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Ergonomic Evaluation of Workstation for Sewing Machine Operators in Ethiopia

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Abstract

Objectives: This study aims to fill this gap by evaluating sewing workstations and analyzing the prevalence of work-related musculoskeletal disorders and associated risk factors for operators in case company.

Methods: The sample included 217 sewing machine operators. Data were collected through standardized Nordic MSDs questionnaire and strain index tool for distal upper extremities on selected garment workers. And also using logistic regression analysis were used to identify the factors that influence the prevalence of work-related Musculoskeletal disorders and associated risk factors for operators.

Result: The result showed that the prevalence rate for Musculoskeletal pain in different body regions was 93.9% in the low back, 93.3% in the upper back, 76% in the neck, 65.4% in the hip/thigh/ and buttocks, 52.0% in the shoulder, 45.8% in the elbow, 40.2% in the wrist or hand, 33% in the knee and 36.9% in the ankle or feet. Moreover, the Strain Index (SI) score indicates hazardous (57%) and some risk (29%), uncertain (21.7%), and probably safe (3.5%) of upper extremity disorders during performing their tasks.

Conclusion: After analysis of the data using regression models, the result revealed that the suitability of the sitting chair with the sewing workstation, the comfort of the working environment, job satisfaction, medical history in the previous 12 months related to MSDs, working experience, education level, and gender were the most significant factors associated with the prevalence of WRMSDs among various body parts. The finding revealed the workstation of sewing machine operator and emphasized the need for ergonomic interventions to minimize the MSDs among them.

Keywords: MSDs (Work-Related Musculoskeletal Disorders); Strain index; Nordic MSDs Questionnaire

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Introduction

More than half of all countries in the world do not keep official statistics on work-related occupational sickness. Particularly in underdeveloped nations, there is a lack of data reporting in the domain of work-related sickness and musculoskeletal disorders. In nowadays, Garment is a rapidly growing sector in Ethiopia. Reports show that until the end of 2007 E.C. There were 102 garment industries in Ethiopia. Among these garments, 79 of them were found in Addis Ababa and 22 of them were found Oromia special zone near Addis. Approximately more than 10,000 workers (70% female) were working in this sector which became a great source of employment.

In the report of the Ethiopian Ministry of Labor and Social Affairs (MOLSA), from 279 establishments in the year 2014/2015, a total of 5,135 work-related accidents were reported and among which 5,092 (99.16%) were non-fatal. This resulted in a cost of 2,195,960.74 ETB for a medical case and an absence of 12,612 workdays by injured employees. According to MOLSA report of 2014/15 in manufacturing industries 2856 (56.62%), victims were registered as work-related accidents and diseases, in which garment industry is one of the most hazardous sectors because mostly garment factory works are repetitive and requiring strong visual demands, improper postural requirements and involving long hours sitting or standing in one position.

In the sewing section, the risks for sewing machine operators have been linked to conditions such as poor workstation design, and actions should be taken to eliminate the causes of this disorder and make the workplace safe and healthy for the operators.

So, this paper mainly focuses on assessing the prevalence and associated risk factors of work-

Figure 1: Sewing section workstation in Desta garment plc.

related musculoskeletal disorders in different body segments of operators in sewing workstations in the case company.

As we see in Figure 1, in Desta garment, the sewing section workstation is not scientifically looking suitable.

Finally, this paper conducted to fill this gap by ergonomically evaluating the prevalence of musculoskeletal disorders in different body segments and associated risk factors for sewing section operators, and then using logistics regression analysis to identify which factors are significantly associated with musculoskeletal disorders.

Literature Review

Ergonomics is the process of designing or arranging workplaces, products, and systems so that they fit the people who use them, and the profession that applies theoretical principles, data, and methods to design to optimize well-being and overall performance.

Maintain neutral posture and ergonomics workstation

The neutral posture is the ergonomic standard for sitting in a chair and using the computer or standing. A posture is considered "awkward" when it moves away from the neutral posture towards the extremes in the range of motions [1].

According to Goggins et al. [2], reported that Ergonomics lowers costs and reduces MSD risk factors since MSDs account for 30% of all worker's comp claims and reduce indirect costs which can be up to 20 times the direct costs and improves productivity by 25% through designing a job to allow for good posture, less exertion, fewer motions, and better heights and reaches, the workstation becomes more efficient and also improves employee engagement, if an employee does not experience fatigue and discomfort during their workday, it can reduce turnover, decrease absenteeism, improve morale and worker efficiency. There are three major categories of the workplace: Sitting, standing, and sit/stand.

Ergonomics in sewing room

The working posture at sewing machines should allow the mobility of the limbs, ergonomically favorable arrangement of working and visible zones, and a stable balanced state when performing the work process. The study stated that 70% of sewing machine operators using foot controls report back pain, 35% report persistent low back pain, 25% have suffered a work-related disorder and 49% of workers experience pain in the neck [3]. Setting up your sewing room properly is of paramount importance regarding operators' physical well-being, in sewing, cutting, and ironing operators positions that tax your posture leads to fatigue, muscle pain, and chronic or serious conditions of the spine [4].

Musculoskeletal disorders (MSDs)

At present, MSDs are one of the most important problems ergonomists encounter in the workplace all over the world and in many countries' prevention of WMSDs has become a national priority. Sitting posture mainly having pain on the low-back and it is one of the most common Musculoskeletal Disorders (MSDs) in sitting position and has been reported to occur in 50% to 90% of all adults with recurrence rates of up to 90%. Approximately 15% to 20% of adults suffer from back pain each year. The operation usually requires the operator to lean forward, with a forward inclined posture of both head and trunk, to focus their attention and have better visual control of the task.

Generally, some studies conclude that the majority of the garment workers had been suffering from some kind of musculoskeletal disorder depending upon the nature of work and their posture [5].

Factors associated with work-related musculoskeletal disorders

Factors associated with the development of WRMSDs in garment workers are categorized in the form of demographic factors (age, sex, marital status, educational level, year of experience, and monthly salary), personal factors (height and weight, smoking habit, habit doing exercise, and medical history of MSDs), job-related factors (payment method, working hour, health and safety training, job satisfaction, comfort of the working environment, and fitness of sitting chair with the working machine) [6].

Logistic regression analysis

In this paper both bivariant and multivariant logistic regression analysis has been used to determine the prevalence of WRMSDs and the significant association between the dependent and independent variables had been examined by both regression analyses.

Logistic regression will model the chance of an outcome based on individual characteristics. Because chance is a ratio, what will be modeled is the logarithm of the chance given by:

$$\ln\left(\frac{\pi}{1-\pi}\right) = \beta o + \beta 1\times 1 + \beta 2\times 2) + \cdots \beta mxm + er \ldots$$

where "π" indicates the probability of an event and "βo" is the regression coefficients associated with the reference group and the

"Xm" explanatory variables and "er" is an error term. At this point, an important concept must be highlighted.

Methodology

Methods

Under the headings of what has been studied, the methods, the instrumentation used, sampling method, data collection, and data analysis, the methods and procedures used in the ergonomic evaluation for sewing operators in the Ethiopian garment manufacturing industry in Desta garment plc are explained. Several approaches were utilized to determine the level of awkward postures by applying logistics regression analysis, identifying which elements are strongly correlated with the severity of MSDs.

