Ergonomic assessment of Sina car montage industry employees 'working positions by REBA (Rapid entire body assessment)

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Abstract

Introduction: Musculoskeletal disorders (MSDs) are most important work-related injuries and debilities in developed and developing industrial countries. In the recent years, the rate of injuries and MSDs in car montage industries compared with other industries was so more. Therefore, the purpose of present study was focused on ergonomic assessment of sina car montage industry employees' working positions in Hamedan.

Materials and methods: This descriptive-analytical study was conducted in 2013. 120 workers with 60 occupational duties from different sections were selected as samples and REBA Technique (high consistency and allow ability) was carried out to assess musculoskeletal loads on workers due to their postures, repetition, and force. Nordic musculoskeletal questionnaire (NMQ) was also used to obtain prevalence of entire body disorders. Finally, data was analyzed by use of statistical tests.

Results: During last year, most suffering from MSDs in studied persons was related to waistline region (34.4%) that was followed by neck and wrist (each of them 31.2%). No tasks were placed in action level of 0 and few cases were in action level of one. Thereby, further actions, ergonomic designing solutions, and multiple preventions are necessary. Other findings are indicated that A limbs compared with B limbs are in higher risk levels, ergonomically and thus incidence of sufferings is greater in these limbs.

Conclusion: The result of present study will point out a need to develop and apply a program by using of ergonomic concepts in order to prevent from MSDs in different car montage industries in the country. Also, it induces the need for improvement procelures for omission of improper postures in studied industry.

Keywords: Ergonomic assessment, automobile montage, REBA

Introduction

USA labour office has defined work-related musculoskeletal disorders (WMSDs) as injuries and damage of muscles, nerves, tendons, joints, cartilage and back vertebrae in encounter with risk factors of work environment (1,2). Work-related musculoskeletal disorders are one of the common factors of occupational injuries and debility appearance in workers, increasing of payable damages

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and decreasing of efficiency in industrial and developing countries (3-4). Musculoskeletal disorders involve third of occupational accidents, every year (5). Also, WMSDs induce third of working-hours' loss resulting from disease (1). There injuries are made because of non-consideration of Ergonomically principles and involved many limbs such as back, neck, shoulders, hands and feet and Finally, they lead to appearance of debility, deprivation and unavailability to facilities (6). Musculoskeletal disorders can affect on workers' ability to do necessities of occupational activities and cause negative effects on production. According to performed investigations, 73 percent of total retrievable damages resulting from WMSDs in health care organization between1994 to1998 in England, Colombia and Canada along with direct costs of these damages have estimated 113 million dollar (3). At present, most prevalent occupational disease in the country is work-related Musculoskeletal disorders and play an impotent role in making human sources unable, thus persistence of country's industries for introducing a proper model for detecting and evaluating occupational risk factors that are present in different working responsibilities, is necessary and its necessity feels more and more (7). Evaluation of injuring factors to Musculoskeletal system is done in different way and in spite of our theoretical knowledge about continuous and significant increase of work-related Musculoskeletal burden of disease, there is an insignificant compiled programming in preventing and controlling these disorders (8). Montage industry is one of the industries in which risk of repeated moves and consequently risk of musculoskeletal disorders is high and in which specific components are added to a product in a regular manner and finally end product is produced. In such industries, there is a high level of suffering from occupational disorders resulting from repeated moves because of presence of various egronomical risk factors such as activity repetition, force imposition, improper body posture and lack of recovery time (6).Therefore, the aim of present in workers of sina segment-making industry in Hamedan and also determination of risk level and introducing reformatory strategies for improving working positions.

