

Field Study

Musculoskeletal symptoms among handicraft workers engaged in hand sewing tasks

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Abstract: Objectives: This study was conducted to determine the prevalence of musculoskeletal symptoms and associated risk factors among Iranian handicraft workers engaged in different hand sewing tasks. **Methods:** Data were collected using questionnaires (including the Nordic Musculoskeletal Questionnaire) as well as direct observations of posture (using the Rapid Upper Limb Assessment [RULA] method) from 632 workers including carpet handicraft workers ($n=222$), textiles handicraft workers ($n=209$), and leather handicraft workers ($n=201$) in Tabriz, Iran. **Results:** The response rate was 88.8%. The overall prevalence of musculoskeletal complaints, particularly in the neck (57.9%), lower back (51.6%), and shoulders (40.5%) was relatively high. The prevalence of neck and shoulder pain was higher among females and with increasing age. Working posture and fast working were associated with neck, shoulder, and lower back pain. Years worked as a sewing worker was associated with neck and lower back pain. Long duration of continuous sitting work (>2 h) without a break was associated with neck pain. Body mass index, marital status, sport/physical activity, smoking, daily working hours, job satisfaction, and perceived pressure due to work had no effect. **Conclusions:** The findings indicate a high prevalence of musculoskeletal pain among the studied handicraft workers and emphasize the importance of individual, physical, and psychosocial aspects of hand sewing tasks in this regard.

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1. Introduction

Musculoskeletal disorders (MSDs) are a common cause of reduced quality of life, increased sick leave, and work disability in both industrialized and industrially developing countries¹⁻⁴. The risk and protective factors of these pains among different occupational groups, particularly in those involved in sedentary and repetitive activities, can be divided into physical, psychosocial, organizational, and socio-demographic factors^{1,5-9}.

Workers involved in hand sewing tasks may experience a high prevalence of MSDs, which may be attributable to repetitive hand and arm movements and to poor working postures that have to be maintained over long periods^{4,10}. These tasks are often highly repetitive, involving the coordination of hands and vision, and are usually done in a sitting posture for a long time during work. The operation usually requires the worker to adopt a forward inclined head and trunk posture for better viewing of the sewing point. Such a condition can impose an excessive physical load on the musculoskeletal system, and may eventually lead to the development of MSDs among these working groups. Therefore, to reduce musculoskeletal pain, there is a need to improve the understanding of the potential factors associated with such complaints among this working population.

Several previous studies have assessed MSDs among workers involved in sewing operations, like garment sewing machine operators^{9,11-14}, shoe sewing machine operators¹⁵, and hand-woven carpet weavers^{10,16}. However, a review of the literature shows that there is limited research on the occurrence of musculoskeletal symptoms and their contributing risk factors among handicraft workers, particularly those engaged in hand sewing tasks. The handicraft industry is one of the most important parts of the economy of many countries, including Iran. According to the statistics released by Iran's Cultural Heritage, Hand-

crafts, and Tourism Organization, there are nearly 300 different handicraft jobs in Iran, which employ approximately 2 million workers in this country. Typical examples of the occupational group engaged in hand sewing tasks are handicraft carpet (e.g., tapestry-woven carpet, rug, or kilim) workers, textile handicraft (e.g., needlework, embroidery) workers, and leather handicraft (e.g., bag, wallet, and shoe) workers. Further research in this area will help to better understand the nature of those occupations involving hand sewing operation and to develop corrective measures and intervention strategies for this population. It also contributes more evidence to the debate and has the potential to inform work practices in other developing societies with similar occupational groups.

The present study was, therefore, conducted to determine the occurrence of musculoskeletal symptoms and their contributing sociodemographic and work-related (psychosocial and physical) risk factors among handicraft workers involved in hand sewing activities, including carpets handicraft workers, textiles handicraft workers, and leather handicraft workers.

2. Materials and Methods

2.1. Study design

This descriptive study was performed in Tabriz, the capital of the East Azerbaijan Province of Northwest Iran.

