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Investigation of musculoskeletal symptoms and ergonomic risk factors among female sewing machine operators in Turkey

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ABSTRACT

This cross-sectional study aimed to identify the prevalence of musculoskeletal symptoms and ergonomic risks in female sewing machine operators at a textile company. The study sample comprised all female sewing machine operators in the company. The sample included 283 sewing machine operators. Data were collected through the use of the adapted Nordic Musculoskeletal Questionnaire and by direct observations via the rapid upper limb assessment (RULA) to determine ergonomic risks. RULA is a validated tool for assessment of ergonomic risks. The mean age of the women was 30.2 (SD: 8.4) and the mean number of years of employment was 13.4 (SD: 5.5). The highest prevalence rates for the women's musculoskeletal symptoms were in the trunk (62.5%), neck (50.5%), and shoulder (50.2%). Of the women, 65% had experienced musculoskeletal pain or discomfort over the last 6 months. Pain intensity of these symptoms was assessed with a visual analogue scale. The average pain intensity of the women was found to be 3.5 (SD: 2.8). Results of the RULA scores were found to be quite high. There were no employees who received RULA scores of 1–2, which indicates acceptable postures (all scores >5). The final RULA scores of 6.9 indicate that the participants' postures at their work stations need to be investigated immediately.
Relevance to industry: This study based on the RULA method allowed to perform a rapid and quite correct evaluation tolls for SMOs. For this research population, the research findings provided fundamental data on the prevalence of musculoskeletal symptoms and ergonomic risks among Turkish female SMOs.

1. Introduction

Musculoskeletal disorders (MSDs) are a major cause of work-related disabilities and injuries in the developed and industrially developing countries (Andersen and Gaardboe, 1993; Choobineh et al., 2004; Kaergaard and Andersen, 2000). MSDs, particularly those of the upper body, are increasingly prevalent in western societies (Strazdins and Bammer, 2004). According to findings in some studies, the prevalence of MSDs is 10%; it is as high as 80% in others (Eerd et al., 2003). Musculoskeletal disorders are more common among women than among men (Dahlberg et al., 2004). Although men and women may have the same job title, they still do not perform the same type of work tasks (Yun et al., 2001). Today, women are probably more often exposed to monotonous repetitive, and heavy work tasks than men, e.g. Health care personnel, cashiers, cleaners, and sewing machine operators (SMOs) (Brisson et al., 1989; Dahlberg et al., 2004).

Sewing machine operation includes jobs that involve operating power sewing machines to sew, alter or repair wearing apparel, linens, blankets, and other fabric articles. This includes operation of automatic sewing machines when the operator must know how to thread the machine, wind bobbins, adjust tension, and oil parts. Sewing machine operators use hands to handle, control, or feel objects, and tools; sit for long periods of time, and repeat the same motions (Kaergaard and Andersen, 2000; Wang et al., 2007). For this reason, a high prevalence of musculoskeletal symptoms of neck, shoulder, back, hand/fingers and lower extremities have been found in studies of female SMOs (Kaergaard and Andersen, 2000; Brisson et al., 1989; Kilroy and Dockrell, 2000; Vihma, 1982).

Turkey, in which this study was conducted, is a developing country with a population of 68 million. Half of Turkey's population is composed of women, 19% of these women (5.7 million) are illiterate (Esin and Öztürk, 2005; Ministry of labour and social security, 2005). While the participation of women in the labour force was 28% in 1988, this percentage decreased to 24.5% in 2004. Of the working women, 77% are family workers without pay and 14% are employed as industrial workers (Esin and Öztürk, 2005). Working women in Turkey have a lot of problems concerning wages, employment, working conditions and social benefits. The vast majority of women working in industry are employed in textiles. Being the most developed sector in Turkey, the textile

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industry has a key role in its economy. There are approximately 4–5 million registered employees in the textiles industry in Turkey. However, the actual number is estimated to be 7–8 million, together with the unregistered workers. Of these employees, 10.9% are women and most of these women work as SMOs. Some studies place, MSD prevalence between 32% and 60% for all employees. It is predicted that this percentage is higher among female employees (Açık et al., 2004; Bilgütay et al., 2004; Çivitci et al., 2004; Tüzün et al., 2004). However, research with working women is not sufficient. In particular, there is almost no information about MSD prevalence in working women. Also, there are insufficient studies which have used reliable ergonomic risk assessment methods of risk prevention. The findings from the studies to be conducted into this issue will make it possible for those providing occupational health services such as occupational health nurses and occupational physicians to learn about ergonomic risk assessment methods. The study was conducted on female SMOs, who are assumed to display higher MSD prevalence. The aim of this cross-sectional study was:

1) To determine MSD prevalence among female SMOs in Turkey using a modified version of Nordic Musculoskeletal Questionnaire (NMQ),
2) To examine the level of ergonomic workplace risk factors by using the Rapid Upper Limb Assessment (RULA),
3) To investigate the relationship between MSDs and demographic factors, work characteristics, and RULA scores.

2. Method

2.1. The workplace

This cross-sectional study was conducted in a textile company that manufactures clothes. The company is located in Istanbul, in north-western Turkey, the most developed city of Turkey in terms of population and economy. A total of 670 employees work in the six different departments of the company. There are 307 employees in the sewing department, where the study was conducted. Of these, 8% are male and 92% are female. The work tasks performed within this department are forming patterns, sewing, ironing, and final inspection. Fabrics come into the pattern department in rolls, are cut in the desired patterns, and then sent to SMOs to be sewn. Each SMO sews the ready-to-sew pieces coming from the pattern department. Then, mid-ironers iron the pieces sewn. Finally, final products (pants, jacket, shirt, etc.) are delivered to final ironers to be pressed and made ready for sale after inspection by final inspectors. When the work environment was evaluated, an awkward work station design was observed. In the extended work area, there are non-adjustable chairs, poor machine design, and unorganized work surfaces. The manufacturing continues on a 24-h/7-day basis with a shift system.

2.2. Participants

The study samples are paid according to their years of employment, an average of 500 USD per month. SMOs perform their tasks sitting. There are two work tasks. The first one is the "sewing" task. The female worker sits on a chair, leans forward at an angle of 45°, and moves her hands backward and forward and to the left and right to move the fabric (45–100 times per minute). The arms are positioned over the machine at an angle between 45° and 90° to the trunk. The head is positioned forward at an angle between 10° and 20°. One of the legs moves the pedal of the sewing machine but the other is static. During the second work task, the female worker bends down to the right at an angle of 45° in order to get the pieces such as zippers and the like (30–50 times per minute).

2.3. Data collection

In this study, the data were obtained with a questionnaire and by direct observation. The questionnaire was prepared based on the Nordic Musculoskeletal Questionnaire (Kourinka et al., 1987). The questionnaire has three sections. On the first section are items to determine musculoskeletal symptoms frequency of pain, and intensity of pain. The subjects were asked questions about the musculoskeletal symptoms (pain, discomfort) they had had over the last 6 months and were asked to mark them on the body discomfort chart. Symptoms of pain or discomfort were recorded as presence of pain. They were also asked "How often do you feel pressured because of your work?" to determine feelings of participants about their work. They were asked to select from one of the following choices: "I have never had", "I have often had", "I have very often had", or "I always have had". The participants were also asked to mark on a Visual Analogue Scale (VAS) for self-reported pain intensity where they thought their pain was. The VAS is a horizontal line, 100 mm in length with the left end of the line representing no pain and right end of the line representing the worst pain. Subjects were asked to mark on the line where they thought their pain was. The VAS score is determined by measuring in millimetres the distance from the left hand end of the line to the point that the subject marked.

In the second section of the questionnaire, information was collected about age, education, and marital status, number of living with children, health-related factors (i.e., body mass index [BMI]), non-work-related physical activity, smoking behaviour, and chronic illnesses. On the third section of the questionnaire, there were items about their work/work-place characteristics: number of hours worked per day and week, total years of employment, and items for evaluation of work station design, type of chair used, machine design, and work surface.

Ergonomic risk factors were assessed through direct observation of women's postures at their work stations by means of the Rapid Upper Limb Assessment (RULA) tool (Mc Atamney and Corlett, 1993, 1996). RULA is a validated tool that assesses biomechanical and postural loading on the work-related upper limb disorders. It provides a method of screening a working population quickly for exposure to a likely risk of work-related upper limb disorders. RULA was developed without the need for special equipment, which provides the opportunity for a number of investigators to be trained in doing the assessment without additional equipment expenditure as, the investigator only requires a clipboard and pen this way.