According to Biadgo et al. [7], the researcher has been taken as the dependent variables, such as the neck, shoulder, upper back, elbows, wrist/hands, lower back, hip/thighs, knees, and ankle/feet, based on the severity of MSDs report from participants using the Standard Nordic MSD questionnaire. And this study has used this dependent variable as a response variable [7].

Independent variables:

- Demographic factors (age, gender. marital status, educational level, year of experience, and monthly salary).
- Personal factors (Body mass index, smoking habit, habit doing exercise, medical history of systematic illness, and medical history of MSDs) [6].
- Job-related factors (payment method, working hour, health and safety training, job satisfaction, comfortable of the working environment, and fitness of sitting chairs with the working machine) [6].
- Strain index score also takes as independent variables.

Target population: The target population of this paper has been concerned with garment manufacturing industries in the Desta garment plc sewing section, in Ethiopia.

Sample proportion: According to Agresti and Coull [8], the proportion of the expected frequency assumption is 50% with the estimated population for Desta garment factory has around 400 sewing machine operators.

Then, the population is fine so we use this formula to get sample size,

Z: Standard or z score: 1.96 (confidence level), P: Population proportion assume 0.5, Q (sample population): 1-P = 1-0.5 = 0.5 = Q, Margin Error (ME): 0.05 (5%), Population size = 400, then,

$$n = \left[\left(Z^2 \times P \times Q \right) + ME^2 \right) / \left(\frac{ME^2 + Z^2 \times P \times Q}{N} \right) \right]$$

n=192.36, Therefore, the researcher needed to survey 193 operators of Desta Garment PLC.

Finally, the sample size was determined using a single population proportion and by adding a 10% non-response rate total sample size for this study is 213 [7].

Sampling technique: After the size of the sample population is determined, purposive or judgmental sampling technique has been used based on their working experience, and willingness to participate in the survey to identify the number of respondents or operators to get the relevant data on the selected area [7].

Hypothesis development: In this study, four tests had been held to determine the relationship between independent and dependent variables, as well as the level of significance of factors linked to the severity of MSD symptoms or pain in different segments of the operators' bodies. All of the tests were evaluated using logistic regression analysis.

1. H1: There is a relation between demographic factors and the severity of MSDs in different operators' body segments. So, in this case, the study formulates a hypothesis to determine the demographic factors, such as age, gender, marital status, educational level, year of experience, and monthly salary, need to check whether demographic variables have strong significance or not with the severity of MSDs, using logistics regression analysis.

2. H2: There is a relationship between personal factors and the severity of MSDs in different operators' body segments. So, in this case, the study formulates a hypothesis to determine the personal factor (Body mass index, smoking habit, habit doing exercise, medical history of systematic illness, and medical history of MSDs) need to check whether personal variables have strong significance or not with the severity of MSDs.

3. H3: There is a relationship between job-related factors and the severity of MSDs in different operators' body segments. So, in this case, the study formulates a hypothesis to determine the job-related factor need to check whether job-related variables have strong significance or not with the severity of MSDs.

4. H4: There is a relation between 4 strain index scores and the severity of MSDs in upper body segments. So, in this case, the study formulates a hypothesis to determine these 4 strain index scores need to check whether 4 strain index score has strong significance or not with the severity of upper body of MSDs.

Data collection

This paper employed both primary and secondary data collection methods to obtain relevant data throughout the last 12 months, which focuses on the ergonomic evaluation of workstations for operators in the sewing workstation.

Completing the strain index survey: According to Steven Moore and Garg, in the strain index, six variables need to be collected for each task; each variable is assigned a rating and a multiplier.

A. The intensity of exertion, an estimate of the strength required to perform the task one time. This is a function of the force required, and upper extremity posture Guidelines for assigning a rating criterion are presented table in the appendix part.

B. Duration of exertion is calculated by measuring the duration of all exertions during an observation period, then dividing the measured duration of exertion by the total observation time and multiplying by 100.

$$\%\ \text{Duration of Exertion} = \frac{100 \times \text{duration of all exertions (sec)}}{\text{total observation time (sec)}}$$

According to Drinkaus et al. tasks that attribute were recorded with a stopwatch and considering as time busy. It is defined as the time during which the operator was occupied performing a task and would be unable to perform another task at that time with that hand

and it's assumed as the duration of exertions.

The ratio of busy time to cycle time provides insight into how much non-busy time is available to the worker. This non-busy time may be used for rest, or it may provide time to correct if an error or disruption occurs, busy time was used to determine the allocated time for each task. Allocated time for a task is the amount of time a person is busy plus the amount of rest associated with that task. So allocated time was determined the total observation time in seconds using a stopwatch.

C. Efforts per minute are measured by counting the number of exertions that occur during an observation period, then dividing the number of exertions by the duration of the observation period, measured in minutes. synonymous with the frequency of exertions per minute. The number of exertions is calculated as busy time without rest in required time in minutes

$$\text{Efforts per Minute} = \frac{\text{number of exertions}}{\text{total observation time (min)}}$$

D. Hand/Wrist posture is an estimation of the position of the hand or wrist relative to the neutral position or it is the anatomical posture of the hand.

E. Speed of work is an estimation of how fast the worker is working.

F. Duration of task per day is a measure of how much of the workday is allocated to performing that task.

Then total strain index is calculated by multiplying all the above steps,

Strain Index = IE × DE × EM × HWP × SW × DD.

Based on Steven Moore and Garg, the result that getting from the strain index help to identify the level of job risk,

- SI Scores less than or equal to 3 are probably safe.
- SI Scores between 3 to 5 are uncertain, Job may place an individual at increased risk for distal upper extremity disorders.
- SI Scores between 5 to 7 indicates there is some risk.
- SI Scores greater than or equal to 7 are probably hazardous.

According to Nagaraj et al., a separate strain index scoring sheet was used for each operator. And these four scores of strain index considering as independent variables and logistic regression analysis has been conducted because to determine the relationship between musculoskeletal symptoms and these four-strain index score for each upper body parts during the last 12 months.

Questionnaire design: During the last 12 months, Standardized Nordic MSDs questionnaires employed to examine associated factors for the work-related musculoskeletal condition and its severity in various body segments.

The Standard Nordic Musculoskeletal Disorder Questionnaire has two parts:

In the first part, the questionnaires helped to collect information about independent variables or factors such as demographic factors, according to Aghili et al. [9], (age), Gender [10], Nagaraj et al. (marital status). According to Jahan et al., (education level), Abraha et al. [10] (year of experience), and Girma, (monthly salary). Information associated personal factors such as, according to Nagaraj et al, (Body Mass Index (BMI)), Silva et al. [11] (smoking habit), Abraha et al. [10] (habit doing exercise), and Biadgo et al. [7], (medical history of MSDs). And information associated with job-related factors such as, according to Kebede and Tafese [6], (payment method), Biadgo et al. [7] (working hour), Tamene et al. (health and safety training). Mekonnen et al. (comfortable of the working environment). According to Nazerian et al, (fitness of sitting chairs with the working machine), and according to Girma, job satisfaction was assessed using the liker scale to identify the level of satisfaction on the work, the option was 5 Likert scales (very unsatisfied, dissatisfied, neutral, satisfied, and very satisfied), and the researcher was converted into one independent variable. These had been computed according to Macdonald's workplace job satisfaction scale.

