Title: Investigating the Prevalence of Musculoskeletal Disorder Risks in an Auto Parts Manufacturing Industry in Tehran: Comparative Evaluation of the CRAMUD, REBA, and CMDQ Methods

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Abstract

Background: One of the main causes of disablement and reduced workplace productivity is musculoskeletal disorders (MSDs). As common as they are, and with such a negative impact on health as well as the economy, there is an urgent need to properly define the hazard and contributing causes. As common as they are, and with such a negative impact on health as well as the economy, there is an urgent need to properly define the hazard and contributing causes. The comprehensive risk assessment of musculoskeletal disorders (CRAMUD) technique will be used in this study to evaluate the risk of acquiring MSDs and ascertain the point prevalence of these illnesses among workers in Tehran Province who manufacture car components.

Methods: This cross-sectional analytical investigation was carried out in 2024 in a Tehran-based automotive parts manufacturing industry, 340 workers were selected from 360 available workers based on the inclusion criteria. The instruments used included the CRAMUD questionnaire, the Rapid Entire Body Assessment (REBA) method, and the Cornell musculoskeletal discomfort questionnaire (CMDQ) questionnaire were used to measure musculoskeletal discomfort. Data analysis was performed using SPSS version 27 software. The Shapiro-Wilk test was used to assess the data's normality The relationships between all variables were performed using Pearson correlation tests and linear regression analyses. The chi-score test was also evaluated to examine group differences.

Results: The mean CRAMUD MSDs risk score was 11.12 ± 3.53 and the point prevalence of MSDs was 44.8%. Additionally, 18.5% of the samples were highly risky and 26.3% were risky. There was a high positive correlation between CRAMUD, REBA ($r = 0.755$, $p < 0.001$), and CMDQ ($r = 0.776$, $p < 0.001$) scores. Linear regression analysis also showed that physical, personal, and psychosocial items significantly ($p < 0.05$) influenced the CMDQ score.

Conclusions: The results of this investigation confirm the significant prevalence of MSDs in the automotive parts manufacturing industry and the high validity of the CRAMUD method in assessing associated risks. It is suggested that the incidence and severity of musculoskeletal disorders can be prevented by implementing preventive interventions and improving ergonomic conditions.

Keywords: Musculoskeletal disorders, CRAMUD, Point prevalence, Risk assessment, Auto parts manufacturing industry

Highlight:

- Significant prevalence of MSDs in the automotive parts manufacturing industry and the high validity of the CRAMUD method in assessing associated risks.
- Risk of MSDs was significant. The CRAMUD method showed a strong correlation with REBA and CMDQ, which confirmed its validity as a tool for assessing the risk of musculoskeletal disorders

plain explain language:

One of the core causes of disablement and reduced workplace productivity is musculoskeletal disorders (MSDs). Given their high prevalence and the significant health and economic impacts they cause, accurately identifying the risks and contributing factors is critically important. This study aims to assess the risk of developing MSDs using the comprehensive risk assessment of musculoskeletal disorders (CRAMUD) method to determine the point prevalence of these disorders among auto parts manufacturing workers in Tehran Province. The results showed that the risk of MSDs was significant. The CRAMUD method showed a strong correlation with REBA and CMDQ, which confirmed its validity as a tool for assessing the risk of musculoskeletal disorders. The findings also showed that the rate of musculoskeletal problems can be affected by three factors: physical, individual, and psychological, and the physical factor is more effective. Such outcomes illustrate the potential of CRAMUD as an extensive tool to identify MSDs risks in the workplace environment, remembering the multifactorial causality of MSDs and the necessity for combined protective measures. Automated auxiliary equipment and devices should as much as is feasible be adopted for material carriage in other procedures. Special emphasis needs to be paid to reducing psychosocial and individual factors in the work environment that affect the prevalence of musculoskeletal disorders.

