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Case Study

Ergonomic Assessment of Working Postures Using NERPA and REBA Methods (Case Study: Abadan Oil Refinery)

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Abstract

Background: Improper posture is recognized as one of the risk factors in musculoskeletal disorders. So, operational postures assessment is required to correct undesirable postures and reduce musculoskeletal disorders. This study was conducted to specify the risk level of working postures utilizing REBA (Rapid Entire Body Assessment) and NERPA (Novel Ergonomic Postural Assessment) method and determining its relationship with the occurrence of musculoskeletal disorders in the operational occupations of Abadan Oil Refining Company. **Methods**: The current study was a cross-sectional and descriptive-analytical study. Using the Cochran formula, 315 of the operational employees of the Abadan Oil Refining Company were studied. Data were gathered by the methods of REBA and NERPA and analyzed using SPSS 20 and statistical tests. The statistical test of the Pearson correlation coefficient was applied to determine the correlation between the results of REBA and NERPA methods. The confidence level of 95% was taken into consideration. **Results**: Based on the results obtained from REBA method, the highest frequency percentage in the risk level of postural analysis was attributed to 206 subjects (65.4%) in the medium level, 88 subjects (27.9%) in the low level, and 20 subjects (6.3%) in the high level. Regarding the results obtained from NERPA method, the highest frequency percentage in the risk level of postural analysis was attributed to 158 subjects (50.2%) in the high level, 134 subjects (42.5%) in the medium level and 23 subjects (7.3%) were in the very high level. The statistical test results revealed that a statistically significant relationship was observed between the mean score of REBA and NERPA (P<0.001). **Conclusion**: This study's results declared that the NERPA method, by regarding the domain and angles of motion more than the REBA posture assessment, investigated the musculoskeletal health and was more worker-oriented.

Keywords: Posture Assessment; REBA; NERPA; Work-Related Musculoskeletal Disorders (WMSDs); Abadan Oil Refining Company

Introduction

The growing trend of technology, particularly in developing countries, the expansion of production units, and the provision of machine services have improved the quality of work and products. At the same time, in doing so, there are detrimental factors that affect workers' health and threaten their lives.[1] Musculoskeletal disorders may be a very harmful disease for workers and results in

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disability. Thus, musculoskeletal disorders impose negative impact on the performance of manufacturing companies.[2] Moreover, the quality of workers' work declines due to musculoskeletal disorders. It conduces to decreased company productivity in such a way that sometimes even workers will fail to keep working for musculoskeletal disorders.[3] Also, risk factors leading to musculoskeletal diseases impose enormous costs on industry owners and country's economies every year.[4, 5] Generally, dangerous activities are referred to as some activities such as design tool-making activities, activities that require workers to squat down in long-term, static activities, and repetitive activities.[6] Musculoskeletal disorders are emerged as a consequence of the poor ergonomic design of workplaces and are known as one of the biggest concerns in the industrial sector. The assessment method for potential risks is the significant benefit of the primary design, which considers physical injuries. The design assessment method, related to the identifying process of potential ergonomic improvements from various designs or performed activities, is realized as a part of a continuous improvement cycle throughout the different stages of the product life cycle.[7]

Concerning the results observed from 9 Asian and African developing countries in 2011, the number of occupational accidents was equal to 512584, 38.5% of which were associated with musculoskeletal disorders. Furthermore, the number of occupational diseases was considered to be 18121 cases, 71% of which were related to musculoskeletal disorders.[8] A study conducted by Asgarpour et al. on dentists exhibited that 80% of dentists showed discomfort in at least one area of the body within a year. The occurrence of musculoskeletal disorders in the studied subjects was 58% in the neck, 54% in the wrists, 46% in the waist, 37% in the shoulders, and 4% in the legs. The REBA posture analysis technique indicated that approximately 90% of the dental work status was above the mean risk range, which required corrective action.[9] The study carried out by Ranjbarian et al. on the employees working in the Electricity Distribution Company illustrated that the highest outbreak of musculoskeletal disorders in different organs was observed in low back pain and shoulder pain and knee pain were 45.6%, 39.2%, and 36.8%, respectively. There existed a statistically significant relationship between occupation type and REBA risk level.[10] The results of the study by Haghshenas et al. (2016) in an industrial company by making use of the NERPA and QEC (Quantum Error Correction) posture assessment methods, declared that the application of the NERPA method was a suitable tool to assess the prevalence of musculoskeletal disorders .[11]