In the second part, a questionnaire helped to collect information about the severity of musculoskeletal disorders in different body segments that are present while performing a task during the last 12 months. According to Kuorinka et al. [12], the Standardized Nordic musculoskeletal tool was not only developed for clinical diagnosis. According to Biadgo et al. [7], based on the severity of MSDs report from participants and taken as the dependent variables in nine body parts (neck, shoulder, upper back, elbows, wrist/hands, lower back, hip/thighs, knees, and ankle/feet). The results from these surveys determine the amount of severity of musculoskeletal disorders in operators' body segments, and using the analysis tool, determine the associated risk factors and the prevalence of MSDs that are present in the selected company.

Reliability test: The reliability of the Standard Nordic MSDs questionnaire and strain index was pre-tested among 20 (11%), selected operators from participants were tested using Cronbach's alpha =0.710 and 0.762, respectively, and the reliability of this instrument was supposed to be tolerable. The 9th item job satisfaction scale questionnaire was also checked for reliability and a Cronbach's Alpha of 0.796 was found. The goodness of the model fitness has been checked using the Hosmer-Lemeshow goodness of test which showed x^2=6.394 with df=8 and significant of =0.603. the Hosmer-Lemeshow test should be insignificant as the p-value at 0.05 indicates that the variable entered fits the model.

Data analysis

The demographic features, personal factors, job-related factors, and SI score linked with MSDs of the study population were reported as a number, percentages, and frequency using the IBM SPSS version 26 software program for descriptive analysis.

The connection between musculoskeletal symptoms and independent variables for each body part was investigated using bivariate and multivariant logistic regression analysis. To assess the effective variables of MSDs disorders, nine distinct regression models were created for nine different body areas. The association between the dependent and independent variables was examined by bivariant logistic regression analysis. The Odds Ratios (ORs), p-value, and 95% Confidence Intervals (CIs) were calculated from bivariant logistic regression models. The statistically significant level, $p<0.05$ was considered for all statistical tests.

A Chi-square test was used for testing the hypothesis to identify the significant factors for the MSDs among the operators [13]. The data was then displayed in a variety of statistical tools. As a result, all of the data contribute to the completion of the study and the precise determination of the workstation's evaluation.

Table 1: Demographic and personal factors of participants in Desta garment Addis Ababa, Ethiopia, April 2021.

Categories of variables	Frequency (n=179)	Percent (%)
Age		
Valid 19-60	179	100
Gender		
Male	11	6.1
Female	168	93.9
Marital status?		
Single	122	68.2
Married	57	31.8
Educational level?		
Unable to read and write	4	2.2
Primary school completed (1-8)	32	17.9
Secondary school complete (9-12)	118	65.9
Secondary school complete (9-12)	25	14
Years of experience		
≤ 5	96	53.6
6 up to 10	74	41.3
≥ 10	9	5
Monthly salary		
Up to 1500 birr	88	49.2
above 1500	91	50.8
Body Mass Index		
Underweight (≤ 18.5)	54	30.2
Normal range (18.5–24.99)	111	62
Overweight (25.0–29.99)	12	6.7
Obese (≥ 30.0)	2	1.1
Smoking habit		
no	179	100
The habit of doing physical exercise		
yes	53	29.6
no	126	70.4
Medical history of MSDs in the last 12 months		
yes	52	29.1
No	127	70.9

Job-related factors associated with work-related MSDs

Table 2: Job-related factors associated with work-related MSDs in Desta garment Addis Ababa, Ethiopia, April 2021.

Categories of variables	Frequency (n=179)	Percent (%)
Payment method		
payment per month	179	100
payment per production	0	0
Working hours per day		
Eight and below eight hours	179	100
Taking training for health and safety before?		
yes	72	40.2
no	107	59.8
Job satisfaction		
Very dissatisfied	31	17.3
Dissatisfied	49	27.4
Neutral	32	17.9
Satisfied	43	24
Very satisfied	24	13.4
Comfortable of the working environment		
Good	55	30.7
Bad	124	69.3
Fitness of sitting chair with the working machine		
Comfortable	24	13.4
Uncomfortable	155	86.6
If not fit, what do you think should be done?	Valid n=56	100
• The room temperature is hot	2	3.4
• The room temperature is hot and the sitting chair	16	28.8
• Not enough light in the room	3	5.4
• Sitting chair in uncomfortable	33	59
• Sitting chair uncomfortable and time break is not enough	2	3.4

Table 3: Strain index score in upper extremity body in Desta garment Addis Ababa, Ethiopia, April 2021 (n=115).

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Probably safe	4	3.5	3.5	3.5
	Uncertain	25	21.7	21.7	25.2
	Some risk	29	25.2	25.2	50.4
	Hazardous	57	49.6	49.6	100
	Total	115	100	100	

Result

Demographic and personal factors

Table 1 Shows demographic and personal factors of participants in Desta garment Addis Ababa, Ethiopia, April 2021.

Job-related factors associated with work-related MSDs

Table 2 shows sob-related factors associated with work-related MSDs in Desta garment Addis Ababa, Ethiopia, April 2021.

Risk level of distal upper extremity disorders among the operator's: Observational study has conducted on determining the risk level of upper distal extremity disorders among the operators (115), and the result shows that almost half of the operators (49.6%) were at a strain index score level of greater than 7, which indicated that they faced a high risk of upper distal extremity disorders, around 25.2% of operators were at a strain index score level of between 5 up 7, which indicated that those operators are faced some risk while doing their job, and also 21.7% of operators among them were at a strain index score level of between 3 to 5, that means those operators are faced uncertain risk level while doing their job, finally, the only consolation being that 3.5% of operators were at a probable safe risk level (SI ≤ 3) (Table 3).

Prevalence of work-related musculoskeletal disorders in different body: Participants or operators experienced aches, pains, discomforts, or numbness in a different section of the body in the previous 12 months (Table 4).

Causal relationship between WRMSDs symptoms and

Table 4: Prevalence of Musculoskeletal disorders or pains on different body segments among sewing operators (n=179) in Desta garment, Addis Ababa, 2021.

During the last 12 months such as ache, pain, discomforts, numbness in		Frequency	Percent
Neck	yes	136	76
	no	43	24
Shoulder	In the right shoulder	15	8.4
	In the left shoulder	13	7.3
	In both shoulder	65	36.3
	no	86	48
Elbow	In the right elbow	20	11.2
	In the left elbow	10	5.6
	In both elbow	52	29.1
	no	97	54.2
Wrist or hand	in the right wrist/hand	6	3.4
	in the left wrist/hand	14	7.8
	in both side	52	29.1
	no	107	59.8
Upper back	yes	167	93.3
	no	12	6.7
Lower back	yes	168	93.9
	no	11	6.1
In one or both hips, thighs, buttocks	yes	117	65.4
	no	62	34.6
In one or both knees	yes	59	33
	no	120	67
In one or both Ankles or feet	yes	66	36.9
	no	113	63.1

independent variables: During the last 12 months, the frequency of the prevalence of musculoskeletal disorders of the respondents, like pain or symptom in their body parts, such as in the neck (76%), shoulder (52%), elbow (45.8%), wrist and/hand (40.2%), upper back (93.3%), lower back (93.6%), one or both hip, thighs and buttock (65.4%), one or both knee (33%), and one or both ankle/feet (36.9%) were processed to regression analysis to determine the significant association between these pain or symptoms with independent variables as shown in Tables 5-7.