Introduction

The diversity of equipment in industrial contexts frequently results in unexpected occupational injuries. The complexity of resources, and varying work environments, all can impact workers' health(1). Since the mid-20th century, with the rapid growth of industry, diseases, and conditions associated with industrial life have increased at an alarming rate(2). Musculoskeletal disorders (MSDs) are among the most common occupational injury and disability causes(3, 4). MSDs are inflammatory or degenerative musculoskeletal diseases caused by occupational activities that impair muscles, tendons, ligaments, and other associated support structures(5). They may develop gradually over a long exposure to occupational hazards or abruptly as a consequence of sudden trauma(6). MSDs are viewed as being amongst the most frequent occupational diseases within Europe and involve over 33% of workers in various sectors(7). According to the U.S. Department of Labor, the prevalence of MSDs among the U.S. workforce is 29.7% to 32.6%(8). A meta-analysis in Iran reported a high prevalence of work-related MSDs among Iranian workers 50% for lower back pain and 42.1% for knee disorders(9).

These conditions lead to many issues, including disability, impairment in performing activities of daily living, physical and emotional distress, and vocational issues, all of which have direct and indirect costs(10). In the United States, MSDs are estimated to cost $45–54 billion annually through compensation and loss of productivity, while in European countries, they account for about 2% of gross domestic product (GDP)(11, 12).

Many conditions trigger the causation of MSDs in the workplace—almost entirely individual, physical, and psychosocial factors(13). Individual factors are predominant. Research has reported that MSDs are linked to a higher frequency of physical activities such as lifting, tugging, pushing, standing, bending, and doing hard or repetitive tasks. (14).

The auto Parts Manufacturing Industry has a high prevalence of musculoskeletal disorders due to common physical hazards such as manual handling of heavy parts, highly repetitive work cycles, poor posture, and Using high-speed machines or hazardous power tools (15, 16). Most workers in this sector work standing and often report shoulder, leg, and lower back pain due to repetitive and heavy work(17).

In addition to physical risks, personal and psychosocial elements may exacerbate MSDs. For instance, Karwan et al discovered a significant relationship between the occurrence of MSDs and individual factors, including age, work experience, body mass index (BMI), smoking status, and physical activity. (18). Darvishi et al. provided evidence that working conditions, like hours of work, mental workload, and the intensity of ergonomic risks, play an important role in the creation of MSDs(19). Similarly, Rintala et al. reported that workers who had higher levels of physical fitness incurred fewer job-related injuries than less fit co-workers(20). Studies also offer results that psychosocial factors influence MSD development in varied working conditions. A systematic review identified that psychosocial stressors are the causative agents for MSD development(21). Bugajska et al. reported that excessive work demands, lack of control, and poor social support were the primary psychosocial risk factors(22). In addition, a study of epidemiology demonstrated that employees who were exposed to high psychosocial and physical risks developed more MSD symptoms, suggesting a powerful interaction among them(23).

Given these findings, preventing MSDs in industrial settings is essential. Traditional MSD assessment methods primarily focus on physical risks. Therefore, this study utilizes the comprehensive CRAMUD method, which evaluates MSD risk across three domains: personal, physical, and psychosocial. It also compares CRAMUD with two commonly used methods (REBA and CMDQ) within an auto parts manufacturing setting. Since limited research has been conducted on MSDs in this industry and no studies have yet used the CRAMUD method in this context, the present study was designed to fill this gap.

Methodology and Data Collection

This research was a descriptive-analytical cross-sectional study conducted in 2024. The objective was to use the CRAMUD approach to assess the risk and identify the prevalence of musculoskeletal disorders (MSDs) in one of Tehran Province's auto parts manufacturing factories.

Participants

The study participants were male workers from the auto parts division of a car manufacturing company in Tehran Province. Participants were selected randomly, provided they met the inclusion criteria and did not meet any exclusion criteria. All participants' general health status was verified using the General Health Questionnaire (GHQ).

Inclusion and exclusion criteria

The inclusion criteria were the conscious willingness to participate in the study and the completion of the informed consent form, being an official employee of the company and possessing over a year's worth of work experience, not working two jobs, and engaging in a lot of activities during their free time.

The exclusion criteria were the unwillingness to continue the study, the occurrence of an occupational or non-occupational accident for the individual during the study, having structural musculoskeletal abnormalities, a history of severe trauma, and not having a neurological or psychiatric disease.