Materials and methods

In this descriptive-analytical study, working positions of workers in Sina segment making industry in Hamedan through REBA checklist that is a statistics method and by attendance was evaluated. It is necessary to mentioned that 20 persons among employees in this industry were omitted because of working in non-specialized posts and with regard to similarity of responsibilities in different shifts, finally only 60 employees in the morning shift were evaluated as sample. In order to determine the rate of sufferings prevalence, Nordic questionnaire also was completed by studied person. The whole body parts are classified into two groups A and B in the REBA technique. Neck, legs, and trunk in the group A and group B consisted of lower-upper arms and wrist (9-10). For each area of the body, the score is obtained with respect to positions, movements, and gestures of each area of the body from the table (9-11). By knowing the group A score obtained from table A and the force-load score, the final group A score is obtained and the final group B score by knowing the group B score from table B and the coupling-grip score is calculated (9-11). As well as score C is calculated from table C. In static posture, or action repetitiveness (>4 times/min), or rapid posture changing's or instability, a score 1 is added to the score C. Finally, the REBA score is calculated by adding score C to the activity score (9-11).

Rapid Entire Body Assessment (REBA): REBA checklist was invented by Mc

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Atamney and Hignett in England in 1998 in order to analyze working positions of curative - and service- health occupations (9-10). In this method, by observation of each working position in terms of angels head body and upper and lower limbs, a score is given them. A Final score obtained by collecting these scares which with respect to it , the rate of risk that threaten musculoskeletal system of person's body is determine and finally , this method determines need or not need to reform that working position with respect to obtained risk rate(12). Some advantages of this tool include, a) sensitive tool for musculoskeletal risks by classifying the bodies to the parts, b) useful for manual tasks risk assessment, c) prioritization for corrective measures according to risk assessment. On the other some limitations of this tool include is a) does not provide an integrated assessment of biomechanical risk factors, b) cannot steer to the effective controls as the function of severity of various risk factors present in different tasks/jobs(4).

Nordic Musculoskeletal Questionnaire (NMQ): Several musculoskeletal questionnaires there are that can be used for achieving to the data and information about musculoskeletal disorders and their symptoms. Questionnaire-aided data gathering is inexpensive, quick and easy (13). NMQ questionnaire has designed by Kuorinka et al. in Scandinavian countries' professional health institute in 1987 and conation questions about individual and occupational affairs, prevalence of disorders in different parts of body, severing and time of pain and leaving or not leaving workplace because of these disorders (14-15). It should be mentioned that allow ability and consistency of above tools have verified in trout by Mahnaz saremi in a research design that performed many that dentists of Shahed university (16).

Analysis of working positions was performed by transferring data to REBA software. T-test was applied to multiple comparisons of NMQ prevalence or REBA scores between different tasks. NMQ were completed through structured interview and then analyzed with SPSS v. 16. Chi-square test was used to assess univariate associations between variables (demographic and work-related characteristics) and reported MSD symptoms. P values below 0.05 were considered statistically significant.

Results

General characteristics: The sample population consisted of 60 subjects that 47 (77%) of whom men and 14 (23%) were woman. The mean of the ages of the men was 33.44 (SD: 5.98 range 24-49) and the mean of the ages of the women was 34.54 (SD: 5.15, range 27-43).The overall, age, weight and height means of employees were 33.66 (SD: 5.71 years), 69.37(SD: 9.42 kg) and 179.49 (SD: 8.02 cm) respectively, minimum age of 24 years and maximum age of 49 years. Persons' BMI was estimated and distribution of this parameter was normal (range 18.5-25) in most of them (73.1% of investigated persons). The person involved in the study worked in a closed environment. The illumination and air-conditioning were satisfactory but noise level was high at times. The majority (75.4%) of the person used their right hands to accomplish the task.

REBA scores and the prevalence of musculoskeletal symptoms: The body movements of the participants during work tasks were observed in accordance with the REBA form and the scores were recorded. For each employee and observation was used a separate REBA form. Recorded postures by direct observation of each of A and B limbs were analyses and result showed that in A limbs and in most sensitive limb, i.e. back, most persons had an erect posture with the frequency of 51.7%. In the continuation of analysis, REBA ergonomic risk assessment of persons 'postures was performed in other considered regions,

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similarly and it was found that how the posture distribution was with maximum frequency in different regions and result has been shown in Figure 1.