Given the previously conducted researches, musculoskeletal disorders were appeared due to poor ergonomic design and undesirable postures in the workplaces and were seen as one of the biggest concerns in the industry sector. In this line, great efforts should be taken to make certain the ergonomic optimization of the workstation and correction of undesirable postures in the workplace as a human factor.[7, 12, 13] Therefore, in this study, REBA and NERPA posture detection methods were used to examine the role of undesirable postures in the development of musculoskeletal disorders. The aim of comparing the results of these two methods was to study the prevalence of musculoskeletal disorders in different organs.

Methods

The present study was a cross-sectional and descriptive-analytical study in which 315 men were selected and studied using the Cochran formula from the operational employees of the Abadan Oil Refining Company. This study was performed in different operational departments of the Abadan Oil Refining Company. The first inclusion criterion in the study was not having any history of diseases affecting musculoskeletal disorders such as arthritis, rheumatism, mental problems, etc. or any accident

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that led to musculoskeletal injury. Also, other inclusion criteria in this study were conducting daily activities that their repetition could be assessed by REBA and NERPA methods and also having at least one year of work experience in the desired occupation. All employees were involved in the research conduction with their consent. Initially, to respect research ethics, all steps of research were explained to employees. Subjects were allowed to leave the test at any given moment with complete satisfaction.

In this study, data collection tools were REBA and NERPA methods to assess operational working postures and one questionnaire comprising demographic and individual characteristics (including age, gender, level of education, work experience, and occupation). REBA method was proposed in 2000 by Hygent and McAtmany.[14] This method was induced by collaboration between ergonomists, physiotherapists, occupational therapists, and nurses groups. It was developed for assessing various unpredictable working postures in healthcare services and other service industries. The REBA method was observed to assess the entire body and authorized individuals to analyze the upper limbs (arms, forearms, and wrists), torso, neck, and legs. Moreover, other factors in this method, such as displaced force or load, type of load catching (griping), and muscle activity, were scanned in the assessments. In this method, assessing static and dynamic postures was also observed. For the REBA method, it was supposed to go through a series of steps for carrying out the posture assessment. Before starting work with the REBA method, the duration of observation was initially required to be determined. If the task duration was long for assessment, the initial operations should be broken down for a more detailed assessment. Subsequently, to complete the assessment, the following actions were done respectively: the task of observation (for a general assessment of the workplace, including the influence of work arrangement and environment, use of equipment and workers' behavior concerning risk-taking), selection of postures for assessment, scoring postures (which were divided into two groups for scoring the areas of the body: group A including the torso, neck, and legs, and group B including arms, forearms, and wrists), processing scores and obtaining the final REBA score, and ultimately determining the risk level and corrective action priority.

Table 1 exhibited the REBA method's scoring and the determination of the level of corrective action concerning the relevant score.[14] NERPA method was a new technique developed by Sanchez et al. in 2013.[7] For analyzing working postures by this method, each main part of the body was assessed by considering the amount of displacement from its natural state. Thus, respecting the increase in the deviation of that part of its natural state, a number was labeled to it as a posture code. After combining the obtained codes for different parts of the body and estimating the external and muscular forces through the relevant tables, the amount of the final code was determined. This final code indicated the severity of the posture risk and the urgency level of the corrections. This method comprised of 5 forms in which the body organs were separated into two groups of A (including wrist, arm, forearm) and B (including neck, torso, and legs). Generally, the term "Upper Limb" was assigned for group A, and the term "Whole Body" for group B. Scores A and B must be integrated with two values of Muscle Use and Force to achieve the final score (or C, the combination of scores of A, B, Muscle Strength, and Force) (Grand Score). This final score illustrated the likelihood of risk and was suggested to be assessed by the recommended action levels below table 2. Compared to the RULA method, the domain and angles of rotation of the wrist and arm were more considered in the NERPA method, and the rotation angle of the wrist was scored less and more than 70º.

