tailors. The overall RULA scores indicated that both groups faced significant risks of musculoskeletal discomfort, with mean final scores of 4.8 ± 0.51 for textile industry operators and 4.9 ± 0.53 for local tailors.

Further analysis revealed a significant correlation between personal factors such as age, residence, marital status, lifestyle, and smoking habits, and the categories of musculoskeletal discomfort as measured by the Cornell Musculoskeletal Discomfort Questionnaire. These findings underscore the need for targeted ergonomic interventions and further investigations to alleviate the musculoskeletal risks faced by sewing machine operators and tailors in their work environments.

Table 1: Characteristics of Participants (N: 810)

Variables	Frequency	Percentage
Age		
19 or younger	54	6.7
20-23	242	29.9
24-29	174	21.5
30-39	203	25.1
40-55	127	15.7
>55	10	1.2
Material Status		
Married	460	56.8
Unmarried	350	43.2
Life style		
Sedentary	644	79.5
Active	166	20.5
Residence		
Rural	406	50.1
Urban	404	49.9
Hand dominance		
Right-sided	739	91.2
Left-sided	68	8.4
Past medical history of participants		
any trauma	153	18.9
no trauma	655	80.9
Smoking habits of Participants		
Current-smoker	233	28.8
Ex-smoker	15	1.9
Non-smoker	562	69.4
Workplace of participant		
Textile	373	46
Tailors	397	49
Educational level of the Participants		
Illiterate	187	23.1
Primary	288	35.6

Variables	Frequency	Percentage
Elementary	178	22
Matric	131	16.2
Higher	26	3.2
Total working experience of Participants		
Less than 2 years	203	25.1
3-5 years	188	23.2
6-10 years	133	16.4
More than 11 years	286	35.3
Years of experience in current setup		
Less than 2 years	213	26.3
3-5 years	197	24.3
6-10 years	139	17.2
More than 11 years	261	32.2
Duty shift of Participants		
Morning	751	92.7
Evening	59	7.3
Working hours of participants per day		
4 hours	7	0.9
8 hours	629	77.7
12 hours	144	17.8
more than 12 hours	30	3.7
Total	810	100

Table 2: Discomfort profiles for all body parts collected using the CMDQ Mean (SD) score

Discomfort Body parts	Mean (SD)	Discomfort Body parts	Mean (SD)
Neck	1.83(0.71)	Hip	2.92(1.12)
Right Shoulder	2.61(1.00)	Right Thigh	1.04(0.22)
Left Shoulder	2.54(1.08)	Left Thigh	3.89(0.49)
Upper Back	1.50(0.81)	Right Knee	3.90(.47)
Right Upper Arm	3.31(1.02)	Left Knee	1.05(0.25)
Left Upper Arm	3.33(1.01)	Right Lower Leg	3.89(0.48)
Lower Back	1.41(0.73)	Left Lower Leg	3.90(0.46)
Right Forearm	3.40(0.97)	Right Foot	2.10(0.88)
Left Forearm	3.40(0.97)	Left Foot	2.53(0.92)
Right Wrist	1.68(0.78)	Right Hand	2.48(0.98)
Left Wrist	2.99(1.03)	Left Hand	1.04(0.25)

Table 3: Mean RULA score of Sewing machine operators and Local Tailors

Occupation	RULA Section A—Arm and wrist score		RULA Section B—Neck, Trunk and Leg score		RULA Final Score	
	Min-Max	Mean±SD	Min-Max	Mean±SD	Min-Max	Mean±SD
Sewing machine operators in Textile industry	3- 6	4.55±0.54	2- 5	3.21±0.43	4- 6	4.8±0.51
Local Tailor	3- 6	4.11±0.8	2- 5	2.8±0.54	4- 6	4.9±0.53

