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# Risk Assessment of Musculoskeletal Disorders Prevalence in Female Hairdressers using RULA and NERPA Techniques

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ABSTRACT

**Aim:** An Objective measure of ergonomic risk factors in the workplace performs a significant role in preventing the prevalence of Work-related Musculoskeletal Disorders (WMSDs). Hairdressers are exposed to various safety and health risk factors due to the nature of their job. This study aimed to assess the risk of prevalence of WMSDs in female hairdressers.

**Method and Materials:** In this study, the physical postures of 70 female hairdressers were assessed using Rapid Upper Limb Assessment (RULA) and Novel Ergonomic Postural Assessment (NERPA) and then the Nordic Questionnaire (NQ) was used to assess the prevalence of WMSDs.

**Findings:** RULA and NERPA final score in the worst and longest postures for hairdressers was 7. The highest prevalence of WMSDs was reported in the shoulder, knee and, neck area of the body. There was a significant relationship between hairdresser's age and the prevalence of WMSDs in the shoulders, back, waist, knees and, ankles areas. The prevalence of WMSDs was found to have a significant relationship with standing-sitting activities.

**Conclusion:** The findings of this research revealed that the study population had a high prevalence of WMSDs, especially in the shoulder, knee and, neck areas. This study suggested that the conditions of the workplace should be improved. Therefore, in addition to improving working conditions, it is recommended that hairdressers be trained in identifying workplace hazards and so using proper ergonomic standards while working.

**Keywords**: Work-Related Musculoskeletal Disorders (WMSDs), RULA, NERPA, Nordic Questionnaire.

## Introduction

Work-related Musculoskeletal Disorders (WMSDs) in industrialized and developed countries are among the biggest health problems faced by ergonomics and occupational health professionals [1]. One of the most common causes of lost work time, increased costs, and workforce harm is WMSDs [2]. It has been argued that 40 percent of the paid compensation to the workers in the workplace is related to WMSDs [1]. Annually, around 160 million work-related illnesses happen to the workforce in the workplace, according to the International Labor Organization (ILO), of which WMSDs constitute a major part [3]. The National Institute for Occupational Safety and Health (NIOSH) has been ranked WMSDs as the second most important disease in terms of national importance after lung diseases in terms of prevalence, severity, and prevention [4]. According to a research, in 2017, 9.8 million working days were lost in the United Kingdom due to WMSDs, compared with around 35% of all working days lost due to occupational diseases [5]. It has been reported that WMSDs also cost economically so much for the individual, organization, government, and society [6]. Due to the high costs of WMSDs and the increase in work-related absenteeism, the overall direct and indirect costs of these disorders are projected




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to be about 1% of the GDP of developed countries [7]. It has been estimated that WMSDs have become one of the significant public health issues due to the increasing demand for health services using and the temporary and permanent disabilities caused by them that significantly affect the quality of working life [8]. These disorders account for 65 percent of occupational diseases and are one of the most common reasons for work-related disability [9]. These diseases are conditions in which muscles, tendons, and nerves are damaged and symptoms appear as pain, discomfort, and numbness in the limbs [10]. These disorders occur as a result of the cumulative destruction of musculoskeletal tissues caused by physiological and biomechanical stressors exposures over many years [1]. Generally, WMSDs occur in the upper and lower limbs [11]. These disorders occur either gradually during prolonged exposure to the causative agents, or suddenly as a result of heavy impacts to a part of the musculoskeletal system. When work and the work environment contribute to the occurrence of such disorders, MusculoSkeletal Disorders (MSDs) are called work-related musculoskeletal disorders (WMSDs) [12]. Therefore, many countries have considered work-related musculoskeletal disorders prevention as a national priority [13]. In this regard, WMSDs is caused by several factors, one of which is poor (undesirable) work postures [1]. Lifting and moving heavy loads, applying excessive force, contact pressure, repetitive movements, vibration, unfavorable static conditions and unsuitable working environment are other risk factors for WMSDs [14-19].