The implementation of the NERPA method consisted of three steps:

Step 1: Recording the working posture

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Step 2: Scoring system.

Step 3: Determining the action levels

The RULA method had no change in the legs' posture, but a correction score was given to the arms, neck, torso, and wrists after acting each part of the body. Also, in the assessment of the neck and wrists, their motion domain was changed. In this method, the risk level was observed into three groups: low-risk level (L) with green color code with a score of 1 to 2, medium risk level (M) with orange color code with a score of 3 to 4, risk level (H) with red color code with a score of 5 to 8. Table 2 presented the NERPA method's scoring and the determination of the level of corrective action based on this score.[7]

Data analysis

In this cross-sectional and descriptive-analytical study, 315 men were selected by the census, and the data were analyzed by using SPSS 20. Descriptive statistics were applied to report the level of corrective actions, determining the degree of risk factor related to working posture and the frequency of musculoskeletal disorders. Also, the statistical test of the Pearson correlation coefficient was utilized in the present study to determine the correlation between the results obtained from REBA and NERPA methods. A 95% confidence level was observed in all tests.

Results

This study investigated the ergonomic assessment of the working postures of 315 male operational employees of the Abadan Oil Refining Company. The demographic characteristics of the subjects were provided in tables 3 and 4.

Concerning results achieved by REBA method, the highest frequency percentage in the risk level of postural analysis was attributed to 88 subjects (27.9%) in the low level, 206 persons (65.4%) in the medium level, and 20 subjects (6.3%) in the high level. The other data extracted from the REBA method were provided in table 5 and chart 1 in the form of score frequency and of percentage.

Table 1. The final score domain of the REBA method and the determination of the level of corrective action based on the obtained score

The necessity of action and its time	The priority level of corrective actions	Level of danger	Final Score
It is not necessary	0	Negligible	1
It may be necessary	1	Low	3 - 2
Necessary	2	Average	7 - 4
Necessary(as soon as possible)	3	High	10 - 8
Necessary (immediate)	4	Very high	15 - 11

Table 2. The final score domain of the NERPA method and the determination of the corrective action level based on the obtained score

The necessity of action and its time	The priority level of corrective actions	Level of danger	Final Score
acceptable	1	Low	1 - 2
Maybe necessary	2	Average	3 - 4
In the near future	3	High	5 - 6
Necessary (immediate)	4	Very high	7

Table 3. Demographic characteristics of the subjects in Abadan refinery

Age groups (year)	Frequency	Percentage
Lower than 30	101	32.1
31- 40	101	32.1
41- 50	76	24.1
Over than 50	37	11.7
Total	315	100

Table 4. Demographic characteristics of the subjects in Abadan refinery based on their work experience

Background (year)	Frequency	Percentage
Lower than 10	174	55.2
11- 20	53	16.8
21- 30	81	25.7
31- 40	6	1.9
Over than 40	1	0.3
Total	*315	100

Table 5. Score frequency and percentage of the subjects by REBA method

REBA Grouping	Frequency	Percentage
Negligible (not required) (Score 1)	0	0
Low (may be necessary) (between 2 and 3)	88	27.9
Medium (required) (between 4 and 7)	206	65.4
High (necessary as soon as possible) (between 8 and 10)	20	6.3
Very high (urgent required) (between 11 and 15)	1	0.3
Total	315	100

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Regarding the derived results from NERPA method, the highest frequency percentage in the risk level of postural analysis was attributed to 158 subjects (50.2%) in the high level, 134 subjects (42.5%) in the medium level and 23 subjects (7.3%) were in the very high level. The other data extracted from the NERPA method were provided in table 6 and chart 2 in the form of score frequency and of percentage.