2.2. Study population and sample

The study population consisted of those handicraft workers engaged in different hand sewing activities in the study area. These included carpet handicraft workers, textiles handicraft workers, and leather handicraft workers. Data on the number of workers and active workshops in the study region was obtained from the Iranian Ministry of Industries and Mines. There are about 14,000 carpet handicraft workers, 1,500 textiles handicraft workers, and 6,000 leather handicraft workers in the study area, who worked at approximately 1,800, 190, and 370 different workshops, respectively. Those workers who were ≥ 18 years old and had worked at least for one year in their current job were considered as the target population for the study. Sampling was done using a multi-stage random selection process. In the first stage, the required numbers of workshops, which included 60 workshops from each of the three different occupational groups, were selected randomly using a probability proportion to size sampling method. Using the same procedure, participants were then selected from these workshops. Basic information regarding the prevalence of musculoskeletal symptoms among handicraft workers engaged in hand sewing tasks was obtained from 40 participants to determine a proportion for a sampling calculation. Considering a confidence level of 95%, 80% power, and 2-tailed tests, the minimum sample

size required was determined as 316 by G-Power software, which was multiplied by 2 ($n=632$) using a design effect of 2 for cluster sampling, following the recommendations in the literature¹⁷⁾.

2.3. Study procedure and measurements

The data were collected using questionnaires as well as direct observation of the participants during their work. The questionnaire, administered by interviewing the participants, was composed of items on sociodemographic characteristics, work-related psychosocial and physical risk factors, and musculoskeletal pain in the last month. Working postures were assessed through direct observation of the participants' postures at their workstations by the Rapid Upper Limb Assessment (RULA) checklist¹⁸⁾.

2.4. Outcome measurements

The questions on musculoskeletal symptoms were adapted from the modified standardized Nordic Musculoskeletal Questionnaire¹⁹⁾, which has been translated and revised into Farsi and has an established reliability and validity²⁰⁻²²⁾. The prevalence of musculoskeletal symptoms was defined as any pain or discomfort from the nine body areas (neck, shoulders, upper back, lower back, elbows, wrists/hands, hips/thighs/buttocks, knees, and ankles/feet) lasting for more than one day during the previous month. The location of these anatomic areas was also demonstrated by a drawing in the questionnaire. The response alternatives were: No/Yes. Those participants who reported pain in any of these body areas were asked to rate its severity using a scale of 1 as very low pain to 5 as very high pain. Disruption of normal activities due to musculoskeletal symptoms (No/Yes) was also included.

The sociodemographic details included gender, age, weight, height, body mass index (BMI, weight/height^2), educational level (Illiterate, Primary school, Secondary school, and Diploma), and marital status (Single, Married), as well as individual habits such as being involved in regular sport and physical activities each week (for at least 30 min) (No/Yes) and smoking habits (No/Yes).

The questions regarding the work-related psychosocial and physical factors were based on prior knowledge and a literature review^{4,11-13)} and included daily working hours, years worked as a handicraft worker, having a second job (No/Yes), fast working (No/Yes), duration of continuous sitting work without a break (breaks >10 min), perceived pressure due to work (No/Yes), and job satisfaction (Low, Moderate, High). The questionnaire was tested on a sample of 65 participants in order to obtain feedback on the content, clarity, and wording of the items of the questionnaire. The test-retest reliability (stability) of the questionnaire items using Kappa coefficients ranged from 0.80 to 0.98, which indicates a good reliability of the measure.

The Rapid Upper Limb Assessment (RULA)¹⁸⁾ was used to assess the working postures of handicraft workers

at their workstations. The RULA is a reliable and validated observational method for assessing biomechanical postural loading on the musculoskeletal system that can contribute to MSDs. This method gives a score for each body part, where combinations of individual scores for upper arm, lower arm, and wrist are called score "A," those for neck, trunk, and leg give score "B," and the final score is called the "grand score," which indicates the musculoskeletal loading associated with the worker's posture. The original version of the RULA checklist has been translated and revised into Farsi and has been shown to be valid and reliable⁴. The observations and recordings of working postures were performed by two trained observers. The inter-rater reliability of the RULA scores using Kappa coefficients was found to be high (Kappa coefficients ranged from 0.82 to 0.99).