The hairdressing career is one of the professions where the incidence of WMSDs has resulted in multiple complaints [8]. In this profession, due to repetitive movements, long working periods time in standing positions, and incorrect working conditions, the probability of such disorders have been increased. [20]. A research conducted by Khandan et al. Showed that female hairdressers suffer from pain in the legs, back, neck, and shoulders [21]. Hairdressers have the highest prevalence of WMSDs in the elbow, neck, wrist, shoulder, hips, ankle, knee, and back respectively, according to a report conducted by Froorash et al., on males and females hairdressers [22]. Another study showed that pain in the elbows, shoulders and back areas were the most prevalence WMSDs in hairdressers, respectively [23]. Another study found that the prevalence of WMSDs and related risk factors among hairdressers is high [24]. Since one of the most important risk factors for WMSDs is poor posture at work, postural assessment is used as the core and basis of many methods of determining the risk of WMSDs [25]. Postural assessment methods of Rapid Upper Limb Assessment (RULA) and Novel Ergonomic Postural Assessment (NERPA) allow the assessment of a wide range of risk factors for these disorders. Since the ergonomic conditions of female hairdressers and providing control solutions have not been fully investigated, in this study, the physical postures of these individuals were examined by observational methods using RULA and NERPA techniques, and also the prevalence of symptoms of WMSDs was investigated using The Nordic Questionnaire (NQ).

## Method and Materials

The present study was a descriptive study conducted in the year of 2020 on 70 female hairdressers in Sabzevar, Iran. Among the study inclusion criteria, the hairdressers whose work experience was more than one year were entered into the study., However, the exclusion criteria of this study were people with congenital musculoskeletal

**Table 1)** Frequency Distribution of Musculoskeletal Disorders and its Relationship with Age in Female Hairdressers in Sabzevar, Iran

| Row | Organs | Organs Pain (Yes / No) | Musculoskeletal Disorders Prevalence Based on Age | | | | | P - value |
|---|---|---|---|---|---|---|---|---|
| | | | <25 N(%) | 25-30 N(%) | 30-35 N(%) | 35-40 N(%) | 40< N(%) | |
| 1 | Neck | No | 39(55.56) | 24(33.33) | 31(44.44) | 24(33.33) | 22(31.25) | 0.458* |
| | | Yes | 31(44.44) | 47(66.67) | 39(55.56) | 47(66.67) | 48(68.75) | |
| 2 | Shoulder | No | 35(50) | 4(5.56) | 24(33.33) | 31(44.44) | 5(6.25) | 0.003** |
| | | Yes | 35(50) | 66(94.44) | 47(66.67) | 39(55.56) | 66(93.75) | |
| 3 | Elbow | No | 47(66.67) | 51(72.22) | 47(66.67) | 47(66.67) | 57(81.25) | 0.879** |
| | | Yes | 24(33.33) | 19(27.78) | 24(33.33) | 24(33.33) | 13(18.75) | |
| 4 | Wrist | No | 43(61.11) | 47(66.67) | 16(22.22) | 31(44.44) | 31(43.75) | 0.320* |
| | | Yes | 27(38.89) | 24(33.33) | 54(77.78) | 39(55.56) | 39(56.25) | |
| 5 | Upper Back | No | 62(88.89) | 43(61.11) | 31(44.44) | 8(11.11) | 22(31.25) | 0.003* |
| | | Yes | 8(11.11) | 27(38.89) | 39(55.56) | 62(88.89) | 48(68.75) | |
| 6 | Waist | No | 47(66.67) | 24(33.33) | 16(22.22) | 16(22.22) | 26(37.50) | 0.045* |
| | | Yes | 24(33.33) | 47(66.67) | 54(77.78) | 54(77.78) | 44(62.50) | |
| 7 | Hips and thighs | No | 66(94.44) | 52(72.22) | 54(77.78) | 62(88.89) | 61(87.50) | 0.415* |
| | | Yes | 4(5.56) | 19(27.78) | 16(22.22) | 8(11.11) | 9(12.50) | |
| 8 | Knee | No | 35(50) | 35(50) | 24(33.33) | 24(33.33) | 5(6.25) | 0.018* |
| | | Yes | 35(50) | 35(50) | 47(66.67) | 47(66.67) | 66(93.75) | |
| 9 | Ankle | No | 43(61.11) | 66(94.44) | 54(77.78) | 39(55.56) | 9(12.50) | 0.050** |
| | | Yes | 27(38.89) | 4(5.56) | 16(22.22) | 31(44.44) | 61(87.50) | |

* Chi-square test
** Fisher test

diseases and those who had musculoskeletal disorders caused by an accident. To do the research, firstly the aims and procedures of the study were explained to the potential participants , and if they were satisfied to take part in the study and they signed the consent form, they were entered to the study voluntarily.

