Original Article

Journal of Occupational Health and Epidemiology
Journal Homepage: https://johe.rums.ac.ir/
JOHE
Rafsanjan University of Medical Sciences

Association between Working Posture and Anthropometric Compatibility with Workstations among Female Tailors in North Khorasan Province, Iran

Ali Dormohammadi[1], Mohsen Mahdinia[2], Vida Rezaei-Hachesu[3], Rajabali Hokmabadi[4*]

1. Instructor, Dept. of Occupational Health Engineering, School of Public Health, North Khorasan University of Medical Sciences, Bojnurd, Iran.
2. Assistant Prof., Dept. of Occupational Health, School of Public Health, Qom University of Medical Sciences, Qom, Iran.
3. Assistant Prof., Dept. of Occupational Health, School of Medical Sciences, Khoy University of Medical Sciences, Khoy, Iran.
4. Assistant Prof., Dept. of Occupational Health Engineering, School of Public Health, North Khorasan University of Medical Sciences, Bojnurd, Iran.

CrossMark

Citation: Dormohammadi A, Mahdinia M, Rezaei-Hachesu V, Hokmabadi R. Association between Working Posture and Anthropometric Compatibility with Workstations among Female Tailors in North Khorasan Province, Iran. J Occup Health Epidemiol. 2023;12(4):260-70.

Article Info

*** Corresponding author:**
Rajabali Hokmabadi,
E-mail:
abi.hse2006@gmail.com

Article history
Received: Mar 2023
Accepted: Oct 2023

doi 10. 61186/johe.12.4.260

Print ISSN: 2251-8096
Online ISSN: 2252-0902

Peer review under responsibility of Journal of Occupational Health and Epidemiology

Abstract

Background: One of the important principles of workstation design is the anthropometric compatibility of the workstation with people. Designing workstations by the anthropometric characteristics of employees can prevent awkward working postures and reduce the risk of such disorders. The present study aimed at investigating the anthropometric compatibility of workstations among Female Tailors and its association with working postures.

Materials and Methods: This cross-sectional study was conducted in female tailors in north Khorasan province in 2021. Participants were randomy selected and invited to the study. Working postures were assessed in workstations using the NERPA technique. Anthropometric dimensions were measured by ISO 7250 and anthropometric compatibility with the workstation was investigated. Mann-Whitney, Chi-square and T-test were used when analyzing the data.

Results: two hundered and ninty six tailors with a mean age of 26.5±12.7 years participated in this study. There was no significant association between posture scores and anthropometric conformity in the dimensions of chair back height, width, and depth. Anthropometric Compatibility with chair height and desk height is the only important factor of a workstation with a significant effect on people's posture ($P<0.01$). The final score of the NERPA method determined that 30 workstations (15%) had a low-risk level, and 166 stations (85%) had a high-risk level.

Conclusion: Anthropometric incompatibility with workstation generally deteriorated the working postures. However, anthropometric compatibility with seat-height and desk height were the ones with a significant association with working posture. Therefore, the seat height and desk heightshould be considered first for redesigning workstations.

Keywords: Design, Musculoskeletal Disorders, Ergonomics, Posture.

Introduction

Musculoskeletal disorders are the main cause of lost work time, increased costs and work-related disabilities in developed and developing countries, and they are among the most important issues faced by ergonomists all over the world; these disorders are the result of poor ergonomic design, which is one of the biggest concerns and problems in industrial sectors [1-4].

Various risk factors play a role in the occurrence of these disorders, such as unfavorable posture, lifting and carrying heavy loads, repetitive movements, vibrations, high force, contact pressure, low temperature, and unfavorable lighting [5-7]. According to the statistics published by the Iranian Statistics Center and the Ministry of Health and Medicine, 76% of the workers have unfavorable physical conditions. Since unfavorable conditions during work are one of the most important risk factors for these disorders, in many methods of assessing the risk of contracting for these disorders, posture analysis is considered the axis and basis of evaluation [8-10].

Observational methods of assessing exposure to risk factors of musculoskeletal disorders are the most common methods used in this field due to their ease, flexibility and low cost [11]. Posture analysis methods are considered effective methods to evaluate work activities in terms of ergonomics, so predicting the likelihood of musculoskeletal disorders using these methods will effectively reduce injuries [12-13]. The NERPA (Novel Ergonomic Postural Assessment) method is a new method obtained from the modification and development of the RULA (Rapid Entire Body Assessment) method, and its evaluation structure is similar to the RULA method, but it has fewer limitations. In this method, changes have been made in the range of movement of the organs, and the possibility of angular observation error can be reduced by entering the software and being used in industrial manual assembly operations [14-15].

Several studies have been conducted in the field of musculoskeletal disorders in tailors; soghasemi et al., conducted a study to investigate the association between working posture and anthropometric compatibility with workstations in sewing operators. This study showed anthropometric compatibility with seat height and desk height had a significant association with working posture [15]. Brohi et al. conducted a study to investigate the prevalence of musculoskeletal disorders among sewing machine operators using the Nordic questionnaire and numerical rating scale. This study showed a high prevalence of musculoskeletal symptoms in the lower back of operators [16]. Abate and Hailemariam concluded by examining the physical condition of the sewing operators that the design of the operator's seat has a significant association with the occurrence of pain in different parts of the body, especially in the upper and lower parts of the body with a high chance ratio of 93% [17]. The results of Alrahman et al.'s study showed that WRMSDs were more prevalent in the upper body parts of the experimental group. The RULA method also showed that workers in the right and left parts of their bodies are at medium and high risk [18]. Also, the results of Mehta et al.'s study showed that most tailors first experienced musculoskeletal disorder symptoms from 7 days to 12 months [19]. Diant and her colleagues concluded that their working postures were mostly unfavorable and were significantly related to the prevalence of musculoskeletal disorders in their bodies [20]. Öztürk and Esin reported similar results by examining the working conditions of sewing machine operators in Turkey [21].