In the RULA assessment method, a score is calculated for the posture of each body part. A score of 1 indicates the ''best'' or most neutral posture, e.g. arms by the sides, elbows in approximately 90° flexion, wrists in neutral position, forearms mid-way between pronation and supination, neck in 10° flexion, trunk and legs sitting and well supported. A score of 4 indicates the "worst" position, e.g. shoulder flexion above 90° or flexion between 45° and 90° and abduction. The combined individual scores for shoulder, elbow and wrist are called score "A" and those for neck, trunk and legs give score "B". Muscle use and force exerted in each working position are attributed a score of 1 and 0 respectively, because they are static postures without loading. These scores are added to scores A and B to obtain scores "C" and "D". Based on the design of the RULA method, each combination of scores C and D is called a "grand score" and reflects the musculoskeletal loading associated with the worker's posture. Low grand scores (of 1 or 2)

indicate that the work posture is acceptable. However, action is suggested for the higher scores. For example, further investigation and changes may be recommended for grand scores of 3 or 4 if required; prompt investigation and changes are recommended for grand scores of 5 or 6 and immediate investigations and changes for a grand score of 7.

2.4. Reliability and validity of RULA

As RULA had never been used in Turkey before, the tool was translated into Turkish. Seven experts in the fields of ergonomics and public health evaluated the tool in Turkish for the sake of content validity. The final draft of the RULA in Turkish was prepared in light of the suggestions made. An important reliability measure with a tool such as the RULA is the inter-raters reliability (Polit et al., 2001). Three trained observers independently observed 93 SMOs performing their tasks. Each observer recorded their observations in 93 RULA form for each operator. Then, their observations were compared and contrasted to examine the uniformity among each other. The mean percentages of agreement of raters were found to be between 80% and 86% for RULA items. To establish whether RULA scores provided a good indication of the musculoskeletal loading sustained by these workers, the Chi-square test was used to determine whether the individual body part scores were significantly associated with the reported pain, ache, or discomfort in the corresponding body region. The results were shown to provide a valid measure of body discomfort (Massaccesi et al., 2003).

2.5. Data analysis

Statistical analysis was performed with SPSS (version 11.0). Descriptive statistics of the general characteristics, work, and workplace characteristics, and ergonomic risks of the study population were presented as numbers, percentages, and mean ± standard deviation. The analytical statistics were carried out using chi-square test and logistic regression analysis. Chi-square test was used to assess univariate associations between variables (demographic and work-related characteristics) and reported MSD symptoms. We estimated the association [Odds ratios (OR) and 95% confidence intervals] between risks and the prevalence of musculoskeletal symptoms in unadjusted logistic regression model. Nine different regression models were developed for nine different body parts in order to determine the effective variables of MSD symptoms. These included the head, neck, shoulder, upper/lower back, upper/lower limb, wrist, and finger. In each body part, the prevalence of symptoms was determined as dependent variable, and total 16 general/workplace characteristics and 3 RULA scores as independent variable. *P* values below 0.05 were considered statistically significant.

3. Results

3.1. General characteristics

The study sample comprised all 283 SMOs. The mean of the ages of the women was 30.2 (SD: 8.4 range 16–50) and the majority of them were in the 21–40 year old age group (69.9%). The vast majority (81.6%) of the women had an elementary school education. More than half (63.9%) were married with at least one or two children (55.8%). The vast majority of the study population (93.9%) was not physically active (e.g. aerobic activity at least three times a week and/or resistance training at least twice a week). Nearly one-third of them (31.4%) had a chronic health problem. It was also determined that 34.2% of the participants were cigarette smokers. The subjects' mean BMI was found to be 23.3 (SD: 4.0) (Table 1).

Table 1
General, and occupational characteristics, and their relationship to musculoskeletal symptoms (*N*: 283).

