Validity and reliability of the Persian version of the Dutch musculoskeletal questionnaire

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Abstract

Background: Dutch Musculoskeletal Questionnaire (DMQ) is used to examine physical and environmental risk factors and to identify high-risk groups for exposure to the risk factors of musculoskeletal disorders at workplace. The aim of this study was to develop the Persian version of the DMQ and to assess its psychometric properties.

Methods: This study was conducted on 212 employees of Gas Transmission Company. Using a standard forward-backward translation procedure, the English version of the questionnaire was translated into Persian and culturally adapted. Content validity was established by 10 expert opinions. The intraclass correlation coefficient (ICC) was used for the statistical analysis of reproducibility. Kuder-Richardson-20 was used for internal consistency and confirmatory factor analysis for structural validity.

Results: This study revealed high internal consistency and good test-retest reliability for the Persian version of the questionnaire. The means of the content validity ratio (CVR) and content validity index (CVI) for the total 35 items of the questionnaire were 0.96 and 0.91, respectively. The internal consistency of the factors was satisfactory, ranging from 0.83 to 0.88. Confirmatory factor analysis confirmed the existence of 7 factors in the questionnaire and an acceptable fit for the Persian version of the DMQ.

Conclusion: The Persian version of the DMQ has acceptable psychometric properties. Thus, it can be used as a valid instrument to assess workload and to identify high-risk groups of musculoskeletal disorders at workplace.

Keywords: Ergonomics, Dutch musculoskeletal questionnaire, Validity, Reliability

Introduction

Nowadays, the incidence of musculoskeletal disorders is high among workers. These disorders, in addition to their effect on workers' health, impose high costs for organizations (approximately between 0.5% and 2% of gross domestic product (GDP) in some countries) (1, 2). Therefore, prevention of work-related musculoskeletal disorders (WMSDs) has been considered as a national priority (3). These disorders have been found to be a serious problem at workplace and can lead to reduced physical ability, disease, and early retirement of workers (4-7). Furthermore, it is the main risk factor of work loss days and dissatisfaction among worker s and one of the important causes of

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↑What is "already known" in this topic:
Dutch Musculoskeletal Questionnaire (DMQ) is a valid and reliable tool for measuring self-report musculoskeletal workload, dangerous conditions, and related symptoms in different working groups. This questionnaire allows making a quick but comprehensive survey of the work environment.

→What this article adds:
This study investigated the psychometric properties of the Persian version of DMQ and showed that this version can be considered as an acceptable tool in future studies. This questionnaire can be used to rank different worker groups for exposure to musculoskeletal disorders risk factors.

disability and absence in many jobs (8, 9).

The incidence of work-related musculoskeletal disorders is intensified by various factors present in the workplace, including inappropriate postures, mechanical pressure in certain parts of the body, repetitive movements, intense activity, and static work (10). Several studies have determined the relationship between work-related diseases and workplace physical risk factors (11, 12). Many workers in industrial environments are exposed to work-related discomfort and pain. Occupational risk factors are the most important threatening causes to the health of workers (13). Work-related musculoskeletal disorders reduce performance and health of workers (14, 15). Studies have shown that workers with low performance can have substantial economic and social consequences (16, 17). However, the main cause of musculoskeletal disorders is the delayed identification of exposure to the risk factors for these disorders at workplace (18, 19).

To prevent work-related musculoskeletal disorder, it is important to identify physical and environmental risk factors of WMSDs at workplace to categorize different working groups in workload to design work-rest cycles. The Dutch Musculoskeletal Questionnaire (DMQ) is a useful tool for assessing risk factors of musculoskeletal disorders in 7 different dimensions at workplace and identifying high-risk groups in terms of exposure to these risk factors. The first objective of this study was to describe the process of cross-cultural adaptation of the DMQ to Persian and to verify the psychometric properties of the questionnaire (ie, reproducibility, structural validity, internal consistency). The second objective was to assess the risk factors of WMSDs and identify high-risk groups in Iran Gas Transmission Company. Based on the objectives of this questionnaire, (identifying working groups in terms of exposure), 3 different working groups were selected for evaluation.