Data collection tools in this study were the Nordic musculoskeletal disorders Questionnaire (NQ), RULA and NERPA. In this study, RULA and NERPA methods were used to determine the level of the worst and the longest period time of occupational posture.

The RULA method is an observational method that, along with its simplicity of implementation, has good validity and reliability [26]. Risk factors assessed in the RULA method include the number of movements, muscle static work, and force applied [1]. In RULA method, sampling is performed by observing the posture of the limbs where the worst and longest period time of the postures are applied. After selecting the worst and the most frequent posture, the assessment is done. After selecting the desired posture, using diagram A, the postures of the arm, forearm, and wrist are assessed. Then, using the relevant table, the combined effect of group A postures is determined. Then, using diagram B, the postures of the neck, dorso, and legs are also assessed, and using the relevant table, the combined effect of group B postures is determined. In the next step, the point of


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**Table 2)** Frequency Distribution of Musculoskeletal Disorders and its Relationship with the Activity Type of Female Hairdressers in Sabzevar, Iran

| Row | Organs | Organs Pain (Yes / No) | Musculoskeletal Disorders Prevalence Based on Activity Type N(%) | | | p-value |
|---|---|---|---|---|---|---|
| | | | Sitting | Standing | Sitting / Standing | |
| 1 | Neck | No | 9(12.50) | 25(35.90) | 9(13.04) | ⁎⁎< 0.001 |
| | | Yes | 61(87.50) | 45(64.10) | 61(86.96) | |
| 2 | Shoulder | No | 9(12.50) | 27(38.46) | 6(8.30) | *0.023 |
| | | Yes | 61(87.50) | 43(61.54) | 64(91.70) | |
| 3 | Elbow | No | 62(87.50) | 56(79.49) | 70(52.17) | *0.040 |
| | | Yes | 9(12.50) | 14(20.51) | 33(47.83) | |
| 4 | Wrist | No | 62(87.50) | 29(41.03) | 49(69.57) | **0.002 |
| | | Yes | 9(12.50) | 41(58.97) | 21(30.43) | |
| 5 | Upper Back | No | 9(12.50) | 24(33.33) | 18(26.09) | *0.006 |
| | | Yes | 62(87.50) | 47(66.67) | 52(73.91) | |
| 6 | Waist | No | 9(12.50) | 39(56.41) | 24(34.78) | *0.040 |
| | | Yes | 62(87.50) | 31(43.59) | 46(65.22) | |
| 7 | Hips and thighs | No | 62(87.50) | 63(89.74) | 52(73.91) | **0.272 |
| | | Yes | 9(12.50) | 7(10.26) | 18(26.09) | |
| 8 | Knee | No | 62(87.50) | (39)56.41 | (37)52.17 | **0.039 |
| | | Yes | 9(12.50) | (31)43.59 | (33)47.83 | |
| 9 | Ankle | No | 9(12.50) | 27(38.46) | 3(4.35) | *0.002 |
| | | Yes | 62(87.50) | 43(61.54) | 67(95.65) | |

* Chi-square test
** Fisher test

muscle activity and the point of applying force are added to points A and B, and points C and D are determined, respectively. Then, after calculating the C and D points using the relevant table, these two points are combined and the final points are obtained. The final point is an estimate of the prevalence risk level of MSDs in the upper limbs, and the higher the point shows the greater risk of prevalence of these disorders [27]. The NERPA method was also used to assess the worst and longest period time posture.

One of the most recent upper limbs posture assessment techniques is the NERPA method, that first proposed by Sanchez-Lite A et al., In 2013. The NERPA method is a modified edition of the RULA method and both have a similar structure [28], but it has major changes compared to the RULA method, so it allows for a more accurate assessment of physical condition [29]. This method has been validated in 2015 by Khandan et al. and its validity has been aprooved [30]. This is a paper and pen method, similar to the RULA method. In this method, the organs of the body are divided into two groups A and B. Group A organs include the arm, forearm, and wrist, and group B organs include the neck, torso, and legs. Through considering the force effect and repetition of motion, the final points of A and B are obtained and the final point of NERPA is calculated using the relevant table, and after calculating the final point, the priority level of corrective action is determined [31]. The Nordic questionnaire was used to assess the prevalence of MSDs among hairdressers in this research [32]. The




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Nordic Questionnaire includes demographic factors such as age, sex, weight, height, right or left hand, and the prevalence of MSDs in 9 areas of the body, including neck, shoulders, elbows, wrists, back, waist, hips or thighs, knees, and ankles [33]. In addition to the assessments, this questionnaire was completed for all individuals in the present study. To provide accurate information and posture assessment using NERPA and RULA methods, an attempt was made to evaluate every single type of their activities in a more comprehensive manner. Finally, the data were entered into STATA12 software and Chi-square, Fisher, and Kruskal-Wallis tests were used, and Spearman correlation coefficient was used to determine the type and degree of correlation between the two quantitative variables. The Statistical tests significant level was considered $P < 0.05$.