Independent variables (*n*)	Musculoskeletal symptoms		Statistics	Significant
	Yes ($n = 184$)%	No ($n = 99$)%		
Age				
≤20 (38)	78.9	21.1	$\chi^2 = 3.92$, $df = 2$	$p > 0.05$
21–40 (198)	84.3	15.7		
≥41 (47)	93.6	6.4		
Education				
Elementary (231)	84.4	15.6	$\chi^2 = 0.86$, $df = 2$	$p > 0.05$
High School (47)	89.4	10.6		
University (5)	80.0	20.0		
Marital status)				
Married (181)	87.3	12.7	$\chi^2 = 1.90$, $df = 1$	$p > 0.05$
Single (102)	81.2	18.8		
Living with children				
Yes (158)	87.3	12.7	$\chi^2 = 1.34$, $df = 1$	$p > 0.05$
No (125)	82.4	17.6		
Medical history of systemic illness				
Yes (89)	93.3	6.7	$\chi^2 = 6.73$, $df = 1$	$p < 0.01$
No (194)	81.4	18.6		
Regularly exercise				
Yes (17)	71.4	28.6	$\chi^2 = 1.07$, $df = 1$	$p > 0.05$
No (276)	85.5	14.5		
Body mass index				
Underweight (27)	10.8	2.4	$\chi^2 = 6.15$, $df = 3$	$p > 0.05$
Normal weight (158)	53.9	66.7		
Overweight (72)	24.9	28.6		
Obesity (1)	10.0	8.8		
Cigarette smoking				
Yes (97)	90.7	9.3	$\chi^2 = 2.73$, $df = 1$	$p > 0.05$
No (186)	83.5	16.5		
Total working time (yr)				
1–10 (87)	86.2	13.8	$\chi^2 = 0.11$, $df = 2$	$p > 0.05$
11–20 (105)	84.6	15.4		
>21 (91)	84.8	15.2		
Daily working time(h))				
8–10 (243)	85.2	14.8	$\chi^2 = 0.18$, $df = 2$	$p > 0.05$
11–14 (40)	84.6	15.4		
Weekly working time (h)				
40–50 (81)	82.7	17.3	$\chi^2 = 3.45$, $df = 1$	$p > 0.05$
≥51 (212)	91.4	8.6		
SMO experience (yr)				
1–5 (128)	87.7	12.3	$\chi^2 = 1.80$, $df = 1$	$p > 0.05$
≥6 (155)	81.9	18.1		
Use of scissors				
Yes (265)?	86.4	13.6	$\chi^2 = 5.20$, $df = 1$	$p < 0.05$
No (18)	66.7	33.3		
Use of adjustable chair				
Yes (104)	86.0	14.0	$\chi^2 = 0.29$, $df = 1$	$p > 0.05$
No (179)	83.0	16.3		
To feel pressured because of work				
Never (12)	64.3	35.7	$\chi^2 = 59.90$, $df = 3$	$p < 0.001$
Often (208)	95.7	2.5		
Very Often (41)	95.8	4.2		
Always (12)	95.9	4.1		
RULA/A score				
≤5 (203)	86.7	13.3	$\chi^2 = 2.23$, $df = 1$	$p > 0.05$
≥6 (80)	18.8	81.3		
RULA/B score				
≤7 (152)?	81.6	18.4	$\chi^2 = 3.35$, $df = 1$	$p > 0.05$
≥8 (131)	89.3	10.7		
RULA/GRAND score				
≤6 (24)	95.8	4.2	$\chi^2 = 5.99$, $df = 1$	$p < 0.05$
7 (259)	84.2	15.8		

3.2. Work and workplace characteristics

All of the women in the study worked as SMOs. Their total years of employment was 13.4 (SD. 5.5) and company experience was 7.3 (SD: 5.7) years on average. The average working hours of the women was 9.8 (SD: 1.1) hours a day and 52.2 (SD: 9.8) hours a week. Their

average daily workload was 563.2 (SD: 394.4) pieces/day. It was determined that 37.1% of the participants had been working 11–20 years and 54.7% of them had been working as SMOs for more than 6 years. Also, 85.8% of the female SMOs in the study worked for 8–10 h a day and 74.4% worked for more than 51 h a week (Table 1). The women involved in the study worked in a closed environment. The researchers observed that the illumination and air-conditioning were satisfactory but noise level was high at times. The work tasks of the women were mentioned before under the "participants" title. There were three breaks during the day: a one-hour lunch break and two 10-min breaks. Only 36.7% of the women had adjustable chairs. The majority (93.6%) used scissors while working the vast majority of the women (95.2%) used their right hands. Most of the women, 95.7% indicated that they felt pressured because of their work (Table 1). They did not wear any kind of uniform. Twelve percent had had a work-related accident. There was a medical unit in the workplace with a part-time physician and a full-time a nurse. On the other hand, it was observed that although physical examinations before beginning of employment and other periodic examinations were performed regularly, there were no ergonomic programs being conducted at all.