2.5. Statistical analysis

The analysis of the data was performed using SPSS software (version 17.0; SPSS, Chicago, IL, USA). Sociodemographic data and work-related characteristics of the study participants were tabulated. The chi-squared test, t-test, and ANOVA analyses were used to examine the differences between genders and occupations. The three body regions of neck, shoulder, and lower back had the highest prevalence of musculoskeletal symptoms among all body areas, and therefore these were examined more closely in the study. Therefore, logistic regression models (e.g., three different regression models were developed for neck, shoulder, and lower back areas) with odds ratios (ORs) and 95% confidence intervals (95% CIs) were developed to estimate the effects. The relationship between the prevalence of musculoskeletal symptoms and study variables (sociodemographic and work-related characteristics) was initially assessed using univariate binary logistic regression analysis. Variables that achieved statistical significance ($p < 0.05$) in the univariate analysis were subsequently included in a multivariate analysis. For this, a backward stepwise procedure was used to select independent variables in each model that had p -values of less than 0.05 in the final model. The assumptions of each model (including the presence of outliers and collinearity) were checked and the Hosmer-Lemeshow goodness-of-fit test confirmed the models. $P < 0.05$ was considered as statistically significant.

2.6. Ethical considerations

All study participants signed a written informed consent form, which was approved by the Ethics Review Committee of the Tabriz University of Medical Sciences (TBZMED.REC.1394.597).

3. Results

3.1. Description of the study sample

The study population consisted of 18-75 year-old participants ($n=711$), of whom 89% ($n=632$) participated in the interview (response rate, 88.8%; carpet handicraft workers: 89.1%, textiles handicraft workers: 87%, leather handicraft workers: 86.0%). They included 222 carpet handicraft workers, 209 textiles handicraft workers, and 201 leather handicraft workers. The main findings of the study are presented in Tables 1 through 4. Demographic details were as follows (mean \pm SD): age, 34.5 ± 11.5 years; weight, 67.9 ± 12.1 kg; height, 165.2 ± 10.1 cm; BMI, 24.9 ± 4.1 kg/m². Other sociodemographic and work-related characteristics of the participants can be seen in Tables 3 and 4.

3.2. Prevalence of symptoms

A total of 76.2% ($n=482$) of the participants reported neck, shoulder, or lower back pain at some time during the preceding month. About 32% of those who reported complaints indicated one location of pain; the remainder (68%) reported more than one location of pain. Table 1 shows the prevalence and severity of musculoskeletal symptoms among the study participants. The overall prevalence of musculoskeletal complaints, particularly in the neck (57.9%), lower back (51.6%), and shoulders (40.5%) was relatively high. The prevalence of shoulder symptoms was significantly higher in leather handicraft workers than in the other occupational groups ($p < 0.01$). About 35% of the respondents reported disruption of normal activities due to musculoskeletal symptoms, and this percentage was 22% for neck pain, 17% for shoulder pain, and 24% for lower back pain.

3.3. Severity of symptoms

The ratings of the severity of complaints (on the scale of 1-5) were as follows (mean \pm SD): neck, 3.5 ± 1.0 ; shoulders, 3.3 ± 1.1 ; and lower back, 3.7 ± 1.0 . The mean severities of neck, shoulder, and lower back symptoms were higher in leather handicraft workers compared to the other studied groups ($p < 0.01$). The severity ratings for the neck, shoulders, and lower back area were also found to differ significantly between males and females (Table 1).

3.4. Working postures

Table 2 shows the RULA scores by occupation and gender of the study population. The overall mean RULA grand score of 5.7 corresponded to an action level of 3, which indicated that most handicraft workers in this study needed an investigation and modifications in their working habits soon. The results showed significant differences in the RULA scores by occupation and gender of the participants (as shown in Table 2). The results indi-

Table 1. Prevalence and severity of musculoskeletal symptoms by occupation and gender (n=632).