The general interpretation, mean and standard deviation of different body organs were exhibited in table 7 based on REBA and NERPA methods and the type of occupation.

Table 6. Score frequency and percentage of the subjects by NERPA method

NERPA Grouping	Frequency	Percentage
Low (acceptable) (between 1 and 2)	0	0
Medium (maybe necessary) (between 3 and 4)	134	42.5
Top (in the near future) (between 5 to 6)	158	50.2
Extremely high (urgent) (7)	23	7.3
Total	315	100

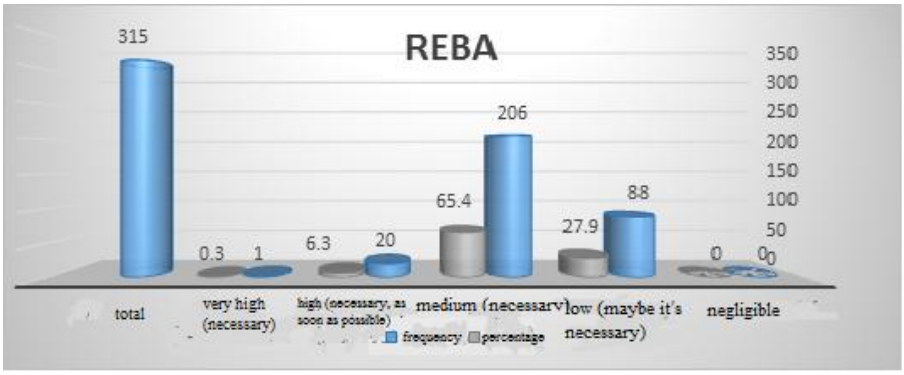

Figure 1. Frequency and percentage of corrective actions levels based on REBA method

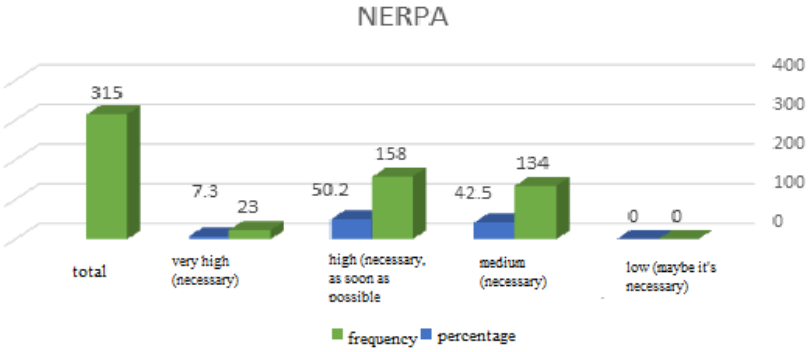

Figure 2. Frequency and percentage of corrective actions levels based on NERPA method