3.3. RULA scores

The body movements of the participants during work tasks were observed in accordance with the RULA form (by the first author) and the scores were recorded. A separate RULA form was used for each employee and observation. In order not to break the workers' concentration, the observations were carried out without letting workers know about. However, the workers were told that they would be observed before the study was initiated. The women's mean Score A, Score B and grand score were found to be 5.3 (SD:0.5, range:4–8), 7.1 (SD:0.9, range:4–9) and 6.8 (SD:0.6, range:5–7) respectively. Score A includes the upper and lower limb and wrist scores. Score B includes neck, trunk and legs scores. The grand scores are obtained by adding posture scores to the muscle use and force scores. The mean score A of 5.2 indicates that the workers upper/lower arms were neutral according to their postures (arms are down adjoining to the trunk and move backwards and forwards at 20° at maximum). It was observed that there was a 90° extension from the trunk (front part) towards the top and the workers' wrists were in extension (sagital plane) of up to 15°. The fact that score B was found to be 7.1 indicates that the workers' necks were in more than 20° flexion to the front, back and the sides and their trunks bent to the left at 60°. The risk scores of the legs were determined to be within normal limits; there was no strain on their legs. The final mean RULA score of 6.9 indicates that the employees' postures at their work stations need to be investigated and some changes are required immediately. There were no participants who received RULA scores of 1–2, which indicates an acceptable posture. The final RULA score ranged from a minimum 5 to a maximum of 7.

3.4. The prevalence of musculoskeletal symptoms

The highest prevalence rate of musculoskeletal pain or discomfort was in the trunk region (62.5%), (upper back (34.8%), and lower back (23.9%)), and neck region (50.5%), shoulder region (50.2%), upper limb (22.3%), wrist (18%), hand and fingers (12.7%), and lower limb (12%). The findings from this study also showed that 65% of the women had experienced MSDs over the last 6 months. The participants' reports about disruption of normal activities due to pain were grouped as never (19.7%), often (69.9%), very often (8.1%), and always (2.1%). In the analysis of factors affecting the prevalence of musculoskeletal symptoms, it was determined that having a chronic disease ($p < 0.01$), use of scissors ($p < 0.05$), feeling pressured because of work ($p < 0.001$), were influential factors (Table 1). When the relation between the prevalence of musculoskeletal symptom and RULA scores were evaluated, no statistically significant difference was found between score A (upper-lower limb and wrist score) and score B (neck, trunk, leg score). However, grand score was higher in women with musculoskeletal symptom than in those with no symptom ($p < 0.05$) (Table 1).

When the participants answered the questionnaire about the intensity of their pain a mean pain intensity value of 3.5 (SD: 2.8) was determined. Those with chronic health problems ($p < 0.01$) and the cigarette smokers ($p < 0.01$) had higher pain intensity values.

3.5. Relationship between risk factors and musculoskeletal symptoms: logistic regression analysis

"Feeling pressured because of work" was the strongest predictor of all body region's musculoskeletal symptoms (Table 2).

3.5.1. Head symptoms

The main statistically significant risk factor was (Table 2): "To feel pressured because of work" (4.6 times higher risk than never felt pressured), (OR: 4.68, CI: 2.11–10.40), (Table 2).

3.5.2. Neck symptoms

The main statistically significant risk factor was "To feel pressured because of work" (OR: 5.01, CI: 1.38–18.24). "Weekly working time" (≥51 h a week) was also a risk factor (OR: 2.29, CI: 1.02–10.01), (Table 2).

3.5.3. Shoulder symptoms

"To feel pressured because of work" was identified as independent risk factor (OR: 7.70, CI: 3.28–18.10), (Table 2).