Appropriate workstation design can reduce the risk of these disorders in various ways and minimize inappropriate working postures. Also, properly designing the workstation with the proper use of muscles can prevent the application of excessive forces to some extent. People in stations designed based on ergonomic principles perform better and suffer less fatigue and discomfort. Finally, the possibility of their disability due to work-related musculoskeletal disorders is less [22]. The tailors' job is one of the jobs that the operators have to do work, which includes activities such as, cutting clothes, repairing, and using an auto press Fig 1. Tailors must bend forward for long periods to perform their job duties, whether standing or sitting. This work situation puts much biomechanical pressure on their back and neck. These factors, along with the repetitive movements required for tasks related to sewing, increase the risk of musculoskeletal disorders in these people. Because sewing machine operators use their hands to transport, control, and move tools and objects, sit for long periods, and, repeat similar movements [23]. For this reason, studies conducted on female tailors have shown a high prevalence of musculoskeletal disorders in the neck, shoulder, back, hands/fingers, and lower back [24-26].

Fig. 1. Unfavorable postures of tailors in cutting, sewing, and using auto-press phases

One of the important principles of workstation design is the anthropometric compatibility of the workstation with people. In other words, workstations and other equipment should be designed based on the anthropometric dimensions of the target population [27-28]. To achieve anthropometric compatibility, the most desirable option is to provide chairs and tables with adjustable height, but industrial managers are not very interested in the huge costs of tables and chairs with adjustable height. Therefore, using chairs and tables with a fixed height is common in industries and small workshops. Regarding fixed height chairs and tables used in industries, there are two general problems: a) It is not clear exactly what these tables are made of and according to what standard. In the best case, one can hope that their construction is based on standards such as ISO 14738, where the data provided is also based on the European population; b) In the case of using a table and chair of fixed height, the design should be based on the 95th percentile of the population and the use of footrest by smaller people, which is not observed in many industries, especially small workshops. As a result, people's working postures when using tables and chairs of fixed height are usually unfavorable. In the past, associations have been presented to check the anthropometric compatibility of people and workstations [29-30]. Despite this, these associations have been less analyzed in industrial environments. They are mainly used in schools to check the anthropometric compatibility of students with classroom desks and benches [15,31].

The main discomfort of the workers of this trade is pain in the area of cervical and lumbar vertebrae, shoulders and legs, and it is necessary to check the chair used by this trade. In sewing workshops, they use different chairs, none prepared based on the standard. If these associations are suitable for evaluating work and industrial environments, they can be used as a guide for designing workstations with desks and chairs of fixed height. One approach to evaluating these associations is to examine their association with people's posture. Sewing machine operators in this sector face high health risks due to the design of the workplace, due to focused attention and static body posture, and the importance of health issues related to continuous working hours and static posture should be considered. Accordingly, this study examined the anthropometric compatibility of female sewing operators, their workstations and their association with working postures.

Materials and Methods

This cross-sectional study was carried out 2021 in the Female tailors 'workshops in North Khorasan province. The sampling method was simply random. The way of selecting the samples was such a way that after visiting the tailoring workshops and the satisfaction of the tailors, their workstations were evaluated. The studied population, taking into account the confidence level of 95%, predicting the prevalence of musculoskeletal disorders in the studied subjects based on the results of the study by Tafeseet al; equal to 50% and accuracy equal to 0.07 and using formula number 1[31], the number of 196 people were determined:

Formula 1.

$$1)\ n = \frac{z_{1-\frac{\alpha}{2}}^{2} \times P(1-P)}{d^2}$$

The criterion for entering the study was having at least one year of work experience and not having mental and physical problems. Exclusion criteria were having musculoskeletal disorders before engaging in this work or a history of accidents or diseases affecting these disorders. This study was reviewed by the research committee of North Khorasan University of Medical Sciences and approved with the code of ethics IR.NKUMS.REC.1400.153. Before starting the work, a written consent form was received from the participants, who were informed about the topic and the study method. Participation in the research had no financial burden for the participants, and they were free to participate or leave the study at any time. Information The participants were collected using the demographic information checklistcreated by the researcher. This checklist considered factors such as age, work history, body mass index, and duration of work and rest. People performed their job duties in sitting and standing workstations. Standing workstations were used to perform tasks such as ironing and cutting fabric, and sitting workstations were used for sewing machines.

The anthropometric dimensions of people were measured in standard standing and sitting postures according to ISO 7250-1 standard. The dimensions measured in this study were riding height, rump length, knee rump, elbow height in a sitting position, rump width, thigh thickness, shoulder height in a sitting position, sitting height and shin height. Finger, elbow height, shoulder height, and reach in standing position.