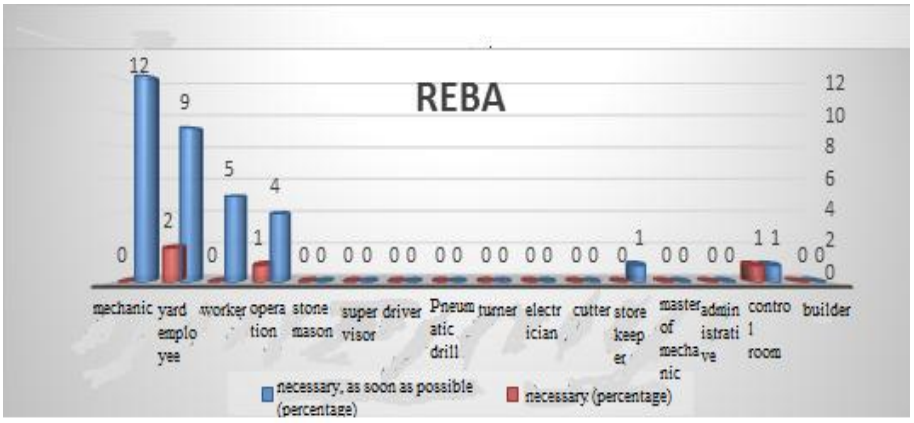

Figure 3. Posture assessment by REBA method separately for operational units

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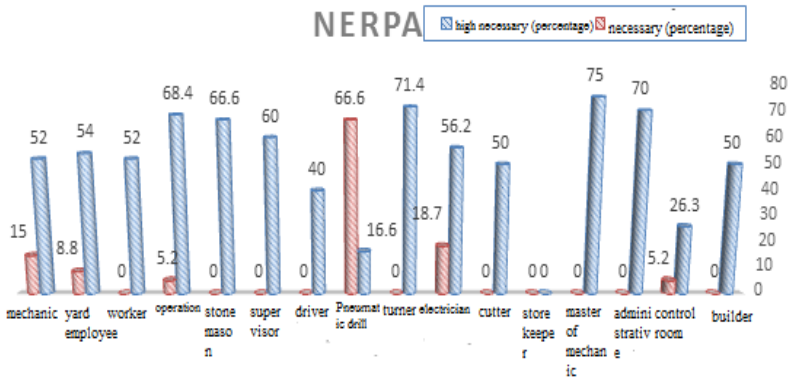

Figure 4. Posture assessment by NERPA method separately sorted by occupations for operational units

Table 7. General interpretation of mean and standard deviation of NERPA and REBA scores in operational and administrative employees

Occupational group	Number	Mean	Std. Deviation	Level of REBA corrective actions	Occupational group	Number	mean	Std. Deviation	NERPA level of corrective action
mechanic	73	5.67	0.06	Low (maybe necessary)	mechanic	73	5.67	0.57	High (in near future)
Site employee	68	5.3	0.11	Low (maybe necessary)	Site employee	68	5.3	1.02	High (in near future)
Worker	23	4.56	0.88	Low (maybe necessary)	Worker	23	4.56	0.99	Average (maybe necessary)
Operation	19	5.6	0.35	Low (maybe necessary)	Operation	19	5.6	1.67	High (in near future)
Rock thrower	6	3.8	1.3	Average (necessary)	Rock thrower	6	3.8	1	High (in near future)
Supervisor	10	3.6	1.02	Average (necessary)	Supervisor	10	3.6	0.44	High (in near future)
Driver	5	2.4	0.36	Average (necessary)	Driver	5	2.4	0.46	High (in near future)
Pneumatic drill	6	5	0.24	Low (maybe necessary)	Pneumatic drill	6	5	1	High (in near future)
Lathe	18	4.44	0.78	Low (maybe necessary)	Lathe	18	4.44	0.64	High (in near future)
electrician	16	5.43	0.48	Low (maybe necessary)	electrician	16	5.43	1.23	High (in near future)
Cutter	16	4.75	0.74	Low (maybe necessary)	Cutter	16	4.75	1.12	Average (maybe necessary)
warehouse keeper	3	4.66	0.14	Low (maybe necessary)	warehouse keeper	3	4.66	0.88	Average (maybe necessary)
Mechanic	8	3.12	0.42	Average (necessary)	Mechanic	8	3.12	1.09	High (in near future)
Official	20	4.8	0.77	Low (maybe necessary)	Official	20	4.8	0.97	High (in near future)
Control room	19	5.47	0.64	Low (maybe necessary)	Control room	19	5.47	1.37	Average (maybe necessary)
Bricklayer	2	3.5	0.44	Average (necessary)	Bricklayer	2	3.5	1.22	Average (maybe necessary)
Welder	2	5	0.37	Low (maybe necessary)	Welder	2	5	1.04	High (in near future)
Scaffolding maker	3	2	0.75	Average (necessary)	Scaffolding maker	3	2	1.6	Average (maybe necessary)
Rigger	2	2.5	0.49	Average (necessary)	Rigger	2	2.5	0.57	Average (maybe necessary)

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In Figure 3, examining each unit, in which the posture assessment was performed, revealed that in the REBA method, mechanical workers (12%) and yard employees (9%) were at a high level and only yard employees (2%) were at a very high level.