3.5.4. Upper limb symptoms

Three statistically significant risk factors were found (Table 2). "Being over 41 years" (8.42 times higher risk than being under 20 years), (OR: 8.42, CI: 1.41–50.10). "Use of scissor"(3.39 times higher risk than not use of scissor), (OR: 3.39, CI: 1.31–8.70)", and "To feel pressured because of work" (10.31 times higher risk than never felt pressured), (OR: 10.31, CI: 2.13–49.80), (Table 2).

3.5.5. Wrist symptoms

Three variables with significant odds ratios were identified thorough logistic regression analysis. "To feel pressured because of work" was the strongest predictor of having wrist symptoms. Women who reported that they had felt pressured because of work were over 9 times more likely to have had wrist symptoms than those who had not (OR: 9.12, CI: 1.38–60.29). Those who had elementary school education were nearly 3 times more likely to have had wrist symptoms than women who had high school graduates (OR: 3.20, CI: 1.32–7.73). Women who worked over 21 years were over 3 times more likely to have had wrist symptoms than those who had worked 1–10 years (OR: 3.42, CI: 1.01–11.50), (Table 2).

3.5.6. Finger symptoms

Three significant odds ratios were identified as a result of logistic regression analysis. "To feel pressured because of work" (8.08 times higher risk than never felt pressured), (OR: 8.08, CI: 1.75–22.4). "Use of scissor" (4.26 times higher risk than not use of scissor), (OR: 4.26, CI: 1.57–11.6), and "Being RULA score A over 6

Table 2
Determinants of according to body parts' musculoskeletal symptoms: unadjusted logistic regression (N: 283).

According to body parts having musculoskeletal symptoms	Variables (%)	Unadjusted OR[a]	95% CI[b]
Having headache ($n = 118$)	*To feel pressured because of work* (with symptom %)		
	Never (24.5)	1.00	
	Often (52.5)	4.68	(2.11–10.40)
	Very often/always (22.5)	4.34	(1.18–15.45)
Having neck symptoms ($n = 141$)	*Weekly working time (h)* (with symptom %)		
	40–50 (63.8)	1.00	
	≥51 (36.2)	2.29	(1.02–5.10)
	To feel pressured because of work (with symptom %)		
	Never (11.3)	1.00	
	Often (77.3)	5.01	(1.38–18.24)
	Very often/always (9.9)	3.46	(1.64–20.01)
Having shoulder symptoms ($n = 140$)	*To feel pressured because of work* (with symptom %)		
	Never (7.1)	1.00	
	Often (78.6)	7.70	(3.28–18.10)
	Very often/always (14.2)	1.84	(4.05–19.20)
Having upper limb symptoms ($n = 63$)	*Age (yr)* (with symptom %)		
	<20 (4.8)	1.00	
	21–40 (77.8)	5.52	(1.10–27.50)
	≥41 (17.5)	8.42	(1.41–50.10)
	Use of scissor (with symptom %)		
	No (77.8)	1.00	
	Yes (22.2)	3.39	(1.31–8.70)
	To feel pressured because of work (with symptom %)		
	Never (7.9)	1.00	
	Often (73.0)	10.31	(2.13–49.80)
	Very often/always (18.9)	3.67	(1.11–12.4)
Hawing wrist symptoms ($n = 51$)	*Education (yr)* (with symptom %)		
	Elementary (70.6)	3.20	(1.32–7.73)
	High school (29.4)	1.00	
	Total working time (yr) (with symptom %)		
	1–10 (25.5)	1.00	
	11–20 (33.3)	2.49	(0.88–7.04)
	>21 (41.2)	3.42	(1.01–11.50)
	To feel pressured because of work (with symptom %)		
	Never (5.9)	1.00	
	Often (7.4)	9.12	(1.38–60.29)
	Very often/always (15.7)	7.08	(1.47–33.90)
Having finger symptoms ($n = 35$)	*Use of scissor* (with symptom %)		
	Yes (31.4)	4.26	(1.57–11.60)
	No (68.6)	1.00	
	To feel pressured because of work (with symptom %)		
	Never (2.9)	1.00	
	Often (75.4)	8.08	(1.75–22.4)
	Very often/always (15.7)	6.97	(1.04–16.98)
	RULA score A (with symptom %)		
	≤5 (14.3)	1.00	
	≥6 (85.7)	2.75	(1.09–6.89)

RULA=Rapid upper limb scale.
[a] Odds ratio.
[b] 95% confidence interval.

point" (2.75 times higher risk than women who RULA score A had have less than 5 point (Table 2)).