## Findings

In the present study, 70 hairdressers from beauty salons in Sabzevar were selected. Of these hairdresser about 61.43% of whom were married and 38.57% of whom were single. Age distribution of the participants in the study in the age group were as follows: under 25 years 24%, in the age group of 25-30 years about 26%, in the age group of 30-35 years17%, and in the age group of 35-40 years 14% and older than 40 years constituted 24% of the total study population. About 92.86% of the participants did not have regular exercise and only 14.7% of them had regular exercise. Almost 80% of the study population performed most of their activities in sitting position, 20% of them worked in standing-sitting position, and also only 10% of the study population had non-occupational diseases history. These people were generally involved in various tasks such as eyelash extensions, nail implants, massage, make-up and face make-up, eyebrow correction, haircuts, tattoos, hair color, hair dryer, hairdressing, and skin cleansing. The findings of the Nordic questionnaire indicate the amount of pain in the previous 12 months in different areas of the body such as the neck, back, shoulders, wrists, and other parts listed in the Tables 1 and 2. Thus, in Table 1, "The frequency distribution of musculoskeletal disorders and its relationship with the female hairdressers' age in Sabzevar" is given. In Table 2, "Frequency distribution of musculoskeletal disorders and its relationship with the type of their activities in female hairdressers in Sabzevar" is explained separately.

Another factor influencing the prevalence and severity of these disorders, is the number of working hours a person works during a day. Thus, to assess the effects of working hours on the WMSDs prevalence, Table 3 shows the frequency distribution of WMSDs and their relationship with the duration of activity in female hairdressers in Sabzevar. About 59% of the participants worked 8 hours or less and the remaining 41% worked more than 8 hours a day at the workplace. Using Kruskal-Wallis test for NERPA and RULA, the final point obtained from these two methods in different parts of the body among hairdressers showed that the minimum point obtained by the NERPA method is 6 and the maximum point is 7. Thus, the minimum point obtained from the RULA method was equal to 6 and the maximum point was equal to 7, which indicates that the level of risk was high and very high respectively. The results of correlation evaluation between the final score obtained from NERPA and RULA methods using Pearson correlation test showed that there were a significant relationship and positive correlation between them ($P < 0.05$).

## Discussion

In this study, the working postures of female


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**Table 3)** Frequency Distribution of Musculoskeletal Disorders and its Relationship with the Activity Duration of Female Hairdressers in Sabzevar, Iran

| Row | Organs | Organs Pain (Yes / No) | Musculoskeletal disorders based on activity duration N(%) | | p-value |
|---|---|---|---|---|---|
| | | | 8 hours | 10 hours and more | |
| 1 | Neck | No | 32(46.3) | 24(34.5) | **<0.001 |
| | | Yes | 38(53.7) | 46(65.5) | |
| 2 | Shoulder | No | 10(13.8) | 24(34.1) | *0.023 |
| | | Yes | 60(86.2) | 46(65.9) | |
| 3 | Elbow | No | 55(78) | 43(62.1) | *0.040 |
| | | Yes | 15(22) | 27(37.9) | |
| 4 | Wrist | No | 38(53.7) | 43(62.1) | **0.002 |
| | | Yes | 32(46.3) | 27(37.9) | |
| 5 | Upper Back | No | 15(22) | 29(41.4) | *0.006 |
| | | Yes | 55(78) | 41(58.6) | |
| 6 | Waist | No | 34(48.8) | 27(37.9) | *0.040 |
| | | Yes | 36(51.2) | 43(62.1) | |
| 7 | Hips and thighs | No | 51(73.2) | 19(26.8) | **0.272 |
| | | Yes | 70(100) | - | |
| 8 | Knee | No | 10(13.8) | 29(41.5) | **0.039 |
| | | Yes | 60(86.2) | 41(58.5) | |
| 9 | Ankle | No | 10(13.8) | 21(29.3) | *0.002 |
| | | Yes | 60(86.2) | 49(70.7) | |