Sample Size Determination

Based on a cohort study that estimated the prevalence of musculoskeletal disorders among Iranian men at 53%, the sample size was calculated using a 95% confidence level and a 90% test power. The exact calculation formula follows.

$$n = \frac{p(p-1)z^2}{d^2}=340$$

In the sample size formula, p refers to the estimated prevalence of 0.53, z refers to the confidence level of 95%, i.e., 1.96, and d refers to the margin of error. We used an estimate of 53% based on a national cohort of Iranian men (Najafi et al., 2023), which although not specific to auto parts workers, reflects the general prevalence of MSDs in the working male population. Given the absence of prior studies in this specific industrial context using the CRAMUD method, this was deemed an appropriate and conservative estimate. Based on the calculation done using this formula, the minimum sample size was estimated to be 340 participants. Out of 360 male workers who were employed in the selected industry, 343 workers were considered. However, 3 employees declined to respond. Moreover, 5 participants were disqualified due to a lack of responses or poorly completed questionnaires, leaving 335 participants who enrolled at the last minute and whose data were included in statistical analysis(24).

Data Collection Tools

CRAMUD questionnaire:

Through observation, this questionnaire will be used to evaluate physical, psychological, and individual items. There are 38 questions in two portions of the tool that was designed. Explanations are to be completed by the worker and observational questions are to be completed by the expert(s). The Rapid Entire Body Assessment (REBA) method will be used to determine the worst and most frequent physical condition of the individual in each of the limbs of Group A (back, neck, and legs) and Group B (arm, forearm and wrist). The range of scores for this questionnaire range from 0 to 25.5, with the highest indicating the level of musculoskeletal disorders of the individual. (Table 1)

Table 1-Score and risk level of musculoskeletal disorders using the CRAMUD method

Risk Level	Score
Low	Less than 8.5
Medium	8.51 to 11.02
High	11.03 to 15.31
Very high	More than 15.31

According to the study by Yazdanirad et al. (2022), the questionnaire's content validity and reliability were extremely good. Cronbach's alpha coefficient was computed and reported as 0.94, while the average values of CVR and CVI were determined to be 0.77 and 0.934, respectively(25).

REBA questionnaire:

Since the activities of the auto parts workers involved a combination of dynamic and static body positions, Workers' risk of poor posture and repetitive motions was identified and evaluated using the Rapid Entire Body Assessment approach. This technique was created by Hignett and McAtamney to examine the working positions of healthcare professionals and entails an examination of the neck, trunk, upper limbs (arm, forearm, and wrist), and lower limbs (legs). In this method, each working position is scored by observing the head, trunk, and lower and upper limbs, according to their angles. Also, factors such as force, grip type, and muscle activity are added to the limb scores. A final score is obtained from the total scores, which determines the degree of risk to the individual's musculoskeletal system. Ultimately, this method determines the need or lack of need to modify that work situation, based on the level of risk obtained(26, 27). The score and risk levels for muscular-skeletal diseases using the REBA approach are displayed in Table 2.

Table 2-Score and risk level of musculoskeletal disorders using the REBA method

Risk Level	Score
Negligible	1
Low	2-3
Medium	4-7
High	8-10
Very high	11-15

CMDQ questionnaire:

The three phases of this questionnaire, which includes a body map, are: frequency of discomfort (never, 1-2 times in the past week, 3-4 times in the past week, once a day, and multiple times a day); intensity of discomfort (slightly, moderately, and very uncomfortable); and interference with workability during the previous week (not at all, slightly uncomfortable, and significantly uncomfortable), and analyzes 12 body parts, which are a total of 20 body parts, based on the degree of organ damage in a self-reported manner. The CMDQ questionnaire is currently used in the United States and other countries around the world and is well-known as a valuable tool in assessing the degree of musculoskeletal discomfort. To calculate the total score of discomfort due to musculoskeletal disorders, the scores of frequency (0, 1.5, 3.5, 5, and 10), severity (1, 2, and 3), and interference (1, 2, and 3) in each body region were multiplied together and then the obtained values were added together(28, 29). In the study of Afifzadeh et al. (2010), who examined the validity and reliability of the Persian version of this questionnaire, they evaluated the validity and reliability of this questionnaire as desirable. The Cronbach's alpha coefficient for this questionnaire was calculated and reported as 0.986(30).