Table 4: Association of variables with CMDQ

Variables	slightly uncomfortable	moderately uncomfortable	very uncomfortable	N/A	Total	χ^2 value	p-value
Age (years)							
19 or younger	3(5.6)	24(44.4)	0(0)	27(50)	54(100)	38.67	<.001
20-25	5(2.1)	158(65.3)	0(0)	79(32.6)	242(100)		
26-29	12(6.9)	93(53.4)	0(0)	69(39.7)	174(100)		
30-39	14(6.9)	117(57.6)	3(1.5)	69(34)	203(100)		
40-55	10(7.9)	92(72.4)	1(0.8)	24(18.9)	127(100)		
>55	0(0)	8(80)	0(0)	2(20)	10(100)		
Marital status of Participants							
Married	32(7)	288(62.6)	4(0.9)	136(29.6)	460(100)	12.74	0.005
Unmarried	12(3.4)	204(58.3)	0(0)	134(38.3)	350(100)		
Lifestyle of Participants, Residence of Participants, Marital status of Participants,							
Sedentary	37(5.7)	439(68.2)	4(0.6)	164(25.5)	644(100)	88.48	<.001
Active	7(4.2)	53(31.9)	0(0)	106(63.9)	166(100)		
Residence of Participants							
Rural	8(2)	257(63.3)	1(0.2)	140(34.5)	406(100)	20.17	<.001
Urban	36(8.9)	235(58.2)	3(0.7)	130(32.2)	404(100)		
Hand dominance of Participants							
Right sided	36(4.9)	439(59.4)	4(0.5)	260(35.2)	739(100)	17.5	0.008
Left-sided	8(11.8)	51(75)	0(0)	9(13.2)	68(100)		
Past medical history of participants							
any trauma	1(0.7)	99(64.7)	0(0)	53(34.6)	153(100)	17.12	0.009
no trauma	42(6.4)	392(59.8)	4(0.6)	217(33.1)	655(100)		
Smoking habits of Participants							
Current-smoker	19(8.2)	141(60.5)	1(0.4)	72(30.9)	233(100)	19.67	0.003
Ex-smoker	2(13.3)	7(46.7)	1(6.7)	5(33.3)	15(100)		
Non-smoker	23(4.1)	344(61.2)	2(0.4)	193(34.3)	562(100)		

DISCUSSION

Sewing machines, long integral to the textile industry, have evolved significantly, enhancing both local and industrial productivity. Despite these advancements, improper use and positioning can lead to severe musculoskeletal disorders (MSDs) and posture abnormalities, diminishing worker efficiency. The study highlighted significant musculoskeletal discomfort in the upper limbs, particularly the right and left forearms, with mean discomfort scores of 3.40 (0.96), and in the lower limbs, the right knee was most affected with a score of 3.90 (0.47). These findings are corroborated by research from Iman Dianat et al., which identified similar discomfort patterns among right-handed individuals who predominantly use their right leg while sewing (12).

The assessment of ergonomic risk using the Rapid Upper Limb Assessment (RULA) revealed poor workstation setups, indicating a pronounced risk of work-related MSDs. This aligns with findings from Nag et al., who noted that poor postures were prevalent among sewing machine operators, and from Habib et al., who identified significant ergonomic risk factors including awkward neck and back postures and repetitive hand and arm movements. The burden of MSDs could be mitigated through minor ergonomic adjustments, which are typically cost-effective as these risk factors are modifiable.

Moreover, studies by Zara et al. and Robin Burgess et al. emphasized the role of ergonomics in improving productivity and reducing MSDs. They suggested that integrating quality management with ergonomic improvements enhances overall workplace efficacy and worker health (19, 20). N Larson et al. further supported this by demonstrating that ergonomic interventions directly correlate with increased productivity and reduced incidence of work-related musculoskeletal disorders (21).

The current study also found significant associations between musculoskeletal discomfort and demographic factors such as age, with younger workers more likely to develop work-related MSDs (24), contrasting with other studies that linked higher MSD risk with older age (25). This discrepancy might reflect differences in workplace roles, workloads, and ergonomic awareness among age

groups. Smoking was another factor examined, with some studies suggesting it as a predictor of MSDs (28), although this link is not universally accepted (29).

Participants leading sedentary lifestyles exhibited higher susceptibility to musculoskeletal discomfort. This observation is consistent with literature suggesting that an active lifestyle may mitigate the risks of MSDs (30, 31). Encouraging physical activity could therefore be beneficial in reducing MSD-related pain among workers.

The study's cross-sectional design limits the ability to establish causal relationships between risk factors and work-related MSDs. Further research is warranted at a broader geographic and demographic level to enhance ergonomic awareness and postural control. The majority of participants were also found to misinterpret their activity levels, considering their work as active when it is predominantly sedentary. This underscores the need for educational interventions to clarify these misconceptions.

While sewing machines have transformed the textile industry, their use without proper ergonomic considerations continues to pose health risks. Addressing these issues through targeted ergonomic interventions and comprehensive worker education can lead to substantial improvements in worker health and productivity. Future studies should explore the clinical aspects and mechanisms underlying the impact of sewing work on the musculoskeletal system, offering insights that could help tailor interventions more effectively.

CONCLUSION

Work-related musculoskeletal disorders (WRMSDs) were found to be highly prevalent among sewing machine operators and tailors. Common complaints included pain in the neck, lower back, right shoulder, and various lower limb regions such as the left knee, hip, left thigh, and left knee, with these complaints more frequently reported in textile workers compared to other occupational groups. Local tailors, in particular, experienced higher incidences of discomfort in the left foot and right knee than in other body regions. A significant association was observed between age and working posture with musculoskeletal complaints, indicating that these factors are critical in the development of WRMSDs. However, no statistically significant associations were found between musculoskeletal complaints and other demographic variables, except for age and gender. This highlights the need for targeted ergonomic interventions and preventive measures that consider specific demographic and occupational risk factors to reduce the burden of WRMSDs among these workers.

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