* Chi-square test
** Fisher test

hairdressers in Sabzevar, Iran were assessed using RULA and NERPA methods, and also the Nordic questionnaire was used to assess the WMSDs prevalence. According to the results of this study, the highest WMSDs prevalence in hairdressers was in the shoulder, knee and, neck areas respectively. A study conducted by previous researcher showed that the WMSDs prevalence in the shoulder area was high [23]. Another study conducted by Gisele Mussi showed that the most involved organs were the shoulders and neck [34]. The results of the above two studies are completely consistent with the results of the present study. However, a research conducted in 2019 by previous study showed that the highest prevalence of WMSDs is in the upper back and wrist [8]. Another research conducted by Froorash et al., showed that the most WMSDs prevalence was in the elbow area [22]. According to the results of the above studies, it seems that despite the difference in the WMSDs prevalence in different parts of the body, in general, the WMSDs prevalence in the upper areas is much more evident, which shows the importance of ergonomic corrective measures in the upper areas. Amongst factors that lead to musculoskeletal disorders in hairdressers, repetitive movements, long periods of time spent in static postures, and incorrect postures can be mentioned [35]. As shown by the current research, the most WMSDs prevalence is in the shoulder,


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knee and neck areas respectively, which can be due to working in inappropriate postures, working at a height higher than shoulder height and standing for a long time. This means that paying attention to the risk factors associated with WMSDs in these areas and eliminating them in the workplace can be an effective measure to improve working conditions and prevent such disorders, and any prevention should be based on controlling the risk factors associated with these areas [25]. According to the findings of this report, there was a significant relationship between aging and the occurrence of WMSDs in the shoulders, back, waist, knees and ankles, which has been mentioned in some studies [8, 35]. The biological/functional structures of the human body, such as muscles, joints, and tendons and degeneration with age may explain the resemblance. In another study, however, there was no significant relationship between aging and the WMSDs prevalence [36]. Another research also showed that there was no significant relationship between individuals, age and the prevalence of pain in any of the organs [22]. Based on the data analysis, there was a significant relationship between the type of activity and the occurrence of disorders, which it seems that people who have sitting- standinging activities are more likely to suffer from WMSDs. There was no significant relationship between work experience and mean age with the WMSDs prevalence, which has been mentioned in another study [36]. However, inconsistent with the results of the present study, in a study conducted in 2019, it was found that the relationship between increasing work experience and increasing WMSDs is significant [37]. Furthermore, in the study of Froorash et al. It was mentioned that there is a significant relationship between increasing work experience and the WMSDs prevalence in some body organs [22]. Based on the results of RULA and NERPA posture assessments in this profession, the point of the worst postures in both methods is equal to 7, so in both methods, the point of 7 means a very high risk level and requires ergonomic corrective intervention to be implemented as soon as possible. According to the Spearman test, the correlation between the RULA and NERPA methods is high, which this similarly has been mentioned in a previous study which the correlation coefficient between NERPA and RULA methods was 0.93 [30]. According to the results of the consistent and inconsistent studies with the present study, hairdressers are exposed to many ergonomic hazards due to their physical activities, which lead to the WMSDs prevalence in various areas of the body, and so this profession must be thoroughly examined from an ergonomic point of view to prevent WMSDs. Amongst limitations of the present study problems such as difficult access to individuals can be mentioned. Furthermore, NQ self – reporting might interfere the exact findings of the study. However, the results of this study are in consistent with other valid studies that is its' strong points of the present study.

## Conclusion

In this study, an increase in the prevalence of WMSDs was shown in the study population, particularly in the shoulder, knee, and neck areas. is recommended that hairdressers should be educated in identifying their workplace hazards and properly applying ergonomic standards and procedures. In future studies, it is suggested that the REBA method be used individually and in combination with the NERPA method to assess the risk of musculoskeletal disorders in a larger sample of hairdressers and compare the results with the results of the present study.

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participants of the study.

**Author Contribution:** FS analyses and interpret the data. MJSh reviews the literature. ST collect data and fill out the questionnaires. OA supervised all and confirmed stages of the study. All authors read the manuscript and approved it.

**Conflict of Interests:** The authors declare that there is no conflict of interest for this study.

**Ethical Permission:** All principals of ethics were considered in this study. Participants were familiarized with aim and procedures of the study. All participants were satisfied to be studied and signed the consent form.

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