In Figure 4, examining each unit, in which the posture assessment was performed, exhibited that in the NERPA method, pneumatic drill workers (66.67%), mechanics (15%), electricians (18.7%), and yard employees (8.8%) were seen at a very high level of corrective action.

Having examined the relationship between individual variables, mean score of working postures using REBA and NERPA methods, multiple linear regression analysis represented that a statistically significant and strong relationship was evident between mean REBA score and NERPA mean score (P <0.001).

Discussion

In this study, workers working postures of different units of Abadan oil Refining Company were evaluated using Rapid Entire Body Assessment (REBA), and the Novel Ergonomic Postural Assessment (NERPA) and the prevalence of musculoskeletal disorders in these employees were evaluated. In this study, by examining the relationship between individual variables, mean score of working postures using the REBA method, and NERPA method, multiple linear regression analysis showed that there was a significant relationship between the mean score of REBA and the mean of NERPA score (P < 0.001). In the study of the family and colleagues who examined the ergonomic status of workers of the operating unit using NERPA, REBA, and RULA methods, there was a significant relationship at the risk level of two methods NERPA and REBA.[15] In a study conducted by Sancher and his colleagues in the beverage industry, the conclusion that both the RULA and REBA technique had the highest correlation with the NERPA .[16]

The results of this study showed that the highest percentage and frequency of employees' postures (REBA) were studied in moderate, high, low, and very high-risk levels, consistent with the results obtained in this study, the study of Zamanian et al. (2014) in regard to ergonomic assessment of musculoskeletal disorders risk by method REBA showed that the highest percentage of the population was in the moderate risk level, and these researchers considered the necessary level of ergonomic corrective actions for the studied subjects[17] Also, Askarpoor et al. (2013) in a study to investigate ergonomic risk factors among dentists in Semnan City were used REBA method. This study showed that about 90 percent of the dental work condition was assessed at the top of the average risk range, which was considered a necessary corrective action.[18] In another study conducted by Karami Matin et al. (2013) on the risk assessment of musculoskeletal disorders in the workers of stone quarries and cutting industries of Kermanshah in 2013, the final score of REBA method for the studied subjects in the rocks and stone quarries, 9.06 and 4.6, respectively, the necessity of corrective actions of each in the necessary category (immediate) and necessary.[19] In the study of Haghshenas et al. (2016) to assess the risk of musculoskeletal disorders in the industrial company, using two methods of NERPA and QEC in the industrial company was determined based on NERPA results, 20.6% of workers had 1 or 2 points that showed low-risk level, 26.43% of the workers had a score of 3 or 4, indicating the average risk level and 33.33% of the workers had a score of 5 or 6, which had a high level of risk and 20.12% of the traders had a rating of 7 or more, indicating a high level of risk.[11] The results of this study showed that the highest percentage and frequency of employees' postures (NERPA) were studied in high risk, moderate, very high and low, and the necessity of applying control and corrective measures for the studied staff in the near future, maybe necessary, essential (immediate), is not necessary, The NERPA method showed that the highest percentage of the population of the study was at a high level of risk, based on these researchers, the

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level of which it should be done to change soon and reform as well as more precise research. In our study, we found that in REBA method, the mechanical workers (12%), the staff of the enclosure (9%), level 4, and the only work area (2%), respectively. Are at the top 5 levels. The results show that the workers of the shop, pipe and pump mechanics, due to static activities, rotation and bending of the trunk, also the muscle force in the wrist and elbow area have the highest risk of exposure to the high level.