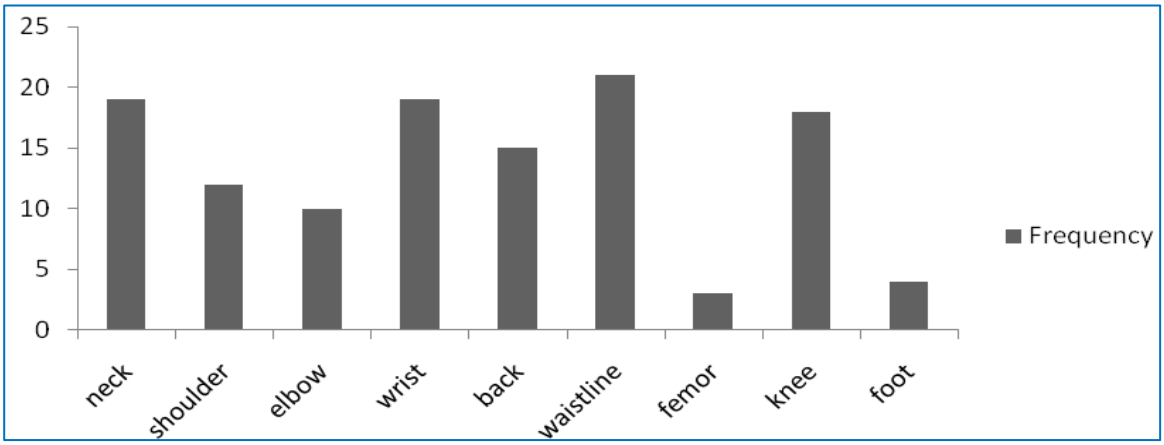


Figure 1. Disorder distribution in different region of employee's body

In terms of disorder duration in different regions of body, dewing 12 last months, 34.4, 31.2 and 29.5 percent of investigated persons suffered from pain in back, neck and knee regions, respectively. The risk scores of the legs were determined to be within normal limits; there was no strain on their legs. Subsequently, the risk rate and level of reformatory procedure in each unit was evaluated and it was found that there was a risk in most of units and the employees' postures at their work stations need to be investigated and some changes are required immediately (Table 1).

Table 1. The distribution of risk rate and level of reformatory procedure regarding different unit's isolation

	Montage Unit	Production Line	Sourcing Unit	Coloring Unit	Plating Unit
Reformatory procedure	Need May be need	Need Soon need Immediately need May be need	Soon need	Need	Immediately need
Risk rate level	(%83.3) Moderate (%16.7) Low	(73.3%) Moderate (19.3%) High (4%) Very high (4%)-low	High	Moderate	Very high

There were only a few participants who received REBA scores of 2-3, which indicates an acceptable posture. also results show that there were meaningful relations between shoulder pain and sex ($P< 0.001$) and neck pain and sex ($P<0.002$) . The relations between back , leg and wrist pains and sex were insignificant. The relations between age and body stack index and musculoskeletal disorders were also insignificant. The results of assessment of persons' working position in REBA manner are represented in (Table 2).

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Table 2. The distribution of factors associated with pain in of workers

Organ	Pain due to job	Decrease of activity	Absence from work	Job change
Waistline	13	9	7	3
Wrist	13	7	2	3
Neck	14	10	1	3
Shoulder	9	1	-	1

Also, in the survey standard questionnaire completed by staff in work place was found that absenteeism was higher in people with low back pain than of others, which are consistent with results obtained of analysis posture people risk levels (P<0.001) (Figure 2).



Figure 2. The distribution of factors associated with pain in the workers under study

In study of demographic variables and their association with an increased incidence of muscular skeletal disorders in various organs of workers found no correlation while significant relationship was found between gender and level of risk (P<0.003) (Table 3).