The associations suggested in previous studies were used to check the anthropometric compatibility between people and sitting workstations [28-29]. The most important factors investigated in this section were: chair height, chair seat depth, chair seat width, chair back height and desk height in the sitting position. The most important factor in the design of standing workstations is the desk's height. The height of the work table is designed based on the anthropometric dimension of the height of the elbow in the standing position and the nature of the task. In precise work, the height of the work table should be 5 to 10 cm higher than elbow height, and in light and heavy work, 10 to 15 and 15 to

40 cm lower than elbow height, respectively [32]. Since the activities of the employees were in the category of light work, the appropriate limit for the desk's height was between 10 and 15 cm lower than the height of the elbow. In Table 1, the suitable limit for each of these sections is presented. If the dimensions of the workstation the individual uses are within this range, there is a match; otherwise, there is no match. In this study, if the footing of the base level is used for the measurements related to the workstation, the footing level was considered; However, none of the underfoot workstations were observed. Anthropometric dimensions and workstations investigated in the present study are shown in Fig 2.

Table 1. Determining the associations between the anthropometric dimensions of people and the dimensions of the workstation

Sitting workstations [28-29]	
Seat height (SH) adjustment range	0.87 (Hip height + 2) ≤ SH≤0.996(hip height + 2)
Seat width (SW) adjustment range	1.1(hip width) ≤ SW≤ 1.3(hip width)
Seat depth (SD) adjustment range	0.80(depth of the hip buttocks) ≤ SD≤ 0.99(depth of the hip buttocks)
Back height (BH) adjustment range	0.6(shoulder height) ≤ BH≤ 0.8(shoulder height)
Sitting desk height (**S**iTH) adjustment range	height of the elbow + [0.87(Hip height + 2)] ≤ **S**iTH≤ [0.996 (Hip height+2) + (0.8517 height of the elbow) + (0.1483shoulder height)
Standing workstation (33)	
Standing desk height (StTH) adjustment range	elbow height-15≤ StTH≤elbow height in the standing position-10

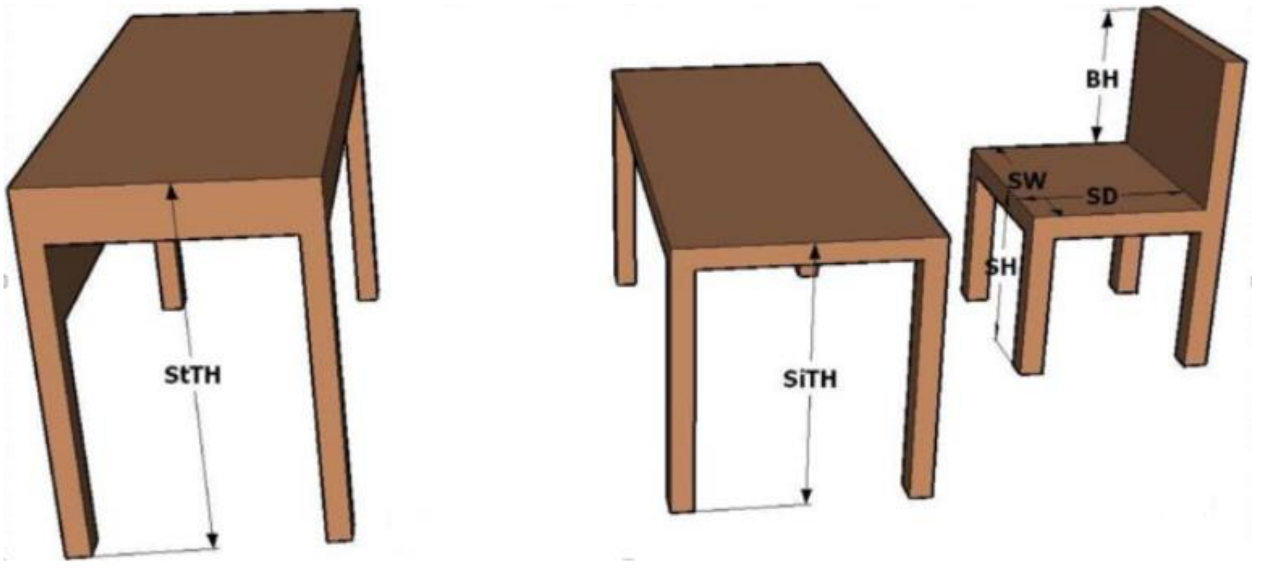

Fig. 2. Anthropometric dimensions and workstations investigated in the present study

In the present study, the NERPA method was used to evaluate people's posture in standing and sitting workstations. In 2013, Sanchez-Lite and colleagues [14] presented the NERPA posture assessment method based on the RULA method [33]. This method evaluates the posture of different body organs, including the neck, trunk, and upper limbs (arm, forearm, and wrist), along with the amount of muscle force and external force on the body. The NERPA scoring system follows 15 distinct steps. Body parts are classified into two groups A and B. Group A includes the arms, forearms, wrists, and group B includes the neck, trunk, and legs. Then, the A and B scores are obtained by considering the effect of force and repeating the movement. Finally, the final NERPA score is determined according to Table C (Fig 3), and finally, after calculating the final score, the priority level of corrective action is determined according to Table 2 [14,34].