In bivariate logistic analysis, only p-values, less than 0.05 are considered significant factors for the severity of work-related MSDs, such as WRMSDs in the neck, as well as a correlation between independent variables. The prevalence of neck and ankle or feet symptoms was associated with operators, who had not a habit of doing physical exercise had a chance of more than 1.2% times and 3% times to develop WRMSDs in the neck and ankle/feet than operators, who had a habit of doing physical exercise {OR: 0.129, 95% CI: CI(0.017-0.990)}, and {OR: 0.036, 95% CI: CI(0.007-0.646)} respectively. Workers who had not satisfied with their job had more chances to develop WRMSDs in the neck than operators who satisfy with their work. And the operators, when performing their job, the score of SI was in hazardous were a chance to develop WRMSD in the neck than others with an odds ratio =0.004 (95% CI, 0.003-0.257) (Table 5).

The survey comprised a total of 193 garment workers, with a complete response rate of 176 (92.74%) among all respondents. All participants were over the age of 18, with 168 (93.9%) of them being female and 122 (68.2%) being single. Only 4% of the workforce were unable to read or write, with the majority (65.9%) having completed high school. According to the respondents' job experience, 96 (53.6%) had served for less than or equal to 5 years, while 74 (41.3%) had worked for 6 to 10 years. In terms of monthly compensation, 88 (49.2%) of the workers earned up to 1500 ETB per month, while 50.8 percent earned more than 1500 ETB per month. According to WHO categorization, 111 (62%) workers have a normal Body Mass Index (BMI) (18.5 kg/m^2 to 24.9 kg/m^2), whereas 2 (1.1%) have an obese BMI (18.5 kg/m^2 to 24.9 kg/m^2). Almost all of the employees (100 percent) do not smoke. Only 53 (29.6%) of workers engage in regular physical activity. In the previous 12 months, 52 (29.1%) of them have had a medical history of MSDs (Table 1).

After bivariate logistic regression was done for each body part, the multivariate analysis was done by considering conceptual framework (Figure 2), and to avoid an excessive number of variables and unstable

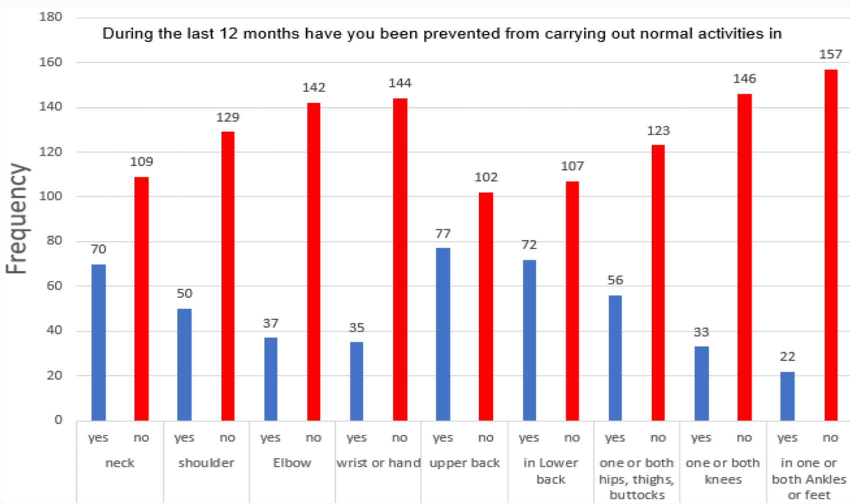

Figure 2: Prevalence of MSDs that prevented from carrying out normal activities.

Table 5: Bivariate logistic regression analysis of factors associated with neck, shoulder, and elbow symptoms or pain (n=179).

	WRMSDs in the Neck (Yes=136, No=43)				WRMSDs in the Shoulder (Yes=93, No=86)				WRMSDs in the Elbow (Yes=82, No=97)			
			95% CI for EXP(B)				95% CI for EXP(B)				95% CI for EXP(B)	
Variables	Sig.	Exp (B)	Lower	Upper	Sig.	Exp (B)	Lower	Upper	Sig.	Exp (B)	Lower	Upper
Gender Female (2)	0.548	0.299	0.006	15.477	0.321	1.519	0.322	2.433	0.748	0.092	0.003	1.717
Marital status? Married (2)	0.112	4.78	0.695	32.866	0.355	1.12	0.003	1.454	0.537	0.927	0.554	2.104
Educational level?	0.058	13.725			0.032				0.634			
Basic Edu. (1)	0.05		0.993	18.856	0.032	5.472	0.04	10.443	0.748	0.123	0.103	3.846
Grade 1-8 (2)	0.167	5.293	0.498	56.287	0.76	1.296	0.003	2.343	0.243	0.491	0.034	1.554
Grade 9-12 (3)	0.692	0.626	0.062	6.33	0.54	1.099	0.03	2.342	0.816	1.246	0.048	4.708
Years of experience	0.93				0.043				0.0263			
≤ 5 (1)	0.999				0.069	1.208	0.034	2.871	0.067	1.19	0.032	1.873
6–10 (2)	0.999				0.043	3.202	0.056	6.982	0.043	2.32	0.009	4.135
Monthly salary Up to 1500 ETB (1)	0.073	17.846	0.766	415.928	0.988	1.604	0.023	2.34	0.92	0.984	0.039	1.212
Body Mass Index	0.99				0.76				0.902			
BMI ≤ 18 (1)	1	0	0		0.65	1.045	0.003	2.321	0.99	0.904	0.86	5.116
BMI 18.5-24.9 (2)	1	0	0		0.877	1.006	0.087	2.13	0.96	0.449	0.139	3.151
BMI 25-29.9 (3)	1	0	0		0.88	1.601	0.047	1.92	0.746	1.224	0.021	2.121
A habit of doing physical exercise No (2)	0.039	0.129	0.017	0.99	0.49	1.739	0.034	1.822	0.405	0.219	0.073	6.221
medical history of MSDs yes (1)	0.73	0.64	0.051	8.074	0.988	1.348	0.023	1.243	0.655	0.007	0.163	1.029
Working hours >8 (1)	0.31	5.11	0.219	119.124	0.999	1.289	0.032	1.231	0.708	0.072	0.0076	1.009
taking training for health and safety before? No (2)	0.513	1.447	0.478	4.378	0.789	1.763	0.021	1.233	0.553	0.024	0.092	1.023
Job satisfaction	0.049				0.045				0.032			
Very dissatisfied (1)	0.004	0.005	0.005	0.064	0.043	6.313	1.092	12.022	0.043	6.313	0.092	12.022
Dissatisfied (2)	0.004	0.004	0.003	0.077	0.044	4.517	0.021	8.302	0.044	3.517	0.041	6.302
Neutral (3)	0.515	0.074	0	186.415	0.988	1.973	0.223	2.002	0.988	1.973	0.223	2.002
Satisfied (4)	0.069	0.063	0.003	1.244	0.99	2.035	0.021	3.001	0.99	2.035	0.021	3.001
Comfortable of the working environment Bad (2)	0.898	1.195	0.078	18.269	0.047	5.826	0.62	10.009	0.051	6.826	0.62	12.009
Fitness of sitting chair with the working m/c Uncomfortable (2)	0.182	0.221	0.024	2.025	0.88	1.104	0.028	1.982	0.88	1.104	0.028	1.982
Strain Index Score	0.079				0.099				0.032			
Strain Index Score (2)	0.701	2.584	0.02	326.846	0.082	1.114	0.023	1.2345	0.158	1.88	0.021	1.211
Strain Index Score (3)	0.304	0.169	0.006	5.037	0.649	1.883	0.321	2.122	0.065	4.057	0.087	8.981
Strain Index Score (4)	0.01	0.004	0.003	0.257	0.67	1.931	0.031	2.021	0.023	2.021	0.021	7.201

NB: Statistically significant values are shown in bold
Exp(B) = Odd ratio
Numbers in bracket indicate data codding when analyzing through the SPSS tool

estimation in the final model, only variables with a p-value <, =0.03, in the bivariant analysis, were taken into the multivariant analysis.