Methods
Study population and data collection
This cross sectional study was conducted on the employees (administrative, operational, welder employees) of the Gas Transmission Company located in Hamadan Province during October 2016 to March 2017. Out of 212 employees in the study, 15 dropped out and analyses were done on 197 participants, of whom 107, 55, and 35 were administrative, operative, and welder staff, respectively. All eligible participants had 2 years of work experience.

Data were collected using office automation. After performing the necessary coordination, the Persian version of the questionnaire was loaded into the company's automation system, and the staff from different parts were asked to complete the questionnaire. In some parts, where the staff did not have access to the automation system (operational staff and welders), department officials were asked to collect data by giving questionnaires to the workers. The participants were ensured that their information would be kept anonymous; the response rate was 92.2%. This study was approved by the Research Center of Iranian Gas Transmission Company, and informed consent was obtained from all eligible participants.

Questionnaire (scoring and translation)
The DMQ is used to measure self-report musculoskeletal workload, dangerous conditions, and related symptoms. The questions examine musculoskeletal disorders risk factors but do not examine discomfort rate introduced by exposure to risk factors (20). Questionnaire completion does not require any training. This questionnaire allows making a quick but comprehensive survey of the work environment. This questionnaire has 55 questions and 7 dimensions. The answer to all questions is binary (Yes/No). The scope of the questionnaire includes a force applied, dynamic loads, static loads, repetitive loads, ergonomic environment, vibration, and atmospheric conditions. There are also 4 questions about work posture that are not related to any factor and come at the first part of the questionnaire.

Scoring
The scoring method was based on participants' positive answers (One point was given for positive answers.). The maximum score for each dimension is equal to the number of questions in that dimension. Standardization was needed considering the difference in the number of questions in each dimension and the necessity of comparing dimension scores with each other. Therefore, the scores in each dimension ranged from 0 (minimum) to 10 (maximum).

Translation
In the first stage of the study, the original version of the questionnaire, was translated into Persian using the standardized forward-backward translation method (21). In this method, first, the original version of the questionnaire was translated into Persian by 2 professional translators, independently. Next, these versions were combined and analyzed. Then, the combined version was again translated into English by an independent translator from the first-level translators who had no access to the original version of the questionnaire. Eventually, during the exchange sessions, the translated and original versions were compared and, finally, the Persian version of the DMQ was prepared.

Statistical analysis
Content validity: Quantitative and qualitative methods were used to determine content validity. Content validity ratio (CVR) was used in the content quality process, and 10 ergonomics and occupational health professionals were asked to check the necessity of each scale based on the 3-part spectrum: (1) essential, (2) useful but not necessary, and (3) not necessary (22). Considering the number of experts who had access to questions, the minimum acceptable value was considered at 0.62 to confirm each item in the next step. Content validity index (CVI) was used to evaluate quantitative content validity. Experts were asked to classify questions based on simplicity, relevance, and clarity in the 4-part spectrum (1= not relevant; 2 = somewhat relevant; 3 = quite relevant; 4 = highly relevant classes for relevance). For each item, CVI was calculated by summing up the number of experts giving a rating of either 3 or 4 and dividing it by the total number

of experts. The minimum acceptable value to confirm each item was considered at 0.78 (23).

Reliability: ICC test-retest method was used to verify the repeatability of the final questionnaire. The questionnaires were distributed twice among 30 employees with a fortnight working schedule; then, intercorrelation between them was calculated. Scores were categorized as follow: less than 0.40 (weak), 0.40 to 0.60 (moderate), 0.61 to 0.80 (good), and greater than 0.80 (great) (24). Kuder-Richardson 20 score was calculated to assess internal consistency of the questionnaire, and a score greater than 0.7 was considered satisfactory (25).

Construct validity: Confirmatory factor analysis (CFA) method was used to evaluate construct validity and adoption dimensional degree between the original and translated versions of the questionnaire. To diagnose and confirm the dimensions of the questionnaire, the following indices were used: χ^2 with a degree of freedom (X^2/df), comparative fit index (CFI), Tucker-Lewis index (TLI), and root mean square error estimation (RMSEA). Goodness of fit index ranges are as follow: X^2/df smaller or equal to 3 and CFI greater than 0.9 shows proper fit and greater than 0.95 indicates excellent fitness; TLI index values above 0.9 show a proper fitness and higher than 0.95 suggest an excellent fitness; RMSEA index values less than 0.08 indicate a good model fitness and less than 0.05 suggest excellent fitness (26, 27). SPSS version 21 and M-plus version 5 software packages were used for data analysis.