4. Discussion

This study conducted to determine MDSs and ergonomic risks in female SMOs is the first of its kind in Turkey. Textile is an important sector in Turkey, comprising 32% of the exports. Women are the principal workers in this sector. This study based on the RULA method allowed to perform a rapid and quite correct evaluation tolls for SMOs.

The results of this study showed that these women have both a high level of MSDs as well as high ergonomic risks. The average age of the women participating in this study was 30.2 years, they had worked an average of 13 years and the majority (65%) had experienced MSDs in various parts of the body in the last 6 months. The areas identified by most women as complaint were the trunk (62.5%, 34.8% upper back, 23.9% lower back), neck (50.5%), shoulders (50.2%), and upper limbs (22.3%). All of these results are interpreted by the authors as quite high and disconcerting, because these results are higher than those found in other studies. In a study conducted with female SMOs in Turkey, the prevalence of MSDs was found to be 50–55% (Çivitci et al., 2004). In addition, in a study conducted by Wang et al. (2007), MSD prevalence was 58%, and in a study by Kaergaard and Andersen (2000), it was 14.4%. In a study conducted by Wu et al. (2009), female wafer-handlers the prevalence of MSDs was 89.1%. In the relevant literature, because of the SMOs' work position, the regions of their bodies with the most MSDs are considered as the neck, shoulders, upper arm, lower arm, wrist and fingers (Eerd et al., 2003; Dahlberg et al., 2004; Kaergaard and Andersen, 2000). Similarly, this study supports this observation as the participants' most common areas with MSDs were the neck, shoulder, and upper arm. In a study conducted by Shuval and Donchin (2005), with computer workers, the most common MSDs were in the neck and shoulder (47.6%). Kaergaard et al. (2000) also reported that the neck and shoulders were the most common sites for MSDs (62.8%).

The pain intensity felt by the women when they were filling out the questionnaire was a mean of 3.5. In the study by Wang et al. (2007), the participants' pain intensity was a mean of 1.4. These study results show that the women participating in our study had more MDSs and higher pain intensity. The authors expected this result because these women work 9.8 h a day and 52.2 h a week. These work hours are very high and does not comply with a law (number 4857) that went into effect in 2003. It states that, in Turkey, women cannot be made to work for more than 7.5 h a day and for more than 45 h a week (Ministry of Labour and Social Security, 2003).

In this study, the women's ergonomic risks were determined by RULA scores. The RULA scores for the participants' upper and lower arm/wrist scores (score A), neck/trunk/legs scores (score B), and the grand scores were found to be quite high (Table 1). This was an expected result because a significant percentage of the women had musculoskeletal symptoms and high pain intensity. Similarly, the RULA final (grand) score supports this, showing the need for their situation to be investigated and for changes to be made immediately. However, there are no other studies from Turkey using RULA. In a study using the "Ovaka Working Posture Analysis System." more than 50% of the female SMOs were determined to have ergonomic risks (Tüzün, 2004). In a similar study from abroad, the grand score was found as 4.7 (Shuval and Donchin, 2005). The high RULA scores may be related to work station design, because the researchers observed that the primary work surface was too high and only 36.4% of the chairs were adjustable. In addition, the company did not have any programs to prevent ergonomic risks. However, according to OSHA's ergonomic guidelines for the prevention of ergonomic risks, there is a need to identify the nature and location of these problems in the workplace and implement measures to reduce or eliminate the problems (Eerd et al., 2003; Rogers, 2003).

In the comparison of MSD symptoms with general, work characteristics and RULA scores, significant differences were found in prevalence of MSD symptoms for having a chronic disease, using scissors, to feel pressured because of work, and RULA grand score (Table 1). In many studies, intense physical activity, high BMI, years worked, advanced age and inadequate education were found to

increase the prevalence of MSDs (Andersen and Gaardboe, 1993; Ming and Zaproudiana, 2003; Waersted and Westgaard, 1991). In this study, however, no statistically significant relationship was found between these factors and MDSs.