The multivariable logistic regression also yielded that the operators who develop work-related MSDs in different parts of their body and determine their strong significance association with factors using p-value and adjusted ratio (Exp(B)) with Confidence Interval (CI) of 95% to determine the strength of associations.

Discussion

The most important finding of this paper was that more than 90% of operators experienced WRMSDs in their upper and lower backs, and the suitability of a sewing section or sitting chair and a comfortable working environment were strongly significant for the severity of WRMSDs [14-20].

Multivariant logistic regression models indicated a significant relationship between variables, such as demographic factors (gender, education level, worked experience in Desta garment), personal factors (medical history in the last 12 months related with WRMSDs), job-related factors (job satisfaction, comfortable of the working environment and suitability sitting chair with the sewing workstation), and strain index score with the severity of the musculoskeletal disorders among nine different body of the operators [21-26]. Dianat et al. stated that gender was a significant factor for upper back symptoms with an odds ratio of 10.9 for males in comparison with females. Whereas the present study reveals that gender and working experience were significantly associated with upper back work-related MSDs or symptoms with an odds ratio of 2.0 to 3.0. In the present study job satisfaction, the fitness of the sitting chair with the sewing workstation, and comfortable of the environment had a significant relationship with musculoskeletal disorders in the lower back. Çivitci et al. studied those female

Table 6: Bivariate logistic regression analysis of factors associated with wrist/hand, upper back, and lower back symptoms or pain (n=179).

	WRMSDs in the Wrist/hand (Yes=72, No=107)				WRMSDs in the Upper back (Yes=167, No=12)				WRMSDs in the Lower back (Yes=168, No=11)			
			95% CI for EXP(B)				95% CI for EXP(B)				95% CI for EXP(B)	
Variables	Sig.	Exp(B)	Lower	Upper	Sig.	Exp(B)	Lower	Upper	Sig.	Exp(B)	Lower	Upper
Gender												
Female (2)	0.072	0.777	0.103	1.846	0.028	4.097	0.203	8.346	0.068	1.077	0.08	2.126
Marital status?												
Married (2)	0.21	0.02	0.034	1.554	0.048	1.938	0.652	3.145	0.082	1.338	0.572	2.532
Educational level?	0.709				0.042	1.011			0.077			
Basic Edu. (1)	0.302	0.28	0.009	1.135	0.022	1.128	0.054	2.135	0.072	1.338	0.028	2.311
Grade 1-8 (2)	0.352	0.956	0.039	1.212	0.153	0.172	0.089	1.932	0.101	1.172	0.089	2.132
Grade 9-12 (3)	0.998	0.433	0.048	1.708	0.964	1.043	0.248	1.882	0.964	1.043	0.248	2.082
Years of experience	0.023				0.015				0.021			
≤ 5 (1)	0.321	1.519	0.86	1.171	0.069	1.544	0.14	3.851	0.089	1.544	0.614	2.051
6–10 (2)	0.041	3.519	0.86	7.171	0.025	2.05	0.321	4.121	0.021	6.05	0.321	12.231
Monthly salary Up to 1500 ETB (1)	0.355	1.12	0.04	1.451	0.114	1.109	0.323	2.0637	0.214	1.109	0.323	2.137
Body Mass Index	0.032				0.013				0.513			
BMI ≤ 18 (1)	0.542	7.472	0.323	14.637	0.043	3.384	0.342	6.102	0.513	1.384	0.342	3.102
BMI 18.5-24.9 (2)	0.76	1.296	0.322	4.4222	0.065	1.105	0.324	2.543	0.085	1.105	0.724	2.203
BMI 25-29.9 (3)	1.54	1.099	0.342	3.102	0.076	2.041	0.321	2.111	0.066	2.041	0.621	2.092
A habit of doing physical exercise No (2)	0.049	3.208	0.324	6.133	0.504	1.201	0.453	2.12	0.304	`1.201	0.653	2.901
Medical history of MSDs yes (1)	0.988	1.604	0.321	2.301	0.017	6.124	0.232	12.231	0.017	3.124	0.272	6.731
Working hours	0.76	1.221	0.231	2.12	0.504	1.81	0.387	2.091	0.189	1.81	0.387	2.191
Taking training for health and safety before? No (2)	0.65	1.045	0.032	1.231	0.51	1.183	0.193	2.211	0.151	1.183	0.393	2.481
Job satisfaction	0.028				0.036				0.016			
Very dissatisfied (1)	0.048	7.601	0.023	13.211	0.036	4.891	0.231	8.241	0.016	7.891	0.631	14.721
Dissatisfied (2)	0.062	3.739	0.231	6.214	0.061	1.466	0.81	2.0325	0.074	1.466	0.581	2.125
Neutral (3)	0.988	1.348	0.212	2.121	0.08	1.47	0.232	4.567	0.072	1.47	0.632	3.567
Satisfied (4)	0.999	1.289	0.211	2.325	0.254	1.83	0.543	2.301	0.154	2.183	0.043	5.301
Comfortable of the working environment Bad (2)	0.037	1.201	0.321	2.567	0.019	3.342	0.721	7.091	0.029	6.342	0.421	13.023
Fitness of sitting chair with the working m/c Uncomfortable 2)	0.035	4.61	0.543	8.301	0.013	5.729	0.21	11.092				
Strain Index Score	0.015				0.093				0.083			
Strain Index Score (2)	0.065	1.032	0.021	2.092	0.775	1.008	0.201	2.1202	0.085	1.008	0.701	2.821
Strain Index Score (3)	0.014	2.727	0.34	4.982	0.762	1.601	0.52	1.99	0.526	1.601	0.052	2.811
Strain Index Score (4)	0.02	3.995	0.201	7.122	0.713	1.175	0.91	2.091	0.037	2.025	0.231	4.021

NB: Statistically significant values are shown in bold
Exp(B) = Odd ratio
Numbers in bracket indicate data codding when analyzing through the SPSS tool

operators were found 50% to 50% develop MSDs in the upper back than males. Whereas this study reveals that female sewing operators had 2 times more chance to develop WRMSDs in the upper back with an odd of 2.021 (95% CI 0.043-4.986) (Table 8) [27-32]. According to Mekonnen et al., work experience, working posture, prolonged sitting were significant factors for the prevalence of WRMSDs in the neck and shoulder in Ethiopia. But in this study the education level of sewing operators had been significantly associated, operator who had completed basic education had a chance to develop WRMSDs in shoulders than other operators who learned above primary education within an odds ratio of 1.128, {95% CI, (0.054-2.135)}. Workers who had not a habit of doing physical exercise had 12% times of chances to develop WRMSDs in the neck than operators who had a habit of doing exercise {OR=0.120, 95% CI: (0.015-0.982)}.