Data Gathering:

Following the acquisition of the required authorization from Shahid Beheshti University of Medical Sciences' Honorable Vice President for Research and Ethics Committee, as well as from the representatives of the auto parts manufacturer, the researchers went to the relevant industry and after explaining the research objectives and obtaining informed consent from the industry employees, Demographic data like age, height, weight, and work experience were gathered in the first step. Then, The participants were then asked to complete the Cornell Musculoskeletal Discomfort Questionnaire (CMDQ) and questions regarding the individual and psychological elements of the Comprehensive Risk Assessment of Musculoskeletal Disorders (CRAMUD) questionnaire. After that, They were permitted to go back to work and carry out their regular tasks. The researchers observed the participants' duties and spoke with them as well as the company's safety and health manager to get information about the physical items of the questionnaire. Using the Rapid Entire Body Assessment (REBA) approach, the worst and most common conditions associated with each body part during working hours were assessed.

Statistical Analysis:

SPSS version 27 software was used to analyze the data. The Shapiro-Wilk test was used to verify the normality of the data distribution. Depending on the normality of the data, the Pearson or Spearman correlation coefficient was discovered for evaluating the relationship between quantitative variables. Qualitative variables between groups were compared with the help of the Chi-square test. Also, linear regression was used to examine the relationship between independent variables and the dependent variable. Before performing regression analysis, we examined standard assumptions including linearity, normality of residuals, homoscedasticity, and independence of errors. Multicollinearity was assessed using the Variance Inflation Factor (VIF), and all VIF values were below 2. The significance level in all tests was considered less than 0.05. In addition, the point prevalence of the variable in question was also calculated.

Results:

There were 335 participants in this study with a mean work experience of 11.63 ± 7.51 years, all of whom were male. The mean age of the participants in the study was 36.99 ± 7.58 years. The mean body mass index (BMI) of the subjects was 26.20 ± 4.22 kg/m2. The demographic factors' mean and standard deviation are displayed in Table 3.

Table 3-Demographic characteristics of participants(N=335)

Variable	Mean	SD
Age(Y)*	36.99	7.58
Height(M)**	176.03	8.50
Weight(kg)	81.87	13.81
BMI(Kg/m2)	26.20	4.22
Work Experience(Y)	11.63	7.51

*Y=years **M=meter

Mean and standard deviation of musculoskeletal disorder risk scores

The CRAMUD score consists of three items: personal, psychological, and physical scores. The mean score estimated for musculoskeletal disorder risk using the CRAMUD method was 11.11 ± 3.53. This score was estimated to be 6.13 for the REBA questionnaire and 604.63 for the CMDQ questionnaire (in Table 4, Figure 1).

Table 4-Mean and standard deviation of musculoskeletal disorder risk questionnaires

Variable	Mean	SD
Physical. items	7.76	3.38
Personal. items	2.15	0.66
Psychological. items	1.18	0.51
Cramud. score	11.12	3.53
Reba. score	6.13	2.99
CMDQ. score	604.63	184.30