In this study, the most effective predictor in many body parts was found as "To feel pressured because of work". In several studies, psychosocial factors, such as high job strain, high job dissatisfaction and to feel less enthusiastic about work, have been reported to increase the MSD prevalence (Choobineh et al., 2009; David, 2005; Denis et al., 2008; Landau et al., 2008; Volkers et al., 2007; Wang et al., 2007). In a study conducted by Wang et al. (2009) high job strain prevalence was 55.1%. In a study, it has been demonstrated that women have more neck pain than men due to the psychosocial factors of their jobs (Volkers et al., 2007). A 2-year follow up study showed that previous physically heavy work, high productivity were predictors of MSDs of neck and shoulder region during the follow up period (Johnson et al., 1988). Being a working woman is a hard issue in Turkey. According to traditional perception, women are second-class citizens in both social environment and working life. Besides working, women should do so many activities such as childcare, house cleaning, cooking, caring of other family members, and shopping. In addition, payments of women are lower than men, who do same work (Esin and Öztürk, 2005). The finding that most of the subjects felt pressured about their work can be related with these factors.

Another important risk appeared to be significantly associated with neck symptoms: This was "working over 51 h in a week" (Table 2). Similarly, in several studies, working for many hours has been observed to increase the symptoms related with neck. In literature, it is suggested that increasing the frequency of physical activity and short resting period would decrease the symptoms related with neck (Chung et al., 1998; David, 2005; Denis et al., 2008; Foglemen and Lewis, 2002; Volkers et al., 2007; Wang et al., 2007).

However, the results of the present study demonstrated that the frequency of physical activities was insufficient in women. The prevalence of persistent neck and shoulder disorders has been found increase with years of employment as SMO (Johnson et al., 1988).

In this study, two variables (that is being over 41 years, and using scissors) emerged as significant predictors of the likelihood of upper limb symptoms. A higher prevalence of wrist symptoms was found in women who have been working $\geq$21 years, and have been graduated from elementary school. In addition, a higher prevalence of finger symptoms was found among women who were scissors users. In literature, there is no clear result about the effect of factors, such as age and education, on MSD development, whereas in the present study, these factors were very effective. However, there are some studies indicating that the MSD prevalence in SMOs would increase with the number of years of employment and using scissor (David, 2005; Denis et al., 2008; Chung et al., 1998).

The primary association examined in this study is the association between RULA scores (ergonomic risks) and MSDs symptoms. In logistic regression analysis women with finger symptoms had a higher RULA arm/wrist score. This association could be explained by the fact that the wrist/finger posture of women with symptoms was a greater extension than women without symptoms.

RULA is an advantageous method for use in the investigation of ergonomic risk factors by being cheap and practical than other observational methods (Ma et al., 2009). Considering the results of this study, it can be effectively used to determine the ergonomic risks. It is an easy method used by professionals, such as non-ergonomist workplace nurses and workplace physicians, who service occupational health. Especially in countries, in which occupational health services are in development stage, such as in Turkey, occupational health service is conducted by only nurses. Nurses that worked in our study reported that RULA method is easy to learn and effective in determination of risk factors.

As expected by the authors, the final mean RULA score pointed out that the employees' postures at their work stations needed to be investigated and some changes were required immediately. There were no participants who received RULA scores of 1–2, which indicates an acceptable posture. It is essential that ergonomic programs for the women in the study population be put into action immediately and medical treatment for those with high symptomatic and risk levels be provided because these women are very likely to suffer from MSD such as carpal tunnel syndrome, tendonitis, or back injuries in the future. The research findings provided fundamental data for this study population concerning the prevalence of musculoskeletal symptoms and ergonomic risks.

5. Conclusion

Although the effect of etiological mechanisms on causing MSDs is still poorly understood, studies have provided evidence that environmental factors and personal factors have an effect on the occurrence of MSDs. We confirmed some of these relationships in our study. In addition the RULA method for the determination of ergonomic risks before the emergence of MSDs was established as quite reliable and easy to use in this study. The women participating in this research were found to have a high level of both MSDs and ergonomic risks. These findings can be used to guide MSD prevention efforts for garment workers in Turkey.

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