Table 2. The final score of the priority level of corrective action according to the NERPA method

Final score	Risk level	Priority level of corrective action
1-2	Low	acceptable
3-4	Medium	Need to study more
5-6	High	Need to study more ergonomic interventions shortly
7 and above	Very high	Need to study more and urgent ergonomic interventions

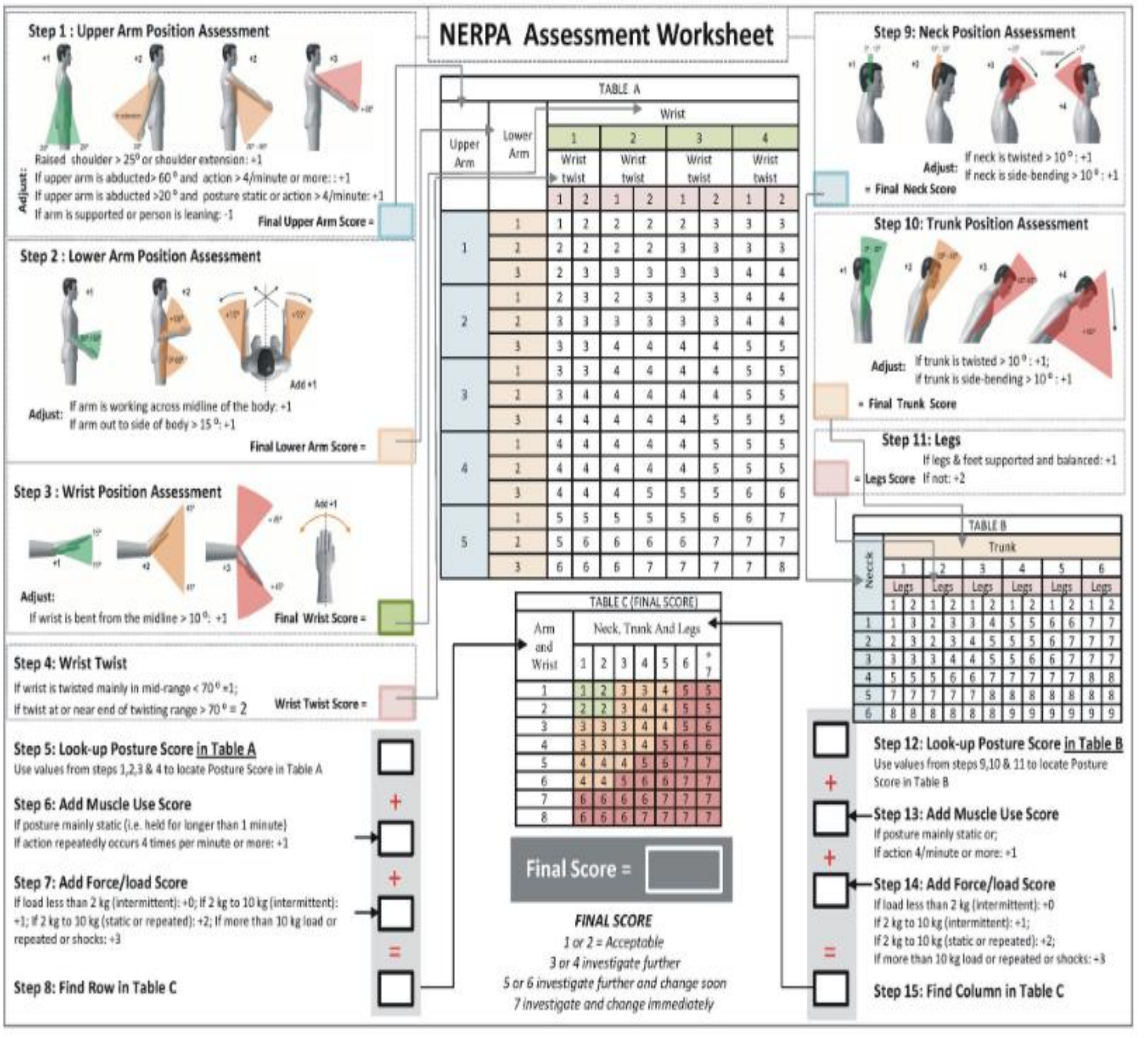

Fig. 3. The NERPA worksheet was modified from the RULA worksheet using new NERPA criteria [14].

The prevalence of musculoskeletal disorders was determined using the Nordic questionnaire. The validity and reliability of the Nordik questionnaire were investigated by Ezgoli et al. in 2015 and confirmed with a correlation coefficient of 0.91 [35]. Nordic questionnaire for the verification of skeletal-muscular disorders in various areas of the body, including the neck, shoulder, upper back, lower back, waist, elbows, wrists, thighs, knees, and ankles [36].

The current research uses descriptive statistics indicators such as mean and standard deviation to describe the data and to check the normality of the data using the Kolmogorov-Smirnov (KS) statistical test.To check the association between the prevalence of symptoms in different body parts and variables using the T-test, Chi-square statistical test, and Mann-Whitney test.This study investigated the association between anthropometric compatibility with workstation and posture score using the Mann-Whitney test. All analyses were done using SPSS 22 software. The level of significance of the statistical tests was considered to be P<0.05.

Results

This study was conducted on 196 female tailors. Most of the people studied were in the age group of 20-29 years (110 people equal to 56%), and the maximum length of work experience of the studied subjects was 6-10 years (85 people equal to 43%). The mean and standard deviation of age and working experience of tailors are 26.5±12.7 and 8.5±4.2 years, respectively. The results of the prevalence of symptoms of musculoskeletal disorders showed that the highest and lowest prevalence of musculoskeletal disorders are related to the lower back (58%) and elbow (9%), respectively.

In this research, to obtain better results, low and medium-risk levels and high and very high-risk levels were merged, and two groups of low-risk levels and high-risk levels were created. As seen in Table 3, and the prevalence of symptoms in different parts of the body has been reported in people in the high-risk group. The chi-square statistical test showed a significant association between the level of risk and the prevalence of symptoms in different areas of the body. The highest percentage of people (92%) in the high and very high-risk level is related to the waist area, and the association between neck, back, waist, thigh, knee and leg disorders with the risk level determined by the NERPA method was significant.