Also, the method of evaluation of the performed posture shows that in the NERPA method of pneumatic drilling workers (66.67%), transducer shop (28.58%), pipe mechanics (23.53%) -Electrical and fieldwork (20%) At very high levels of corrective actions (Level 4). The results show that the pneumatic drilling workers, transducer shop, and tube mechanics due to the large repetitive movements, improper wrist posture in getting instruments, also had the worst back posture, and the biomechanical pressure entered into these areas is the highest value. The amplitude of rotation and the end of the trunk and the half-state of the worker is also placed on the working surface of the trunk in the position between standing and sitting. In this study, the prevalence of musculoskeletal disorders among the studied subjects was low, and only (21) 17.4% in the NERPA posture assessment method was essential and instantaneous measures. In the REBA method, the highest score of measures (11persons) 9.1% at a high level of measures was needed to examine and apply preventive and therapeutic action. In other studies that were conducted in the field of investigating the prevalence of musculoskeletal disorders and symptoms, the prevalence of disorders among different populations was reported. As we can see, the result of our study showed that the NERPA method, or considering the amplitude and movement angles more than the REBA posture assessment method, examines the musculoskeletal system's health, and most workers are centered. Therefore, in addition to other corrective actions performed to prevent and treat musculoskeletal disorders, it is necessary to apply control measures to correct working postures.

Suggestions

The effectiveness of an applied and operational study is determined that by applying the control measures, the specified problem is omitted or reduced as possible. Therefore, in performing health assessments and ergonomics, it is always defined and implemented control measures.

Engineering measures

The most important item, the recommendation, and emphasis to the Central workshop unit (Valve shop, pump shop, electric shop) based on the use of the table with an adjustable base fit the unset of each person in a sitting and stand-up capability based on anthropometric dimensions. The use of rubber insoles in the cutting unit was recommended for long-standing on soft surfaces and reduced pressure on the ankle and waist. Also, the use of the suspended materials and chain block holder to reduce the weight of the aerial machine exchanger and remove the bending and twisting of the waist and reduce the vibration and weight of the machine to the elbow and joint area and better capability of the grip and workers were recommended. It is recommended to design a workplace in a way that will adapt to the dimensions and sizes of the location and work station, with the body size.

Management Actions

Based on the same study, measures such as corrective work postures using individual training and modification of working conditions, preventing individual work and recommending the process of teamwork, reduction of transportation and handling times and force, modifying procedures and procedures, specialized training methods for prevention and treatment of musculoskeletal disorders, such as Back School training and training exercises of the musculoskeletal system, etc. And non-use of people with musculoskeletal problems are in the

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task of working people who are forced to use inappropriate tools on the agenda. The training program, with the help of experienced professors of Back School training and other training mentioned in the form of the educational seminar, was implemented and implemented. Back School's training was first presented in the decade 1970 by a Swedish researcher named Zachrison-Forsil. These trainings were designed and implemented to reduce back pain and to prevent back recurrence. These trainings include training on spine anatomy, biomechanics, Posture.[20-24]

Conclusion

Based on the results obtained from REBA method, the highest frequency percentage in the risk level of postural analysis was attributed to 206 subjects (65.4%) in the medium level, 88 subjects (27.9%) in the low level, and 20 subjects (6.3%) in the high level. Regarding the results obtained from NERPA method, the highest frequency percentage in the risk level of postural analysis was attributed to 158 subjects (50.2%) in the high level, 134 subjects (42.5%) in the medium level and 23 subjects (7.3%) were in the very high level. The statistical test results revealed that a statistically significant relationship was observed between the mean score of REBA and NERPA ($P<0.001$). This study's results declared that the NERPA method, by regarding the domain and angles of motion more than the REBA posture assessment, investigated the musculoskeletal health and was more worker-oriented.

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