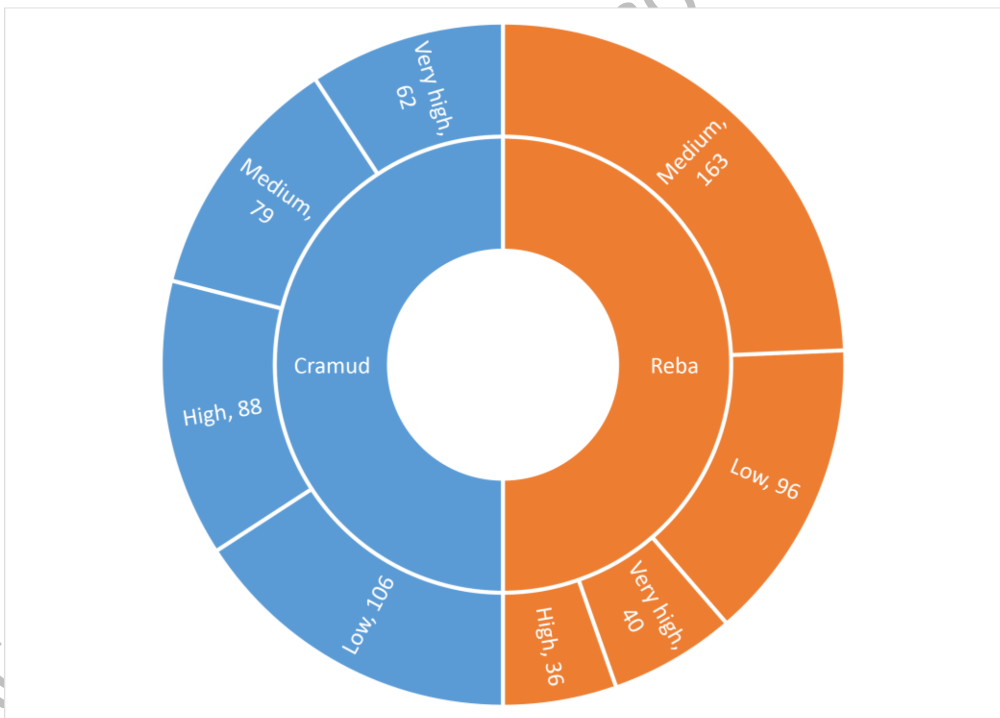

Figure 1-Classification of Musculoskeletal Disorders Risk

Musculoskeletal Disorders Risk Classification

Based on CRAMUD scores, 18.5% of participants were at very high risk, 26.3% at high risk, 23.6% at moderate risk, and 31.6% at low risk. REBA scores also showed that 11.9% were at very high risk, 10.7% were at high risk, 48.7% at moderate risk, and 28.7% at low risk.

Comparison of musculoskeletal disorder risk assessment tools

The CRAMUD tool's relationship to the REBA and CMDQ scores was investigated to determine how well it assesses the risk of musculoskeletal illnesses. The results showed that the scores obtained from CRAMUD have a high correlation with both other tools, which indicates the high ability of this method to identify people at risk. The CRAMUD score has a substantial positive association with the CMDQ ($r = 0.776$, $p < 0.001$) and REBA ($r = 0.755$, $p < 0.001$), according to the correlation analysis between the scores of the musculoskeletal disorders' diagnostic instruments. Additionally, there was a strong association ($r = 0.800$, $p < 0.001$) between the REBA and CMDQ scores. The physical items had the strongest connection ($r = 0.952$, $p < 0.001$) with the overall CRAMUD score among all the CRAMUD components (in Table 5, Figure 2).

Table 5-Correlation Analysis

Variable		**R**	**P-value**
CRAMUD	Reba	0.755	<0.001
	CMDQ	0.776	<0.001
CMDQ	Physical. items	0.743	<0.001
	Personal. items	0.281	<0.001
	Psychological. items	0.113	0.039
CRAMUD	Physical. items	0.952	<0.001
	Personal. items	0.313	<0.001
	Psychological. items	0.077	0.162
CMDQ	Reba	0.80	<0.001