According to Wang et al., confirmed that during the last 12 months medical history was a significant factor in developing WRMSDs in the shoulder. But in this study, a medical history related to MSDs in the last 12 months was linked to musculoskeletal disorders in the upper back. Operators who had a medical history during the last 12 months had a 5%-time chance to develop WRMSDs in the upper back than operators who had not a medical history with an odds ratio of 0.059 {95% CI, 0.005-0.687}. In the present study, from a job satisfaction survey, operators who didn't believe that their working activity is not good for their physical healthy (63.1%), and around 74.8% of them were had not felt their job was not good. So, operators who had not satisfied with their job had 3 times more likely a chance to develop the work-related musculoskeletal disorder in the lower back with an odds ratio of 3.451 {95% CI, 0.021-6.221} [33-40].

Table 7: Bivariate logistic regression analysis of factors associated with one or both hip, thigh, and buttocks, one or both knees, and one or both Ankle/feet symptoms or pain (n=179).

	WRMSDs in one or both Hip, thigh, and buttocks (Yes=72, No=107)				WRMSDs in one or both knees (Yes=59, No=120)				WRMSDs in one or both Ankle/feet (Yes=66, No=113)			
			95% CI for EXP(B)				95% CI for EXP(B)				95% CI for EXP(B)	
Variables	Sig.	Exp(B)	Lower	Upper	Sig.	Exp(B)	Lower	Upper	Sig.	Exp(B)	Lower	Upper
Gender												
Female (2)	0.11	1.057	0.002	1.906	0.999	0	0		0.385	4.417	0.155	126.189
Marital status?												
Married (2)	0.121	1.054	0.022	2.273	0.112	3.076	0.769	12.306	0.615	1.497	0.311	7.208
Educational level?	0.679				0.805				0.92			
Basic Edu. (1)	0.848	0.686	0.015	3.383	0.999				0.999	0	0	
Grade 1-8 (2)	0.64	2.396	0.067	5.269	0.42	2.3	0.303	17.441	0.518	2.425	0.166	35.482
Grade 9-12 (3)	0.629	1.636	0.222	2.08	0.915	1.098	0.199	6.07	0.829	1.303	0.117	14.518
Years of experience	0.05				0.988				0.491			
≤ 5 (1)	0.125	1.755	0.344	2.118	0.999	0	0		0.415	4.733	0.113	198.459
6–10(2)	0.046	4.772	0.076	8.48	0.999	0	0		0.249	9.119	0.213	389.778
Monthly salary Up to 1500 ETB (1)	0.196	1.466	0.381	2.643	0.173	4.316	0.528	35.29	0.067	21.568	1.733	268.455
Body Mass Index	0.1				0.794				0.068			
BMI ≤ 18 (1)	1				1	0	0		1	0	0	
BMI 18.5-24.9 (2)	0.999				1	0	0		1	0	0	
BMI 25-29.9 (3)	1				1	0	0		1	0	0	
A habit of doing physical exercise No (2)	0.683	2.663	0.092	4.771	0.652	0.684	0.131	3.563	0.024	0.036	0.002	0.646
Medical history of MSDs yes (1)	0.241	0.295	0.038	2.271	0.049	0.416	0.069	2.509	0.241	0.273	0.031	2.389
Working hours	0.915	1.16	0.075	2.288	0.178	0.163	0.012	2.285	0.344	0.193	0.006	5.809
Taking training for health and safety before? No (2)	0.978	1.016	0.334	3.086	0.399	1.489	0.59	3.759	0.106	9.105	0.627	132.143
Job satisfaction	0.153				0.898				0.244			
Very dissatisfied (1)	0.129	2.007	0.534	4.354	0.999	0	0		0.907	0.71	0.002	223.288
Dissatisfied (2)	0.064	0.002	0	1.442	0.999	0	0		0.328	0.049	0	20.64
Neutral (3)	0.792	0.329	0.086	1.118	0.999	0	0		0.965	1.166	0.001	1183.907
Satisfied (4)	0.162	0.089	0.003	1636	0.343	3.774	0.242	58.827	0.176	0.142	0.008	2.408
Comfortable of the working environment Bad (2)	0.045	1.159	0.017	2.471	0.205	4.114	0.462	36.655	0.005	0.022	0.002	0.308
Fitness of sitting chair with the working m/c Uncomfortable (2)	0.021	1.034	0.174	2.235	0.025	2.04	0.408	10.2	0.044	8.441	0.965	73.822
Strain Index Score	0.245				0.794				0.787			
Strain Index Score (2)	0.756	2.035	0.023	4.138	0.937	0.874	0.031	24.772	0.999	0	0	
Strain Index Score (3)	0.06	1.116	0.871	2.618	0.319	0.269	0.02	3.559	0.342	3.772	0.243	58.423
Strain Index Score (4)	0.242	2.045	0.25	8.14	0.999	0	0		0.64	0.289	0.002	52.967

NB: Statistically significant values are shown in bold.
Exp(B) = Odd ratio
Numbers in bracket indicate data codding when analyzing through the SPSS tool

According to Dianat et al., sewing operators working posture was a vital factor for developing a musculoskeletal disorder in the upper and low back. But in this study comfortable of the working environment was significantly associated with developing WRMSDs in the low back. And operators who had worked in uncomfortable working environments had 2 times a chance to develop musculoskeletal disorders in the low back with an odds ratio of 2.102 {95% CI, 0.121-4.053}. Ali et al. indicate that there is a considerable mismatch between the garment furniture, such as sitting chair and anthropometric characteristics of workers, In the present study operators (n=179), around 86.6% reported the fitness of the sitting chair with sewing workstation were most significantly associated with the prevalence of MSDs in the different body parts [41-44].

In this paper, multivariant logistic regression revealed that the suitability of the sitting chair with the sewing workstation was more significantly associated with five different operators' bodies. Operators who worked in an unfitted sitting chair with a sewing workstation were six times more likely than those who worked in a fitted sewing section to acquire WRMSDs in the upper back with an odds ratio of 6.729 {95% CI, (0.654-12.032)}. And also, at the same time operators had a chance more than 3 times to develop WRMSDs in the low back with an odds ratio of 3.209 {95% CI, (0.927-6.565)}.

Operators who worked in this workstation had a chance more than 2 times to develop WRMSDs in the hip, thigh/ buttock, and wrist or hand, with odds ratios of 2.021, 95% CI: CI(0.289-4.230) and 2.210,

Table 8: Multivariate logistic regression analysis of most factors associated with the prevalence of MSDs in different Nine bodies (n=179).