Table 3. The relationship between demographic variables and pain in different organs

Demographic variable and correlation with Musculoskeletal disorders in organ studied	P value
Age and correlation with pain in waistline organ	0.107
Age and correlation with pain in neck organ	0.868
Age and correlation with pain disorders in wrist organ	0.612
Age and correlation with pain in knee organ	0.193
Gender and correlation with pain in waistline organ	0.372
Gender and correlation with pain in neck organ	0.768
Gender and correlation with pain in wrist organ	0.762
Gender and correlation with pain in knee organ	0.785
Weight and correlation with pain in knee organ	0.145

Discussion

In evolution of results has not observed any meaningful relation between age and body mass index variables and musculoskeletal disorders in different regions of body, where as in many studies among which studies as Andersen (17) and Ming (18), there was a meaningful relation between high BMI and increase in age and increase of prevalence of MsDs in employees. Other results have suggested that in investigated persons, most suffering duration from musculoskeletal disorders

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related to back region with frequency of 94.4% and was followed by neck and wrist, each with frequency of 31.2% which this is in accordance with findings of other similar studies among which studies of park (19), and Nasl saraji (20).The evaluation of recorded postures in back region, in verification above finagling, has shown that there is a completely meaningful relation between employees' body position in back region and risk level of musculoskeletal disorders (P = 0.001). It was found that there is a notable relation between arms's getting away from body and point in shoulder region which is in concordance with results of similar studies of Fahol (21), and Russo (22). Also, it has shown that there is a meaningful relation between the rate of imposed force by employees and risk level of musculoskeletal disorders (P=0.001) witch suggested high imposed force by employees during work. These findings are in concordance with results of study of miry (23). In this research, prevalence of disorders of back, neck and wrist in studied persons were 34.4, 31.2 and 31.2% , respectively which in comparison with results of studies of saraji et al in which back disorder in 60 percent of percent, neck disorder in 56%, shoulder disorder in 38% and wrist disorder in 31% were reported (20), and also with results of study of Ozturk et al (2011) in Turkey in which back and neck disorders were 62.5 and 50.5% (1), respectively, showed that prevalence of back, neck and wrist disorders with regard to studied population are similar which is not independent from persons' working positions. This finding shows the most effect of working positions in appearance of musculoskeletal disorders in comparison with demographic variables. Other findings of the study have indicated that prevalence of disorders in A limbs are more than B limbs in studied persons. On the other hand, A limb in these persons are in higher risk levels in comparison with B limbs in employees, ergonomically.

Conclusion

It can be concluded that there is a relation between province of musculoskeletal disorders in these persons and their working positions. Furthermore, all of these working positions need to be reformed. On the strength of obtained result, following suggestions can be represented to decrease prevalence of disorders (19):

- Do the work in a sitting posture as for as possible.
- Because the rate of imposing force is decreased by 65% of normal state when wrist is bended and therefore more force imposing is need that this sometimes can be risk full, so it is suggested that during work, flexure of wrist not be more than 150.
-Settlement place of working tools be so that the need to bend or body turn when they are picked up be minimized.
-To maintain normal body weight in order to prevent from appearance of disorders in back and lower move mental limbs.
-Dependent training classes determine in field of recognition of biomechanical risk factors, work-related musculoskeletal disorders and basic and proper ways of work doing.

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References

1. Öztürk N, Esin MN. Investigation of musculoskeletal symptoms and ergonomic risk factors among female sewing machine operators in Turkey. Int J Industr Ergon. 2011; 41(1):585-591.