Occupation	Total	Neck		Shoulders		Lower back	
		Prevalence n (%)	Severity Mean (SD)	Prevalence n (%)	Severity Mean (SD)	Prevalence n (%)	Severity Mean (SD)
Carpets handicraft workers							
Males	85	41 (48.2)	3.4 (1.0)	32 (37.6)	2.9 (1.0)	48 (56.5)	3.8 (1.3)
Females	137	80 (58.4)	2.6 (0.8)	45 (32.8)	3.0 (1.0)	76 (55.5)	2.7 (0.8)
All	222	121 (54.5)	3.0 (1.0)**	77 (34.7)	2.9 (1.0)	124 (55.9)	3.2 (1.2)**
Textiles handicraft workers							
Males	131	74 (56.5)	3.4 (1.0)	31 (23.7)	2.9 (0.8)	75 (57.3)	4.1 (0.9)
Females	78	44 (56.4)	3.0 (0.7)	14 (17.9)	2.2 (0.5)	37 (47.4)	3.3 (0.6)
All	209	118 (56.5)	3.2 (0.9)*	45 (21.5)	2.5 (0.7)**	112 (53.6)	3.8 (0.9)**
Leather handicraft workers							
Males	44	29 (65.9)	4.2 (0.8)	29 (65.9)	4.3 (0.6)	23 (52.3)	4.5 (0.6)
Females	157	98 (62.4)	4.0 (0.8)	105 (66.9)	4.1 (0.9)	67 (42.7)	3.9 (0.9)
All	201	127 (63.2)	4.1 (0.8)	134 (66.7)	4.2 (0.9)	90 (44.8)	4.1 (0.8)**
Whole sample	632	366 (57.9)	3.5 (1.0)**. a	256 (40.5)**. a	3.3 (1.1)**. a	326 (51.6)	3.7 (1.0)**. a

*P<0.05.

**P<0.01.

^a Significant difference between occupational groups.

Table 2. RULA scores by occupation and gender (n=632).

Occupation	RULA A score		RULA B score		RULA grand score	
	Min-max	Mean (SD)	Min-max	Mean (SD)	Min-max	Mean (SD)
Carpets handicraft workers						
Males	3-6	4.5 (0.8)	2-5	3.5 (1.0)	4-7	5.3 (1.1)
Females	3-6	4.2 (0.6)	2-5	3.0 (0.8)	4-7	5.0 (0.8)
All	3-6	4.4 (0.7)**a	2-5	3.2 (0.9)**a	4-7	5.2 (0.9)**a
Textiles handicraft workers						
Males	4-5	4.9 (0.2)	2-4	2.9 (0.9)	4-6	5.4 (0.5)
Females	4-5	4.0 (0.2)	4-5	4.1 (0.4)	6-7	6.1 (0.4)
All	4-5	4.6 (0.5)**a	2-5	3.4 (1.0)**a	4-7	5.7 (0.6)**a
Leather handicraft workers						
Males	4-6	5.3 (0.7)	2-5	4.1 (1.0)	4-7	6.3 (0.8)
Females	3-5	4.6 (0.5)	3-5	4.1 (0.7)	5-7	6.2 (0.6)
All	3-6	4.9 (0.6)**a	2-5	4.1 (0.8)	4-7	6.2 (0.6)
Whole sample	3-6	4.6 (0.6)**. b	2-5	3.5 (1.0)**. b	4-7	5.7 (0.8)**. b

*P<0.05.

**P<0.01.

^a Significant difference (from t-test analysis) between genders.

^b Significant difference (from ANOVA analysis) between three occupational groups.

cated that the mean arm/wrist score (score A) was higher in males than in females (4.9 and 4.4, respectively; $p < 0.01$), but the mean neck/trunk/leg score (score B) (males 3.3 and females 3.7; $p < 0.01$) and RULA grand scores (males 5.5 and females 5.8; $p < 0.05$) were higher in females than in males. By occupation, the leather handicraft

workers received a higher arm/wrist score (score A) (4.4, 4.6, and 4.9 respectively for carpets, textiles, and leather handicraft workers; $p < 0.01$), neck/trunk/leg score (score B) (3.2, 3.4, and 4.1, respectively, for carpets, textiles, and leather handicraft workers; $p < 0.01$) and RULA grand score (5.2, 5.7, and 6.2, respectively, for carpets, textiles,

and leather handicraft workers; $p < 0.01$) than the other studied groups.