	WRMSDs in the Neck (Yes=136, No=43)				**WRMSDs in the Shoulder (Yes=93, No=86)**				**WRMSDs in the Elbow (Yes=82, No=97)**			
			95% C.I. for EXP (B)				95% C.I. for EXP (B)				95% C.I. for EXP (B)	
Variables	Sig.	Exp (B)	Lower	Upper	Sig.	Exp (B)	Lower	Upper	Sig.	Exp (B)	Lower	Upper
A habit of doing physical exercise No (2)	0.048	0.12	0.015	0.982								
Educational level?					0.013							
Basic Edu. (1)					0.012	1.128	0.054	2.135				
Strain Index Score	0.015								0.083			
Strain Index Score (2)												
Strain Index Score (3)												
Strain Index Score (4)	0.016	0.319	0.926	7.28					0.024	3.024	0..452	6.127
	WRMSDs in the Wrist/hand (Yes=72, No=107)				**WRMSDs in the Upper back (Yes=167, No=12)**				**WRMSDs in the Lower back (Yes=168, No=11)**			
			95% C.I. for EXP (B)				95% C.I. for EXP (B)				95% C.I. for EXP (B)	
	Sig.	Exp (B)	Lower	Upper	Sig.	Exp(B)	Lower	Upper	Sig.	Exp (B)	Lower	Upper
Gender Female (2)					0.021	2.021	0.043	4.986				
6 – 10 years of work (2)					0.021	3.05	0.711	6.021				
medical history of MSDs yes (1)					0.024	0.059	0.005	0.687				
Job satisfaction					0.036				0.016			
Very dissatisfied (1)									0.023	3.451	0.021	6.221
Comfortable of the working environment Bad (2)									0.027	2.102	0.121	4.053
Fitness of sitting chair with working m/c Uncomfortable (2)	0.0153	2.21	0.621	4.901	0.012	6.729	0.654	12.032	0.022	3.209	0.927	6.565
Strain Index Score	0.015											
Strain Index Score (2)	0.065	1.032	0.021	2.092								
Strain Index Score (3)	0.021	2.012	0.321	4.762								
Strain Index Score (4)	0.018	2.321	0.311	4.092								
	WRMSDs in one or both Hip, thigh, and buttocks (Yes=72, No=107)				**WRMSDs in one or both knees (Yes=59, No=120)**				**WRMSDs in one or both Ankle/ feet (Yes=66, No=113)**			
			95% C.I. for EXP(B)				95% C.I. for EXP(B)				95% C.I. for EXP (B)	
	Sig.	Exp(B)	Lower	Upper	Sig.	Exp (B)	Lower	Upper	Sig.	Exp (B)	Lower	Upper
A habit of doing												
physical exercise No (2)									0.025	0.037	0.002	0.662
Comfortable of the working environment Bad (2)									0.005	0.022	0.012	0.312
Fitness of sitting chair with working m/c Uncomfortable (2)	0.027	2.021	0.289	4.23	0.021	3.271	0.541	19.545				

NB: All variables included in this table are statistically significant
Exp(B) = Odd ratio
Numbers in bracket indicate data codding when analyzing through the SPSS tool

95% CI: CI(0.689-4.230) respectively.

In the current study, the prevalence of work-related MSDs in the knee, ankle, and foot was significantly associated with operators who had a medical history in the previous 12 months were 3 times more likely to develop MSD in the knees, ankles, and foot than operators who did not have a medical history, with an odds ratio of 3.271, 95% CI: (0.541-2.509). Workers who did not engage in regular physical activity were more than 2.5 times as likely to develop MSDs in one or both ankles/feet than those who did. (OR=0.037, 95% CI: (0.002-0.312. Operators who worked in an unpleasant environment were 2.2 times more likely than those who worked in a pleasant environment to develop MSDs in one or both ankles/feet (OR=0.022, 95% CI: (0.002-0.312). According to Nagaraj et al., the high frequency of repetitive action, less porosity, and uncomfortable hand posture of sitting sewing operations put roughly 60% of operators at risk of upper extremity musculoskeletal disorders. In this study, the researchers observed the level of risk in the upper extremity body and found that roughly 57% of those were in danger and 29% were at risk, indicating that more ergonomics development is needed to lower the risk of upper extremity disorders.

Strain index scores were found to be strongly linked with the prevalence of WRMSDs in the elbow and hand by Nagaraj et al. operators with a strain index score of 3-5 (uncertain), 5-7 (some risk), and greater than 7 (hazardous) were more likely to develop WRMSDs in their wrist or hand in this study, with odds of 1.032 95% CI: (0.021-2.092), 2.012 95% CI: (0.321-4.762), and 2.321 95% CI: (0.311-4.092), respectively. And operators who score SI greater than 7 had more than 31% times more likely to develop WRMSDs in the neck than others {OR=0.319, 95% CI: (0.926-7.280)}. Age, monthly salary, smoking habits, payment methods, and working hours were not found to be significant factors for the prevalence of MSDs in any of the operator's body parts in this study.

Generally, in this paper, the highest occurrence rate for the prevalence of WRMSDs was found in the lower back (93.9%), upper back (93.3%), neck (76%), and hip/thigh/ buttocks (65.4%). The compatibility of a sitting chair with a sewing workstation, as well as the comfort of the working environment, were found to be the most significant factors in the prevalence of work-related MSDs.

Conclusion

From nine body regions lower back (93.9%), upper back (93.3%), neck (76%), and hip/thigh/buttocks (65.4%) were the body parts that developed work-related MSDs among workers in the sewing section. The occurrence of musculoskeletal disorders was significantly associated with the suitability of the sitting chair within the sewing workstation, comfortable of the working environment, job satisfaction, gender, strain index score, a habit of doing physical exercise, working experience, and medical history in the last 12. With a high odds ratio, the suitability of a sitting chair within a sewing workstation and a comfortable working environment was a significantly linked factor to the occurrence of work-related MSDs in the low back (93.9%) and upper back (93.3%) body parts.

Recommendation

Based on the findings in this paper, there is recommendations to the garment sector and the Bureau of Labor and Social Affairs (BOLSA) to focus on maintaining workers' safety and health for increasing productivity of the product and becoming profitable.

To improve productivity and profitability in the garment industry, top management should examine ergonomics issues and correctly apply ergonomics in workstations on a large scale. In the garment sector, the workstation should be assessed regularly to improve the working environment, and firm owners should also provide a good working environment for their employees by addressing their demands, such as honoring a top performer.

Future Work

It may be necessary to improve ergonomically the sewing section workstation, as well as to broaden the scope of the study in order to obtain a result that reflects the rest of the Ethiopian garment companies.