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2. Hagberg M, Morgenstern H, Kelsh M. Impact of occupational and job tasks on the prevalence of carpal tunnel syndrome: a review. Scan J Work Environ Health. 1992; 18(1):277-9.
3. Burnett DR, Kyureghyan NH. Quantification of scan-specific ergonomic risk-factors in medical sonography. In J Industr Ergon. 2010; 40(1):306-14.
4. Najarkola S, Mirzaei R. Assessment of musculoskeletal loads of electric factory workers by rapid entire body assessment. J Health Scope. 2012; 1(2):71-9.
5. Meksawi S, Tangtrakulwanich B, Chongsuvivatwong V. Musculoskeletal problems and ergonomic risk assessment in rubber tappers: A community-based study in southern Thailand. Int J Industr Ergon. 2012; 42(1):129-35.
6. Choobine A, Mokhtarzade A, Salehi M, Tabatabaie H. Ergonomic assessment of the risk musculoskeletal disorders by methods QEC in a rubber factory. Med J. 2006; 7(1):46-55.
7. Habibi E, Karimi S, Hasanzade A. Ergonomic assessment of risks posed by the study investigator to duplicate the activities of employment in assembly industry. J Occup Health. 2007; 5(1):70-5.
8. Barr E, Mari F, Brain D. work-related musculoskeletal disorders of the hand and wrist, J Orthop Sports Phys Ther. 2004; 34(10):610-627.
9. Pascual SA, Naqvi S. An investigation of ergonomics analysis tools used in industry in the identification of work-related musculoskeletal disorders. Int J Occup Saf Ergon. 2008; 14(2):237-45.
10. Lamarão AM, Costa LC, Comper ML, Padula RS. Translation, cross-cultural adaptation to Brazilian- Portuguese and reliability analysis of the instrument Rapid Entire Body Assessment-REBA. Braz J Phys Ther. 2014; 18(3):211-7.
11. Lee TH, Lee YH. An investigation of stability limits while holding a load. Ergonomics. 2003; 46(5):446-54.
12. Jayaraman S, Dropkin J, Siby S, Alston LR, Markowitz S. Dangerous dining: health and safety in the New York City restaurant industry. J Occup Environ Med. 2011; 53(12):1418-24.
13. Bongers PM, Ijmker S, van den Heuvel S, Blatter BM. Epidemiology of work related neck and upper limb problems: psychosocial and personal risk factors (part I) and effective interventions from a bio behavioural perspective (part II). J Occup Rehabil. 2006; 16(3):279-302.
14. Gobba F1, Ghersi R, Martinelli S, Richeldi A, Clerici P, Grazioli P. [Italian translation and validation of the Nordic IRSST standardized questionnaire for the analysis of musculoskeletal symptoms]. Med Lav. 2008; 99(6):424-43.
15. David G1, Woods V, Li G, Buckle P. The development of the Quick Exposure Check (QEC) for assessing exposure to risk factors for work-related musculoskeletal disorders. Appl Ergon. 2008; 39(1):57-69.
16. Mortazavi S. Ergonomics and prevention of disabilities in children. J Special Edu. 2009; 36(5):9-13.
17. Andersen JH, Gaardboe O. Prevalence of persistent neck and upper limb pain in a historical cohort of sewing machine operators. Int J Industr Ergon.1993; 24 (6):677-87.
18. Ming Z, Zaproudina N. Review Computer use related upper limb musculoskeletal (RULA) disorders. Pathophysiology. 2003;9(1):155-60.
19. Park SK, Choi YJ, Moon DH, Chun JH. Work related musculoskeletal disorders of hairdresser. Korean J Occup Environ Med. 2000; 3(12): 395-404.
20. Naslsaraji J, Hosseini MH, shahtaheri SJ, golbabaei F, Gasemkhani M. Evaluation of ergonomic postures of dental professions by rapid entire body

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assessment (REBA), in birjand,iran. J Dentistry. 2005; 18(1):2-7.
21. La Botz D. Manufacturing poverty: the maquiladorization of Mexico. Int J Health Serv. 1994; 24(3):403-8.
22. Russo A, Murphy C, Lessoway V, Berkowitz S. The prevalence of musculoskeletal symptoms among British Columbia. Appl Ergon. 2002; 33(1):385-93.
23. Hashim AM, Dawal SZ, Yusoff N. Ergonomic evaluation of postural stress in school workshop. Work. 2012; 41 Suppl 1:827-31.
24. Mohammadfam I, Keianfar A, Afsartala B. Assess the risk of musculoskeletal disorders - muscle using RULA and QEC and compares them in industrial company. J Occup Health. 2010; 6(1):15-9.
25. Shanahan CJ, Vi P, Salas EA, Reider VL, Hochman LM, Moore AE. A comparison of RULA, REBA and Strain Index to four psychophysical scales in the assessment of non-fixed work. Work. 2013; 45(3):367-78.
26. Fredriksson K, Bildt C, Hagg G. The impact on musculoskeletal disorders of changing physical and psychosocial work environment conditions in the automobile industry. Int J Industr Ergon.2001; 28(3):31-45.

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