3.5. Associations between risk factors and reported musculoskeletal symptoms

The results of the univariate and multivariate logistic regression analyses are shown in Tables 3 and 4. According to the results of the multivariate logistic regression analyses, more females than males reported pain in their neck (OR=1.91, 95% CI: 1.25, 2.93, $p < 0.01$) and shoulders (OR=1.82, 95% CI: 1.10, 3.02, $p < 0.05$). The prevalence of neck (OR=2.31, 95% CI: 1.15, 4.62, $p < 0.05$) and shoulder (OR=3.88, 95% CI: 2.13, 7.07, $p < 0.001$) pain also increased with age (>30 years old). Moreover, the prevalence of shoulder (OR=0.30, 95% CI: 0.15, 0.62, $p < 0.001$) and lower back (OR=0.42, 95% CI: 0.22, 0.82, $p < 0.05$) pain decreased with a higher degree of education. No significant association was found between other demographic factors (including marital status, BMI, smoking habits, and being involved in regular sport and physical activities) and the reported symptoms.

The results of the multivariate logistic regression analyses also showed that fast working was significantly associated with the occurrence of neck (OR=2.54, 95% CI: 1.70, 3.79, $p < 0.001$), shoulder (OR=1.59, 95% CI: 1.03, 2.47, $p < 0.05$), and lower back (OR=1.88, 95% CI: 1.28, 2.76, $p < 0.001$) pain. The number of years as a handicraft worker (>20 years for the neck and >10 years for the lower back pain) was associated with the occurrence of neck (OR=3.04, 95% CI: 1.48, 6.22, $p < 0.01$) and lower back (OR=2.71, 95% CI: 1.58, 4.65, $p < 0.001$) complaints. Neck complaints were also associated with the duration of continuous work without a break (>2 h) (OR=2.85, 95% CI: 1.79, 4.53, $p < 0.001$). Working postures (assessed by the RULA method) were found to be associated with the occurrence of neck, shoulder, and lower back complaints. The RULA A score was associated with neck (OR=1.81, 95% CI: 1.21, 2.72, $p < 0.01$), shoulder (OR=2.21, 95% CI: 1.40, 3.50, $p < 0.001$), and lower back (OR=1.59, 95% CI: 1.09, 2.33, $p < 0.001$) complaints. The RULA grand score was also associated with the occurrence of shoulder (OR=2.66, 95% CI: 1.16, 6.07, $p < 0.05$) and lower back (OR=6.48, 95% CI: 2.98, 14.11, $p < 0.001$) pain. Other work-related factors, including the daily working hours, having a second job, job satisfaction, and feeling pressure due to work were not associated with the reported complaints.

4. Discussion

Few epidemiological studies have investigated the occurrence of musculoskeletal symptoms and their contributing risk factors among handicraft workers. This study was conducted to characterize the working conditions of handicraft workers involved in different hand sewing ac-

tivities with respect to the prevalence of musculoskeletal complaints and their contributing individual and work-related risk factors. The results indicated that the prevalence of musculoskeletal symptoms was considerably high among the study population, with 76.2% of the respondents reporting symptoms, and of these 68% had more than one area of pain or discomfort. This finding confirms that musculoskeletal pain and discomfort is prevalent in this group of workers. More than one-third of the respondents reported disruption of normal activities due to MSDs. Individual factors including gender (being female), age (>30 years old), and lower educational level were independently associated with the occurrence of symptoms. Work-related variables such as years as a handicraft worker (>20 years for the neck and >10 years for the lower back pain), duration of continuous sitting work (>2 h) without a break, fast working, and working postures were also found to be independently associated with the presence of symptoms.