Table 3. Prevalence of musculoskeletal disorders in the study population according to risk level (n=196)

Body areas	Risk level (Ergonomic intervention)				P-value*
	Low (May be necessary)		High (Necessary and as soon as possible)		
	N	Percent	N	Percent	
Neck (n=81)	8	10%	73	90%	0.011
Shoulder(n=60)	11	18%	49	82%	0.255
Elbow (n=18)	3	17%	15	83%	0.078
Wrist and hand(n=54)	7	13%	47	87%	0.065
Back (n=68)	12	18%	63	82%	0.005
Low-back (n=113)	9	8%	104	92%	0.002
Thigh (n=21)	3	14%	18	86%	0.025
Knee (n=75)	10	13%	69	87%	0.003
Foot (n=89)	15	17%	84	83%	0.015

* Chi-square test

The results showed the association between the prevalence of musculoskeletal disorders with age (P-value =0.035), body mass index (P-value =0.018), duration of work (P-value =0.023), duration of rest (P-value =0.025), and work history (P-value=0.012) is significant using the T-test.

The results of measuring the anthropometric dimensions of people in sitting and standing workstations are presented in Table 4. As shown in Table 5, there was no significant association between the posture score and the anthropometric matching in the dimensions of chair back height and width and depth (P-value>0.05). Anthropometric matching with chair height and desk height is the only important factor of the workstation with a significant effect on people's posture (P-value≤0.05). Also, there is no significant association between the posture score and other demographic factors, such as age and body mass index (P-value>0.05). However, in general, the lack of anthropometric compatibility with the workstation leads to an increase in the posture score and the level of ergonomic risk. Based on the results presented in Table 5, there was a significant difference between the postural scores of people in terms of anthropometric compatibility with standing workstations (P-value≤0.05). Despite this, no significant association was observed between the posture score and other demographic factors, such as age and body mass index (P-value>0.05). It is worth mentioning that the sitting and standing workstations investigated in this study were not adjustable.

The final score of the NERPA method determined that 30 workstations (15%) had a low-risk level that ergonomic measures may be necessary, and 166 stations (85%) had a highrisk level that required ergonomic measures to be done as soon as possible.

Table 4. Anthropometric dimensions of people at workstations in the study population (n=196)

Anthropometric dimensions of people sitting at workstations				
Anthropometric dimension	Mean	SD	Percentile 5	Percentile 95
Rider height (cm)	40.25	2.7	35.75	44.5
Depth of capillary(cm)	47.5	2.9	43.5	53.5
The depth of the buttocks(cm)	56.5	2.9	52.5	61.25
Elbow height in sitting position (cm)	23.5	2.8	19	28.1
Button width(cm)	38.5	3.56	32	44.5
Space of thighs(cm)	17.8	1.6	14.5	20.5
Shoulder height in sitting position(cm)	55.65	3.1	51.6	61.5
Sitting height(cm)	80.8	3.5	75.6	86.4
Anthropometric dimensions of people in standing workstations				
Coarse height(cm)	40.5	3.56	35.7	44.3
The height of the knuckle protrusion (cm)	65.6	3.5	59.5	71.6
Elbow height(cm)	101.05	4.5	94.1	108.5
Shoulder height(cm)	131.56	5.7	122.4	140.9
Access limit in standing position(cm)	72.5	7.5	63.6	80.1

Table 5. The association between compatibility with the workstation and the final score of posture in the workstation in the study population (n=196)

Dimensions of workstation	Compliance status	N (%)	Posture score mean (±SD)	P-value*
Sitting workstations				
The size of the back of the chair	Compliance	39(20%)	0.9± (4.7)	0.85
	No compliance	157(80%)	1.05± (4.6)	
Seat height	Compliance	59(30%)	1.25± (4.4)	0.01
	No compliance	137(70%)	0.92± (4.85)	
Seat width	Compliance	78(40%)	1.15± (4.6)	0.57
	No compliance	118(60%)	0.96± (4.75)	
Seat depth	Compliance	143(73%)	1.05± (4.6)	0.23
	No compliance	53(37%)	1.2± (4.25)	
Desk height	Compliance	31(16%)	1.15± (4.21)	0.05
	No compliance	165(84%)	0.98± (4.78)	
Standing workstations				
Desk height	Compliance	(19%)37	1.66± (4.35)	0.01
	No compliance	159(81%)	1.88± (5.48)	

* Mann-Whitney test

Discussion

The prevalence of skeletal-muscular disorders in the studied tailors is high, and the results of the ergonomic evaluation using the NERPA method indicate that the working conditions are inappropriate. Due to the significant association between improper posture and the prevalence of symptoms in some areas of the tailors' body, with the proper design of the workstation, it will be possible to reduce the prevalence of musculoskeletal disorders in them.

According to the results obtained from the present study, the highest prevalence of skeletal-muscular disorders was related to the waist area, and the lowest was the elbow area. In the study of Afif Zadeh [37] and Jabari [38], the highest and lowest prevalence of musculoskeletal disorders were found in the waist and elbow area, which was in agreement with the results of this study. Also, in the study of Hokmabadi et al. [39]and Brohi et al. [16], the most reported disorders were related to the back. In the case of the Schibyestudy [40], the highest prevalence of musculoskeletal disorders was reported in the neck and shoulder area. The difference between the results of the present study and the Schibyestudy is the amount of work experience.