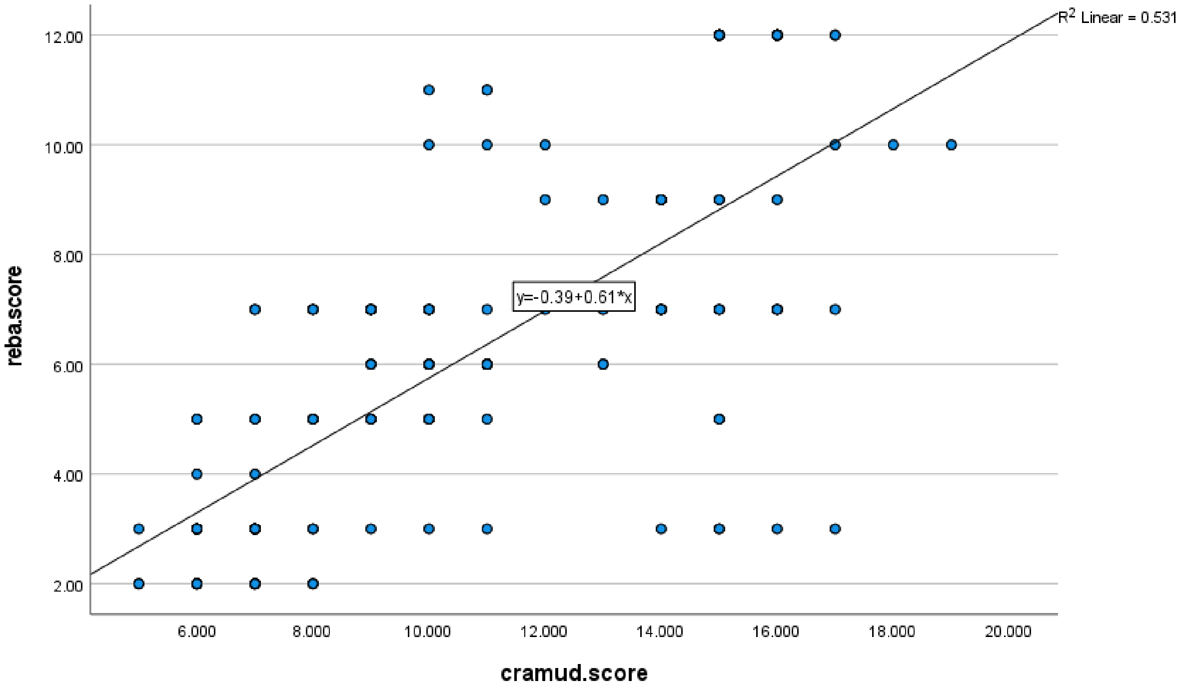

Figure 2-Correlation chart of Cramud and Reba scores

Linear Regression Analysis

Physical, personal, and psychosocial item scores all significantly impacted the CMDQ score ($p < 0.05$), according to multivariate regression analysis. Age and BMI did not significantly affect the CMDQ ($p > 0.05$), according to an analysis of the regression model's demographic factors (Table 6).

Table 6-Linear Regression Analysis

Model	B	SE	P-value	CI 95%	
				Lower	Upper
Physical. items	39.725	1.95	0.001	35.88	43.57
Personal. items	58.184	14.43	0.001	29.80	86.58
Psychological. items	23.511	13.40	0.080	-2.85	49.87
Age	-1.177	1.18	0.319	-3.50	1.14
BMI	-0.927	1.64	0.573	-4.15	2.30
Constant	211.331	53.85	0.001	105.381	317.281

Prevalence of musculoskeletal disorders

According to the CRAMUD score, the point prevalence of musculoskeletal disorders was calculated to be 44.8%. The age distribution study revealed that the 20–29 age group had the lowest incidence rate (24.6%), while the 40–49 age group had the highest incidence rate (58.3%) ($p < 0.001$). Also, the study of body mass index showed that 41.5% and 51.9% of overweight and obese individuals had musculoskeletal disorders, respectively, However, the statistical significance of this link was not established ($p = 0.557$). However, a statistically significant correlation ($p = 0.001$) was found between work experience and whether or not a musculoskeletal condition was present (Table 7).

Table 7-Association of musculoskeletal disorders with variables

Variable	Levels	Musculoskeletal Disorders		Total	P-value
		No (%)	Yes (%)		
Age	20-29	46(75.4)	15(24.6)	61	0.001
	30-39	82(59)	57(41)	139	
	40-49	48(41.7)	67(58.3)	115	
	>49	9(45)	11(55)	20	
BMI	Underweight	4(66.7)	2(33.3)	6	0.557
	Normal weight	72(54.1)	61(45.9)	133	
	Overweight	83(58.5)	59(41.5)	142	
	Obese	26(48.1)	28(51.9)	54	
Experience	1-5	57(66.3)	29(33.7)	86	0.001
	6-10	44(69.8)	19(30.2)	63	
	11-15	33(41.8)	46(58.2)	79	
	16-20	26(37.1)	44(62.9)	70	
	>20	25(67.6)	12(32.4)	37	
Total	-	185(55.2)	150(44.8)	335(100)	-