There were several notable findings regarding the relation of personal factors to musculoskeletal symptoms. The results indicated that gender was a significant factor for neck and shoulder complaints, as females experienced such complaints more frequently than males. Wang et al.¹⁵⁾ also reported a higher prevalence of neck/shoulder complaints in female sewing machine operators than in males. It was also shown that age was significantly positively associated with neck and shoulder pain. It should be noted that better understanding of the task characteristics may provide an insight into the job (re)design to support the user needs of an older working population in the future²³⁾. Moreover, the findings indicated that workers with a higher educational level were less likely to report shoulder and lower back pain than other workers. Since the education level was an independent factor in the multivariate analyses of shoulder and lower back pain, this result would have not been due to chance. Therefore, it is possible that, compared to workers with less education, those with a higher degree of education are more familiar with ergonomic principles and proper methods of task performance. This finding suggests the need for education of those workers who are less aware about the consequences of adopting awkward and static postures during their work, as this can contribute to musculoskeletal pain in this working group.

As shown in this study, working posture was an important risk factor for the neck, shoulders, and lower back pain among handicraft workers involved in hand sewing tasks. This finding highlights the importance of biomechanical risks for the studied workers and provides further evidence that hand sewing operations involve frequent head and trunk bending movements over the duration of the task, and therefore imposes unacceptable postural loading on the upper body and limbs. Our findings indicated that the RULA scores for the workers' upper and

Table 3. Sociodemographic factors and risk of musculoskeletal pain among of the study population (n=632).

	Neck pain			Shoulder pain			Lower back pain			
	Total	%	OR 1 (95% CI)	OR 2 (95% CI)	%	OR 1 (95% CI)	OR 2 (95% CI)	%	OR 1 (95% CI)	OR 2 (95% CI)
Gender										
Male	260	55.4	1.00	1.00	35.4	1.00	1.00	56.2	1.00	1.00
Female	372	59.7	1.19 (1.08-1.30)	1.91 (1.25-2.93)	44.1	1.44 (1.03-1.99)	1.82 (1.10-3.02)	48.4	0.73 (0.53-1.00)	
Age (years)										
18-29	256	42.6	1.00	1.00	23.8	1.00	1.00	39.1	1.00	1.00
30-44	249	63.5	2.34 (1.63-3.34)	1.73 (1.14-2.64)	42.6	2.37 (1.61-3.47)	1.65 (1.04-2.61)	57.4	2.10 (1.47-3.00)	
>44	127	78.0	4.76 (2.92-7.76)	2.31 (1.15-4.62)	70.1	7.48 (4.65-12.05)	3.88 (2.13-7.07)	65.4	2.94 (1.88-4.58)	
P_{trend}^{\dagger}			0.001	0.014		0.001	0.001		0.001	
BMI (kg/m²)										
<21	131	49.6	1.00		22.1	1.00		51.1	1.00	
21-25	209	57.4	1.36 (0.88-2.12)		42.1	2.55 (1.55-4.19)		47.8	0.87 (0.56-1.35)	
>25	292	62.0	1.65 (1.09-2.51)		47.6	3.19 (1.99-5.12)		54.5	1.14 (0.75-1.72)	
Marital status										
Single	223	40.8	1.00		30.6	1.00		40.8	1.00	
Married	409	67.2	2.97 (2.12-4.17)		46.0	1.93 (1.37-2.73)		57.5	1.95 (1.40-2.72)	
Educational level										
Illiterate	130	73.1	1.00		72.3	1.00		56.9	1.00	1.00
Primary school	221	59.7	0.54 (0.34-0.87)		38.5	0.23 (0.15-0.38)	0.39 (0.22-0.67)	59.7	1.12 (0.72-1.74)	1.55 (0.93-2.57)
Secondary school	200	49.0	0.35 (0.22-0.57)		24.0	0.12 (0.07-0.20)	0.24 (0.13-0.45)	46.5	0.65 (0.42-1.02)	1.25 (0.72-2.17)
Diploma	81	50.6	0.37 (0.21-0.67)		35.8	0.21 (0.11-0.38)	0.30 (0.15-0.62)	33.3	0.37 (0.21-0.67)	0.42 (0.22-0.82)
P_{trend}^{\dagger}						0.001			0.001	0.001
Regular sport/physical activity										
No	459	60.1	1.00		44.4	0.53 (0.37-0.78)		53.4	1.00	
Yes	173	52.0	0.71 (0.50-1.02)		30.1			46.8	0.76 (0.54-1.09)	
Smoking										
No	547	55.8	1.00		40.0	1.00		49.5	1.00	
Yes	85	71.8	2.01 (1.22-3.33)		43.5	1.15 (0.72-1.83)		64.7	1.86 (1.16-3.00)	

OR 1=ORs based on unadjusted (univariate) binary logistic regression. OR 2=ORs based on adjusted (multivariate) binary logistic regression. Significant factors on multivariate analysis are shown in bold. † P for trend.