The results of the article showed a significant association between musculoskeletal disorders with age, work experience, and the duration of work, and with increasing age and work experience, the incidence of musculoskeletal disorders among the studied tailors increases, which indicates cumulativeness. The factors affecting the incidence of musculoskeletal disorders are that these results were consistent with the results of Rahimi Moghadam et al. [41], Roshni et al. [42], and Karimi et al. [43]. However, it was inconsistent with the results of the study by Hokmabadi et al. [44], which could be due to the difference in age, gender, and type of profession.

Another important risk factor that had a significant association with the prevalence of musculoskeletal disorders was the long working hours of tailors, so in various studies [45-46] has been suggested to increase the frequency of physical activities and short rest periods to reduce the symptoms of musculoskeletal disorders.

The results of evaluating the level of risk of skeletal-muscular disorders using the NERPA method showed that the risk level is high in the studied society, indicating the inappropriateness of the ergonomic conditions of sewing workshops. The results of NERPA showed that the prevalence of symptoms in different areas of the body is higher in people in the high-risk level group. This shows the need to take corrective measures. Also, there is a significant association between the level of risk and the prevalence of symptoms in different parts of the body. It was obvious that due to the inappropriate design of the workstation and the long working time, all these factors make it unavoidable to adopt a fixed body position during the work period. The result was not far from expected. According to OSHA's ergonomic guidelines, to prevent ergonomic risks, it is necessary to determine the nature and location of these problems in the workplace and to implement measures to reduce or eliminate these problems [47].

The results of posture evaluation using the NERPA method showed that people's working conditions are mostly unfavorable because the required action level is two or more. These results are consistent with the research results of Ghasemi et al. [15], Nagaraj et al. [48] and Dayant et al. [19]. Therefore, based on this evidence, workstations in weaving industries are mostly unfavorable, and it seems necessary to implement ergonomic interventions to improve working postures in this industry. However, it should be noted that these methods have little sensitivity to body angles and, sometimes, a significant change in body position does not change the scores of these methods [49].

In addition, the results of the present research indicated a significant association between anthropometric compatibility with the workstation in terms of chair height and desk height. The results of this study are consistent with the results of Ghasemi et al. [15] and Tondre et al. [50]. In that study, they reported a significant association between the height of the sewing table and pain and discomfort in the neck, trunk, and arms. The present study observed a significant association between the anthropometric compatibility with the work table and the posture score. Also, in that study, the researchers suggested that angling the sewing table by 10 degrees can prevent many undesirable working postures. Considering that all the work tables examined in the present study lacked angles, it is impossible to compare the results of the two studies.

As we mentioned before, there was a significant association between anthropometric matching with chair height and posture scores. In other words, the anthropometric did not match the height of the chair, significantly increasing the postural score of the people. Using a chair with an inappropriate height can harm the posture of other organs, such as the neck, trunk, shoulders, arms, and the results of this study are consistent with the results of Pheasant et al. [26].

According to the explanations given, the chair's height plays a significant role in the position of other body organs, and using a chair with the right height can also prevent the improper posture of other organs. In this study, it was observed that in all cases, the lack of anthropometric compatibility with workstations leads to an increase in the posture work score. Therefore, by creating anthropometric conformity of the posture work score, the ergonomic risk can be reduced. Of course, he also pointed out that anthropometric matching between people and workstations alone cannot guarantee proper working posture. Many studies have shown that poor knowledge of ergonomics is effective in adopting inappropriate working postures. For example, Ekinci et al. [51] showed that the posture of office workers could be improved by using proper ergonomic training. Robertson et al. [52] also concluded that ergonomic training can effectively increase people's knowledge level and improve their working postures. Therefore, it is suggested to pay special attention to training and increasing people's ergonomic knowledge in addition to the appropriate design of workstations and provision of anthropometric matching.

Like any other research, this study also has limitations that should be mentioned. Posture evaluation using conventional methods such as NERPA is based on personal judgment; therefore, it always has some errors. In this study, 196 tailors participated, which seems to be a sufficient sample size. Despite this, the results obtained from this sample size cannot be generalized to all people and any generalization of these results should be done with caution.

It is suggested that in future studies, the assessment of posture among tailors done by other method, and comparison of these methods will be done. It is also suggested that the physical condition of male tailors is also studied and the effect of gender on the occurrence of musculoskeletal disorders of tailor workers is also investigated.

Conclusion

The posture of female tailors is mostly undesirable and requires ergonomic interventions. In general, the anthropometric mismatch between the person and the workstation leads to an increase in the posture score and an increase in exposure to the risk of ergonomic factors. However, anthropometric matching with chair height and desk height was a very influential factor on posture score; Therefore, it is recommended to pay special attention to this dimension for redesigning workstations.

Acknowledgement

The article's authors would like to thank the Vice President of Research and Technology of North Khorasan University of Medical Sciences for their financial support (Project number: 990110).

Conflict of interest: None declared.