References

1. Moore SM, Torma-Krajewski J, Steiner LJ. Practical demonstrations of ergonomic principles. Rep Invest. 2011:1-66.
2. Goggins RW, Spielholz P, Nothstein GL. Estimating the effectiveness of ergonomics interventions through case studies: Implications for predictive cost-benefit analysis. J Safety Res. 2008;39(3):339-44.
3. Mahone. Ergonomics in the textile and apparel industries. Can Insurance Companies. Chicago. 1997.
4. Rebola CB. Synthesis lectures on assistive, rehabilitative, and health-preserving technologies. Designed Technologies for Healthy Aging. 2015;4:1-186.
5. Ahmad SA, Sayed M, Khan MH, Faruquee M, Yasmin N, Hossain Z, et al. Musculoskeletal disorders and ergonomic factors among the garment workers. J Prev Soc Med. 2007;26(2):97-110.
6. Deyyas WK, Tafese A. Environmental and organizational factors associated with elbow/forearm and hand/wrist disorder among sewing machine operators of garment industry in Ethiopia. J Environ Public Health. 2014;2014:732731.
7. Biadgo GH, Tsegay GS, Mohammednur SA, Gebremeskel BF. Burden of neck pain and associated factors among sewing machine operators of garment factories in Mekelle city, the northern part of Ethiopia, 2018, a cross-sectional study. Saf Health Work. 2021;12(1):51-6.
8. Agresti A, Coull BA. Approximate is better than "exact" for interval estimation of binomial proportions. Am Stat. 1998;52(2):119-26.
9. Aghili M, Asilian H, Poursafa P. Evaluation of musculoskeletal disorders in sewing machine operators of a shoe manufacturing factory in Iran. J Pak med assoc. 2012;62(3 Suppl 2):S20-5.
10. Abraha TH, Demoz AT, Moges HG, Ahmmed AN. Predictors of back disorder among Almeda textile factory workers, north Ethiopia. BMC Res Notes. 2018;11:1-7.
11. Silva JMND, Silva LBD, Gontijo LA. Relationship between psychosocial factors and musculoskeletal disorders in footwear industry workers. Prod. 2017;27.
12. Kuorinka I, Jonsson B, Kilbom A, Vinterberg H, Biering-Sørensen F, Andersson G, et al. Standardised Nordic questionnaires for the analysis of musculoskeletal symptoms. Appl Ergon. 1987;18(3):233-7.
13. Reddy O, Alemayehu EA. Ordinal logistic regression analysis to assess the factors that affect health status of students in ambo university: A case of natural and computational sciences college, ambo university. Int J Modern Chem Appl Sci. 2015;2:153-63.
14. Abraha TH, Demoz AT, Moges HG, Ahmmed AN. Predictors of back disorder among Almeda textile factory workers, north Ethiopia. BMC Res Notes. 2018;11(1):304.
15. Ahmed F. Ergonomic to design safe and comfortable work stations for garment workers: Bangladesh perspective. Welcome message from conference chairs. 2017;95.
16. Bagheri S, Ghaljahi M. Ergonomic evaluation of musculoskeletal disorders with rapid office strain assessment and its association with occupational burnout among computer users at Zabol University of medical sciences in 2017. Asian J Water Environ Pollut. 2019;16(1):91-6.
17. Briggs AM, Woolf AD, Dreinhöfer K, Homb N, Hoy DG, Kopansky-Giles D, et al. Reducing the global burden of musculoskeletal conditions. Bull World Health Organ. 2018;96(5):366-8.
18. Chan J, Janowitz I, Lashuay N, Stern A, Fong K, Harrison R. Preventing musculoskeletal disorders in garment workers: Preliminary results regarding ergonomics risk factors and proposed interventions among sewing machine operators in the San Francisco bay area. Appl Occup Environ Hyg. 2002;17(4):247-53.
19. Check J. An ergonomic analysis of the seat-sewing line at Company XYZ. 2010.
20. Chengalur SN, Bernard TE, Rodgers SH. Kodak's ergonomic design for people at work. Wiley. 2004.
21. Chengalur SN, Rodgers SH, Bernard T. Ergonomic design for people at work. Hoboken. Nj: John Wiley & Sons. Inc. 2004.
22. Garg A, Moore JS, Kapellusch JM. The revised strain index: An improved upper extremity exposure assessment model. Ergonomics. 2017;60(7):912-22.
23. Girma Z. Assessing the prevalence of work musculoskeletal disorders and associated factors among workers in selected garments in Addis Ababa, Ethiopia. Thesis report submitted to Addis Ababa University, college of health sciences, school of public health. 2016.
24. Glonek GF, Mccullagh P. Multivariate logistic models. J R Stat Soc Series B Stat Methodol. 1995;57(3):533-46.
25. Grandjean E, Vigliani E. Ergonomic aspects of visual display terminals:

Proceedings of the international workshop, Milan, March 1980. Taylor & Francis Inc. 1980.

26. Guide ASBS. Rapid upper limb assessment (RULA). 2013.

27. Gumbel EJ. Bivariate logistic distributions. J Am Stat Assoc. 1961;56(294):335-49.

28. Helander M. Anthropometry in workstation design. A guide to the ergonomics of manufacturing. Taylor & Francis, London. 2017;17-28.

29. Hignett S, Mcatamney L. Rapid Entire Body Assessment (REBA). Appl Ergon. 2000;31(2):201-5.

30. Kee D, Na S, Chung MK. Comparison of the Ovako working posture analysis system, rapid upper limb assessment, and rapid entire body assessment based on the maximum holding times. Int J Ind Ergon. 2020;77:102943.

31. Kilbom A. Assessment of physical exposure in relation to work-related musculoskeletal disorders-what information can be obtained from systematic observations. Scand J Work Environ Health. 1994;20:30-45.

32. Kim W, Lorenzini M, Balatti P, Nguyen PD, Pattacini U, Tikhanoff V, et al. Adaptable workstations for human-robot collaboration: A reconfigurable framework for improving worker ergonomics and productivity. IEEE Robot Autom Mag. 2019;26(3):14-26.

33. Kouchi M. Anthropometric methods for apparel design: Body measurement devices and techniques. Anthropometry, Apparel Sizing and Design. 2014;67-94.

34. Merisalu E, Mannaste M, Hiir K, Traumann A. Predictors and prevalence of musculoskeletal disorders among sewing machine operators. Agron Res. 2016;14(4):1417-26.

35. Milanese S, Grimmer K. School furniture and the user population: An anthropometric perspective. Ergonomics. 2004;47(4):416-26.

36. Mody GM, brooks PM. Improving musculoskeletal health: Global issues. Best Pract Res Clin Rheumatol. 2012;26(2):237-49.

37. Monnington S, Quarrie C, Pinder A, Morris L. Development of manual handling assessment charts (mac) for health and safety inspectors. Contemporary Ergonomics. 2003;3-8.

38. Saxena S. Labor, global supply chains and the garment industry in South Asia. Routledge. 2019.

39. Silverstein B, Viikari-Juntura E, Kalat J. Use of a prevention index to identify industries at high risk for work-related musculoskeletal disorders of the neck, back, and upper extremity in Washington state, 1990-1998. Am J Ind Med. 2002;41(3):149-69.

40. Sperandei S. Understanding logistic regression analysis. Biochem Med (Zagreb). 2014;24(1):12-8.

41. Tafese A, Nega A, Kifle M, Kebede W. Predictors of occupational exposure to neck and shoulder musculoskeletal disorders among sewing machine operators of garment industries in Ethiopia. Sci J Public Health. 2014;2(6):577-83.

42. Taifa IW, Desai DA. Anthropometric measurements for ergonomic design of students' furniture in India. Eng Sci Technol an Int J. 2017;20(1):232-9.

43. WHO. Global strategy on occupational health for all: the way to health at work, recommendation of the second meeting of the WHO collaborating centers in occupational health, 11-14 October 1994, Beijing, China. World Health Organization. 1995.

44. Yitayeh A, Mekonnen S, Fasika S, Gizachew M. Annual prevalence of self-reported work-related musculoskeletal disorders and associated factors among nurses working at Gondar town governmental health institutions, Northwest Ethiopia. Emerg Med (Los Angel). 2015;5(1):227.