Table 4. Work-related psychosocial and physical factors and risk of musculoskeletal pain among of the study population (*n*=632).

	Neck pain			Shoulder pain			Lower back pain		
	Total %	OR 1 (95% CI)	OR 2 (95% CI)	%	OR 1 (95% CI)	OR 2 (95% CI)	%	OR 1 (95% CI)	OR 2 (95% CI)
Years worked as a sewing worker									
1-10	316 46.8	1.00	1.00	28.8	1.00	1.00	38.3	1.00	1.00
11-20	194 61.9	1.84 (2.27-2.65)	1.35 (0.87-2.10)	42.3	1.81 (1.24-2.63)	1.00	62.4	2.67 (1.84-3.86)	2.28 (1.52-3.44)
>20	122 80.3	4.63 (2.81-7.62)	3.04 (1.48-6.22)	68.0	5.26 (3.34-8.26)	1.00	68.9	3.56 (2.28-5.56)	2.71 (1.58-4.65)
<i>P</i> _{trend} †		0.001	0.010					0.001	0.001
Daily working hours									
1-8	430 56.3	1.00	1.00	41.9	1.00	1.00	48.6	1.00	1.00
9-14	202 61.4	1.23 (0.87-1.73)	1.00	37.6	0.83 (0.59-1.18)	1.00	57.9	1.45 (1.03-20.3)	1.00
Having a second job									
No	589 58.7	1.00	1.00	41.0	1.00	1.00	51.6	1.00	1.00
Yes	43 47.6	0.63 (0.34-1.19)	1.00	31.0	0.63 (0.32-1.25)	1.00	50.0	0.93 (0.50-1.75)	1.00
Working very fast									
No	217 43.8	1.00	1.00	35.5	1.00	1.00	35.9	1.00	1.00
Yes	415 65.3	2.41 (1.72-3.38)	2.54 (1.70-3.79)	43.1	1.37 (1.10-1.93)	1.59 (1.03-2.47)	59.8	2.64 (1.88-3.71)	1.88 (1.28-2.76)
Job satisfaction									
Low	61 49.2	1.00	1.00	44.3	1.00	1.00	36.1	1.00	1.00
Moderate	298 55.7	1.29 (0.74-2.25)	1.00	35.9	0.70 (0.40-1.23)	1.00	51.3	1.87 (1.05-3.30)	1.00
High	273 62.3	1.70 (0.97-2.98)	1.00	44.7	1.01 (0.58-1.77)	1.00	55.3	2.19 (1.23-3.89)	1.00
Duration of continuous work without break (>10 min)									
<1 h	148 46.6	1.00	1.00	37.2	1.00	1.00	54.7	1.00	1.00
1-2 h	205 45.4	0.95 (0.62-1.45)	1.02 (0.64-1.64)	33.2	0.83 (0.53-1.30)	1.00	45.4	0.68 (0.44-1.05)	1.00
>2 h	279 73.1	3.11 (2.05-4.72)	2.85 (1.79-4.53)	47.7	1.54 (1.02-2.31)	1.00	54.5	0.99 (0.66-1.47)	1.00
<i>P</i> _{trend} †		0.001	0.001						
Feeling pressure due to work									
No	79 59.5	1.00	1.00	36.7	1.00	1.00	48.1	1.00	1.00
Yes	553 57.7	0.92 (0.57-1.50)	1.00	41.0	1.20 (0.73-1.95)	1.00	52.1	1.17 (0.73-1.88)	1.00
RULA A score(%)									
1-4	265 49.1	1.00	1.00	29.4	1.00	1.00	40.0	1.00	1.00
≥5	367 64.3	1.87 (1.35-2.58)	1.81 (1.21-2.72)	48.5	2.25 (1.61-3.15)	2.21 (1.40-3.50)	59.9	2.24 (1.62-3.09)	1.59 (1.09-2.33)
RULA B score(%)									
1-4	524 56.5	1.00	1.00	36.6	1.00	1.00	50.2	1.00	1.00
≥5	108 64.8	1.41 (0.92-2.18)	1.00	59.3	2.51 (1.64-3.83)	1.00	58.3	1.38 (0.91-2.11)	1.00
RULA grand score (%)									
1-4	72 29.2	1.00	1.00	12.5	1.00	1.00	12.5	1.00	1.00
≥5	560 61.6	3.89 (2.28-6.66)	1.00	44.1	5.52 (2.69-11.32)	2.66 (1.16-6.07)	56.6	9.13 (4.45-18.72)	6.48 (2.98-14.11)