References

1. Choobineh A, Tosian R, Alhamdi Z, Davarzanie M. Ergonomic intervention in carpet mending operation. Appl Ergon. 2004;35(5):493-6.
2. Kee D. Comparison of OWAS, RULA and REBA for assessing potential work-related musculoskeletal disorders. Int J Ind Ergon. 2021;83:103140.
3. 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.
4. Hokmabadi R, Sepehr P. Assessing the Posture and predicting the factors affecting musculoskeletal disorders in computer uses by neural networks. J Health Saf Work. 2021;11(4):700-19.
5. Mazloumi A, Kazemi Z, Mehrdad R, Vahedi Z, Hajizade L. Risk Factors of Low Back Pain in Iranian Workers during 2000-2015: A Systematic Review. Int J Occup Hyg. 2020;12(3):239-55.
6. Madadizadeh F, Vali L, Harati Khalilabad T, Ezati Asar M. Work-Related Musculoskeletal Disorders among Administrative Employees of Kerman

University of Medical Sciences. Int J Occup Hyg. 2016;8(2):78-84
7. Kee D, Karwowski W. LUBA: an assessment technique for postural loading on the upper body based on joint motion discomfort and maximum holding time. Appl Ergon. 2001;32(4):357-66.
8. Ghanbary-Sartang A, Habibi H. Evaluation of musculoskeletal disorders to method Rapid Office Strain Assessment (ROSA) in computers users. J Prev Med. 2015;2(1):47-54.
9. Mirmohammadi T, Mahmoodi Sharafe H, Mousavinasab N, Raufinia A. Comparison of Novel Ergonomic Postural Assessment and Rapid Upper Limb Assessment Methods for Evaluating the Posture of Employees in an Agricultural Equipment Manufacturing Company in 2017. J Health Res Community. 2019;5(1):71-8.
10. Beheshti MH, Tajpuor A, Jari A, Samadi S, Borhani Jebeli M, Rahmanzadeh H. Evaluation of ergonomic risk factors for musculoskeletal disorders among kitchen workers. Arch Occup Health. 2018;2(2):128-35.
11. David GC. Ergonomic methods for assessing exposure to risk factors for work-related musculoskeletal disorders. Occup Med (Lond). 2005;55(3):190-9.
12. Salimi S, Hasheminejad N, Kangavari M, Pouyakian M, Mohammadpour H. Comparison of the results of three observational methods of assessment of musculoskeletal disorders: a case study in the steel industry. Qom Univ Med Sci J 2016;10(3):81-7.
13. Nasiri I, Motamedzade M, Golmohammadi R, Faradmal J. Assessment of risk factors for musculoskeletal disorders using the Rapid Office Strain Assessment (ROSA) Method and implementing ergonomics intervention programs in Sepah Bank. J Health Saf Work. 2015;5(2):47-62.
14. Sanchez-Lite A, Garcia M, Domingo R, Angel Sebastian M. Novel ergonomic postural assessment method (NERPA) using product-process computer aided engineering for ergonomic workplace design. PLoS One. 2013;8(8):e72703.
15. Ghasemi F, Hasini M, Ahmadi M, Rahmiani Iranshahi M. The Association between Working Posture and Anthropometric Compatibility with Workstations: A Case Study among Sewing Operators. Iran J Ergon. 2021;8(4):15-30.
16. Abate AE, Hailemariam SS. Improving work-related musculoskeletal disorders for sewing machine operators in Ethiopia. Int J Occup Saf Ergon. 2023;29(2):573-85.
17. Alrahman RA, Hamdan J, Alawneh D, Shehab M, Hasan O. Risk Assessment and Biomechanical Analysis of Sewing Machine Operators Using CATIA Software. Proceeding of the 2022 International Conference on Emerging Trends in Computing and Engineering Applications (ETCEA); 2022 Nov 23; Karak, Jordan.
18. Mehta E, Mehta M, Sharma PK. A study on work-related musculoskeletal disorders among sewing machine operators. Indian J Health Wellbeing. 2020;11(1):8-12.
19. Dianat I, Kord M, Yahyazade P, Karimi MA, Stedmon AW. Association of individual and work-related risk factors with musculoskeletal symptoms among Iranian sewing machine operators. Appl Ergon. 2015;51:180-88.
20. Öztürk N, Esin MN. Investigation of musculoskeletal symptoms and ergonomic risk factors among female sewing machine operators in Turkey. Int J Ind Ergon. 2011;41(6):585-91.
21. Delleman NJ, Berndsen MB. Touch-typing VDU operation: Workstation adjustment, working posture and workers' perceptions. Ergonomics. 2002;45(7):514-35.
22. Wang PC, Rampel DM, Harrison RJ, Chan J, Ritz BR. Work-organizational and personal factors associated with upper body musculoskeletal disorders among sewing machine operators. Occup Environ Med. 2007;64(12):806-13.
23. Kaergaard A, Andersen JH. Musculoskeletal disorders of the neck and shoulders in female Sewing machine operators: prevalence, incidence, and prognosis. Occup Environ Med. 2000;57(8):528-34.
24. Kilroy N, Dockrell S. Ergonomic intervention: its effect on working posture and musculoskeletal symptoms in female biomedical scientist. Br J Biomed Sci. 2000;57(3):199-206.
25. Dahlberg R, Karlqvist L, Bildt C, Nykvist K. Do work technique and musculoskeletal symptoms differ between men and women performing the same type of work tasks? Appl Ergon. 2004;35(6):521-9.
26. Pheasant S, Haslegrave CM. Bodyspace: Anthropometry, ergonomics and the design of work. 3rd ed. Boca Raton, United States: CRC Press; 2018.
27. Heidarimoghadam R, Shabani M, Lotfi Y, Ghasemi F, Mohammadi Y. Study of Hand Anthropometry Dimensions on Middle-Aged Women and Men in Hamadan. J Ergon. 2018;6(2):46-54.
28. Parcells C, Stommel M, Hubbard RP. Mismatch of A Classroom Furniture and Student Body Dimensions Empirical Findings and Health Implications. J Adolesc Health. 1999;24(4):265-73.
29. Abd Rahman NI, Md Dawal SZ, Yusoff N, Mohd Kamil NS. Anthropometric measurements among four Asian countries in designing sitting and standing workstations. Sadhana 2018;43(10):1-9.
30. Parvez MS, Parvin F, Shahriar MM, Kibria G. Design of Ergonomically Fit Classroom Furniture for Primary Schools of Bangladesh. J Eng. 2018;2018:1-9.
31. 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.
32. Stack T, Ostrom LT, Wilhelmsen CA. Occupational Ergonomics: Practical Approach A. New Jeresy, United States: John Wiley & Sons, Inc; 2016
33. McAtamney L, Nigel Corlett E. RULA: a survey method for the investigation of world-related upper limb disorders. Appl Ergon. 1993;24(2):91-9.
34. Sanchez-Lite A, Garcia M, Domingo R, Angel