Discussion

The main objective of this study was to assess the risk of musculoskeletal disorders (MSDs) among male workers in an automotive parts manufacturing plant using the CRAMUD method and to determine its effectiveness against commonly used and well-known tools such as the REBA and CMDQ. We hypothesized that CRAMUD accurately identifies workers at risk of MSDs and that physical, individual, and psychosocial factors significantly influence this risk. The results provide strong support for this hypothesis. This study found a prevalence of musculoskeletal disorders (MSDs) among automotive assembly workers with a mean work experience of 11.63 ± 7.51 years in Iran to be 44.8%, indicating long-term exposure to risk factors. This finding necessitates preventive and ergonomic intervention in the work and production environment(31, 32). Automotive parts manufacturing tasks often involve repetitive motions, awkward postures, high force, and sustained muscle strain. For example, workers are frequently involved in overhead work, prolonged standing, or moving heavy parts, all of which contribute to strain on the upper limbs and back(33). The industry's focus on mass production and efficiency often results in minimal variation in work cycles, high repetition rates, and inadequate rest periods. These conditions contribute to the accumulation of fatigue and make workers more vulnerable to musculoskeletal disorders over time(34). This prevalence is similar to that of the comparable working environment but varies somewhat with recent studies. According to a 2023 cross-sectional study by Chen et al. on logistics workers in the automotive manufacturing industry in Guangzhou, China, the total prevalence of work-related musculoskeletal disorders (WMSDs) was 42.9%(35).According to research by Yang et al., 40.6% of workers in the industrial sector had MSDs(36). These consistent findings and near consensus may be indicative of stability in MSDs prevalence across different parts of the motor vehicle sector as well as implying that MSDs continue to represent a significant occupational health concern within manufacturing sectors.

In comparison to the instruments used to assess the prevalence of musculoskeletal disorders, the REBA instrument reported a lower prevalence of musculoskeletal disorders, which may be due to the more comprehensive nature of the CRAMUD instrument than the REBA.

The results of this study showed that the highest incidence of MSDs was in the age group of 40–49 years (58.3%), which confirms the findings of previous studies that middle-aged workers are at risk of developing MSDs due to cumulative physical strain(37). This could be due to the limitations of mobility, posture, and work-related stress in this group of individuals(38). The results also showed that despite the trend of higher prevalence of MSDs among obese individuals (51.9% vs. 45.9% in normal weight), there was no statistically significant association between body mass index and musculoskeletal disorders. This finding is consistent with the studies of Tantawy et al. (39)and Thamrin et al.(40). These results indicate that occupational factors in automotive and auto parts manufacturing may overshadow demographic effects, as Da Costa and Vieira in their study emphasized the greater influence of workplace conditions and factors on the etiology of MSDs(13). Additionally, the study's findings revealed a substantial correlation between age and the CRAMUD musculoskeletal disorder score in the distribution of musculoskeletal disorders, meaning that younger individuals had a lower likelihood of developing musculoskeletal disorders than middle-aged individuals. This finding is consistent with the results of some studies(23, 41). Also, a study on healthcare workers showed that the prevalence of skeletal disorders increases with age and younger workers report a lower rate of these disorders(42). On the other hand, there was a statistically significant relationship between work experience and having a musculoskeletal disorder, which is consistent with the results of Hosseini's study in the tile industry(43). Therefore, according to the results obtained, changing or transferring workers who are older and have a higher work history to low-risk jobs is recommended.

Multivariate regression analysis results indicated that the risk of MSDs was significantly influenced by physical ($B = 39.725$, $p < 0.001$), personal ($B = 58.184$, $p < 0.001$), and psychosocial ($B = 23.511$, $p = 0.080$) components. Physical variables play a prominent influence ($r = 0.952$ with CRAMUD, $p < 0.001$), which is in line with findings from some research that found manual handling and repetitive jobs to be the main causes of MSDs