OR 1=ORs based on unadjusted (univariate) binary logistic regression. OR 2=ORs based on adjusted (multivariate) binary logistic regression. Significant factors on multivariate analysis are shown in bold. † *P* for trend.

lower arm/wrist scores (score A), neck/trunk/legs scores (score B), and the grand scores were relatively high. The relatively high RULA scores in this study highlight that the working postures of the workers were constrained by both the visual and manual aspects of the sewing tasks, and that the design of the sewing workstations had a significant influence on the postures adopted. This means that, in most cases, the working postures of workers under study need to be investigated and some modifications are required immediately. These findings are in part consistent with several previous reports of poor working postures (assessed by the RULA method) among relatively similar occupations such as garment and sewing machine operating tasks^{12,14,24}). In a recent study by Van et al.¹⁴) among garment workers in Cambodia, it was shown that biomechanical/postural risk factors (assessed by the RULA method) were significantly associated with the development of musculoskeletal symptoms among the studied workers.

The results also suggest that there is a need to consider other work-related physical and psychosocial aspects of hand sewing tasks. Interestingly, our findings indicated that perceived speed of work was one aspect of the psychosocial factors^{4,9}) that was independently positively associated with the occurrence of musculoskeletal complaints in the neck, shoulder, and lower back areas. This finding may be attributed to the fact that the study subjects were paid per item, and this provided an incentive to work at high speed and skip adequate rest breaks. Moreover, the finding indicated that the time of employment as a handicraft worker was positively associated with the presence of symptoms in the neck and lower back areas, which is in agreement with several previous reports among other occupations^{4,11,13}). It is also interesting to note that the handicraft workers in this study had frequent periods of continuous sitting work without breaks (e.g., sewing work in a static position for more than 2 hours), which was independently associated with the occurrence of neck complaints. The results from some previous studies suggest that prolonged sitting work without a break may increase the risk for neck/shoulder pain among different occupational groups^{4,13,25}), and that regular rest breaks may reduce the risk for such complaints²⁶). Therefore, handicraft workers involved in hand sewing tasks may be advised to take regular rest breaks in order to minimize exposure and to help recovery from static and awkward postures.

The present study has an advantage that observer error was controlled using two trained interviewers in comparison to studies in which there were separate observers for each case. However, the findings presented should be interpreted in the context of the cross-sectional study design. In addition, the findings highlight the importance of both individual and work-related aspects of sewing tasks in association with MSDs. Thus, in addition to the work-

related factors, it might be beneficial to take into account individual factors (such as age, gender, and education) as potential confounders in future analysis of MSDs among this working group.

5. Conclusions

In conclusion, the findings highlight the importance of both psychosocial and physical aspects of hand sewing tasks in association with musculoskeletal pain and emphasize the need for ergonomic interventions for improving the working conditions of this group of handicraft workers. Specifically, one recommendation may be to improve working postures through workstation design for hand sewing tasks (e.g., based on workers' anthropometry). Moreover, handicraft workers involved in these tasks may also be advised to take regular rest breaks in order to alleviate exposure and also to aid recovery from unhealthy working postures.

Conflicts of interest: The authors declare that there is no conflict of interests.

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