Sebastian M. Novel ergonomic postural assessment method (NERPA) using product-process computer aided engineering for ergonomic workplace design. PLoS One. 2013;8(8):e72703.
35. Baghri H, Shahabi Z, Ebrahimi H, Alaeenejad F. The association between quality of sleep and health-related quality of life in nurses. J Hayat. 2007;12(4):13-20.
36. Kuorinka I, Jonsson B, Kilbom A, Vinterberg H, Biering-Sørensen F, Andersson G, et al. Standardized Nordic Questionnaires for the analysis of musculoskeletal symptoms. Appl Ergon. 1987;18(3):233-7.
37. Kazemi S, Asgari A, Khatib M, Poyafar L, Mohammadi M. Determining the prevalence of musculoskeletal disorders in tailors in Kermanshah, Iran using the Nordic questionnaire (2018). Int J Health Life Sci. 2019;5(1):e85896.
38. Jabari Z, Honarbakhsh M, Zamanian Z. Survey of muscle fatigue for using MFA method and determination of some risk factors of musculoskeletal disorders among tailors in Shiraz, 2015. Iran Occup Health. 2018;14(1):47-56.
39. Hokmabadi R, Ebrahimian H, Asghari MH, Rezaee Z. Assessment of risk factors and prevalence of musculoskeletal disorders in staff members of Imam Khomeini Hospital in Shirvans using REBA method. Occup Hyg Health Promot J. 2018;1(3):217-26.
40. Schibye B, Skov T, Ekner D, Christiansen JU, Sjøgaard G. Musculoskeletal symptoms among sewing machine operators. Scand J Work Environ Health. 1995; 21(6):427-34.
41. Rahimi Moghaddam S, Khanjani N, Hasheminejad N. Evaluating Risk Factors of Work-Related Musculoskeletal Disorders in Assembly Workers of Nishabur, Iran Using Rapid Upper Limb Assessment. Health Dev J. 2012;1(3):227-36.
42. Rowshani Z, Mortazavi SB, Khavanin A, Mirzaei R, Mohseni M. Comparing RULA and Strain index methods for the assessment of the potential causes of musculoskeletal disorders in the upper extremity in an electronic company in Tehran. Feyz. 2013;17(1):61-70.
43. Karami Matin B, Mehrabi Matin A, Ziaei M, Nazari Z, Yarmohammadi H, Gharagozlou F. Risk assessment of cumulative trauma disorders in Quarry and Stone Industries workers Kermanshah in 2013. Iran J Ergon. 2013;1(2):28-35
44. Hokmabadi RA, Esmailzadehe Kavaki M, Mahdinia M. Evalution of Ergonomic Postures of Hairdressers by Rapid Entire Body Assessment. J N Khorasan Univ Med Sci. 2012;3(4):49-54.
45. Wang PC, Rampel DM, Harrison RJ, Chan J, Ritz BR. Work-organizational and personal factors associated with upper body musculoskeletal disorders among sewing machine operators. Occup Environ Med. 2007;64(12):806-13.
46. Denis D, St -Vincent M, Imbeau D, Jette C, Nastasia I. Intervention practices in musculoskeletal disorder prevention: a critical literature rewiev. Appl Ergon. 2008;39(1):1-14.
47. Ming Z, Zaproudiana N. Computer use related upper limb musculoskeletal (ComRULM) disorders. Pathophysiology. 2003;9(3):155-60.
48. Sakthi Nagaraj T, Jeyapaul R, Mathiyazhagan K. Evaluation of ergonomic working conditions among standing sewing machine operators in Sri Lanka. Int J Ind Ergon. 2019;70:70-83.
49. Ghasemi F, Mahdavi N. A new scoring system for the Rapid Entire Body Assessment (REBA) based on fuzzy sets and Bayesian networks. Int J Ind Ergon. 2020;80:103058.
50. Tondre S, Deshmukh T. Guidelines to sewing machine workstation design for improving working posture of sewing operator. Int J Ind Ergon. 2019;71:37-46.
51. Ekinci Y, Atasavun Uysal S, Kabak VY, Duger T. Does ergonomics training have an effect on body posture during computer usage? J Back Musculoskelet Rehabil. 2019;32(2):191-5.
52. Robertson M, Amick BC 3rd, DeRango K, Rooney T, Bazzani L, Harrist R, et al. The effects of an office ergonomics training and chair intervention on worker knowledge, behavior and musculoskeletal risk. Appl Ergon. 2009;40(1):124-35.