in manufacturing. (44). The findings of Park et al.'s study also demonstrate that physical elements have a higher coefficient of influence than both cognitive and personal components. (45). This could be because musculoskeletal problems are directly caused by the physical conditions of the workplace, whereas an individual is predisposed to musculoskeletal disorders by personal and psychosocial variables. The marginal importance of psychosocial factors ($p = 0.080$) is consistent with the results of some studies that support addressing workplace stress and social dynamics in MSDs prevention(21, 46), although the weaker effect in this study could be attributed to the overwhelming influence of the high-intensity physical demands inherent in the work environment. Studies suggest that physical exposures are direct, immediate, and measurable causes of MSDs, often overriding the more subtle contributions of individual characteristics or social context. Studies confirm that in environments such as assembly lines, physical factors have the strongest association with reported pain and disability(47, 48). The results of the correlation study between the scores of the common musculoskeletal disorder assessment tools REBA and CMDQ with CRAMUD showed a strong positive correlation. This result is consistent with the finding of Yazdanirad et al. that there is a strong correlation between CRAMUD and CMDQ scores(25). The stronger correlation between REBA and CMDQ also reinforces their common focus on physical ergonomics, although the broader scope of CRAMUD positions it as a preferred integrated tool for assessing the risk of musculoskeletal disorders. This result is consistent with the results of Yılmaz and Ünve(49). Given the relatively high mean risk scores for musculoskeletal disorders in all three methods, ergonomic interventions are essential in the automotive parts manufacturing industry to prevent injuries, improve worker health, and improve productivity and operational efficiency. The effectiveness of these interventions depends not only on technical design but also on organizational integration and worker participation(50). A participatory research approach in an automotive metal parts factory showed that a focused intervention program in an automotive metal parts factory resulted in a reduction in injuries that was largely attributable to the implementation of ergonomic improvement programs, which included worker training and equipment modifications(51). Similarly, a randomized study in an Iranian automotive factory showed that ergonomic training alone significantly reduced neck and shoulder pain. This suggests that even non-technical interventions – such as workshops and coaching – can have a meaningful impact(52).

Limitations & recommendations:

Given the cross-sectional design of the study and the data collected through self-report, the findings should be interpreted with caution. Therefore, the results may not be generalizable to other occupational groups. Furthermore, this study was conducted on a relatively small sample. Hence, a larger sample size is needed to obtain more robust results in this area.

Although the high correlation between CRAMUD, REBA, and CMDQ supports the convergent validity of the CRAMUD instrument, its predictive validity cannot be assessed due to the cross-sectional design of the present study. So, future longitudinal studies are recommended to assess the ability of CRAMUD to predict the development of musculoskeletal disorders over time.

The researchers recommend conducting longitudinal studies, especially in workplaces with different genders further investigating the role of individual and psychosocial factors in musculoskeletal disorders, as well as examining the impact of ergonomic interventions on the rate of disorders before and after the intervention.

Conclusion:

The results showed that the risk of musculoskeletal disorders is significant. The CRAMUD method showed a strong correlation with REBA and CMDQ, confirming its validity as a tool for assessing the risk of musculoskeletal disorders. The results also showed that all three physical, individual, and psychosocial factors are factors affecting the rate of musculoskeletal disorders, with the physical factor being the most effective. Such results demonstrate the potential of CRAMUD as a broad tool for identifying the risks of musculoskeletal disorders in the workplace and bearing in mind the multifactorial causation of musculoskeletal disorders and the need for combined protective measures. Special emphasis should also be placed on reducing psychosocial and individual factors in the workplace that influence the prevalence of musculoskeletal disorders. However, multi-layered and participatory interventions, including training workshops, participatory ergonomics, and workstation redesign, are a dynamic and participatory approach to significantly reducing musculoskeletal disorders by increasing worker participation in ergonomic assessments and solutions. Management measures such as establishing work-rest cycles and adequate rest periods, timely reporting, and managing early signs of musculoskeletal disorders can also have a significant impact on reducing disorders.

Abbreviation

MSDs	musculoskeletal disorders
(WMSDs)	work-related musculoskeletal disorders
CRAMUD	comprehensive risk assessment of musculoskeletal disorders
REBA	Rapid Entire Body Assessment
CMDQ	Cornell musculoskeletal discomfort questionnaire
GDP	gross domestic product

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Approval Ethics

This work was done with the code of ethics issued by the Shahid Beheshti University of Medical Sciences [No.: IR.SBMU.RETECH.REC.1402 .751]. All study participants completed an ethical consent form, and their information was collected in a completely confidential manner. University of Medical Sciences under ethics code 114959-24827-69-01-93 and IRCT2014051117649N1.

Disclosure statement

The authors did not disclose any potential conflicts of interest.

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Data availability

The authors confirm that the data supporting the findings of this study are available within the article.

Authors Contributions

All of the authors are equally Supervision, methodology, writing original draft, and writing—review review and editing.

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