Results
Demographic information
In this study, 197 employees of Gas Transmission Company, including 107 administrative staff, 55 operators, and 35 welders were studied. The mean values of age, weight, and height in participants were 38.5 years, 77.4 kg, and 1.75 m, respectively. Also, they had 12.2 years of work experience and worked 7-8 hours per day. Table 1 illustrates the detailed descriptive data of the participants.

Validity and reliability
Construct and content validity: The presurvey review from a group of experts led to a number of changes in the wording or structure of some items to improve understandability and readability. Some questions were removed due to their low content validity score based on CVR and CVI, and 35 items remained in the questionnaire and reviews and factor analysis were done. The mean of the CVR and CVI for the total 35 items of the questionnaire was 0.96 and 0.91, respectively. Also, considerable asset value was obtained for all the items. Confirmatory factor analysis was performed to assess construct validity and provide the most appropriate Persian version of the DMQ. Goodness of the fit indices results are as follow: RMSEA= 0.051, TLI = 0.974, CFI= 0.969, (X^2= 1234.7, df= 499.8, X^2/df= 2.47, p< 0.001), which showed good fitness of the model. All dimensions of the questionnaire were correlated with each other. The most correlation was related to the applied force dimension with dimensions of

Table 1. Characteristics of the study participants (N=197)

Variables	Administrative	Operational	Welding
Gender			
Male	93(86.9%)*	55(100%)	35(100%)
Female	14(13.1%)	0(0%)	0(0%)
Education level			
Under diploma	6(5.6%)	7(12.7%)	2(5.7%)
Diploma	20(18.7%)	22(40%)	9(25.7%)
Associate	35(32.7%)	21(38.2%)	14(40%)
Bachelor	37(34.6%)	5(9.1%)	10(28.6%)
Master or higher	9(8.4%)	0(0%)	0(0%)
Family status			
Single	19(17.7%)	5(10%)	3 (8.6%)
Married	88(82.3%)	50(90%)	32(91.4%)

* N(%)

Table 2. The internal consistency of the 7 factors

Dimension	No.Items	Kuder-Richardson index
Force applied	5	0.887
Dynamic loads	4	0.840
Static loads	4	0.836
Repetitive loads	5	0.871
Ergonomic environment	6	0.887
Vibration	2	0.835
Atmospheric conditions	5	0.878

dynamic loads, static loads, and ergonomic environment, with a correlation ranging from 0.59 to 0.73 (Fig. 2). All items on related factors had a significant load factor. Therefore, an optimal version of the DMQ questionnaire, with 35 items and 7 factors, was obtained from an Iranian population. Fig. 2 represents the results of factor analysis.

Reliability and internal stability: The internal consistency values of the Persian DMQ questionnaire by the Kuder-Richardson-20 method are presented in **Error! Reference source not found.**, where the good internal consistency of the questionnaire is noted. Reliability results of ICC test were more than 0.84 that indicated a good reliability of questions.

The comparison of the mean scores for each dimension of the questionnaire in the study population showed that "vibration" (2.5) had the lowest mean score and "repetitive loads" (4.9) had the highest mean score among all the studied dimensions. A standardized average score of all studied factors in the 3 groups is depicted in Fig. 1. The percentage of exposures in 3 groups with poor posture, sitting position, standing position, and walking during work is shown in Fig. 3. The final Persian version of the questionnaire has been added in the Appendix 1).

Discussion
The aim of the present study was to perform a cross-cultural adaptation of the DMQ for Persian speakers and to verify the psychometric properties of the translated tool (reproducibility, structural validity, internal consistency) in a sample of Iranian workers. The content validity of the questionnaire showed that cultural, linguistic, and geographical differences of populations should not be ignored in evaluations. Moreover, standardized versions are not expected to have very similar results based on the language, culture, and customs of different nations (28, 29). In the final Persian version of the questionnaire, which included 35 items, the content validity of the whole dimensions and each item was high, indicating that the Per-
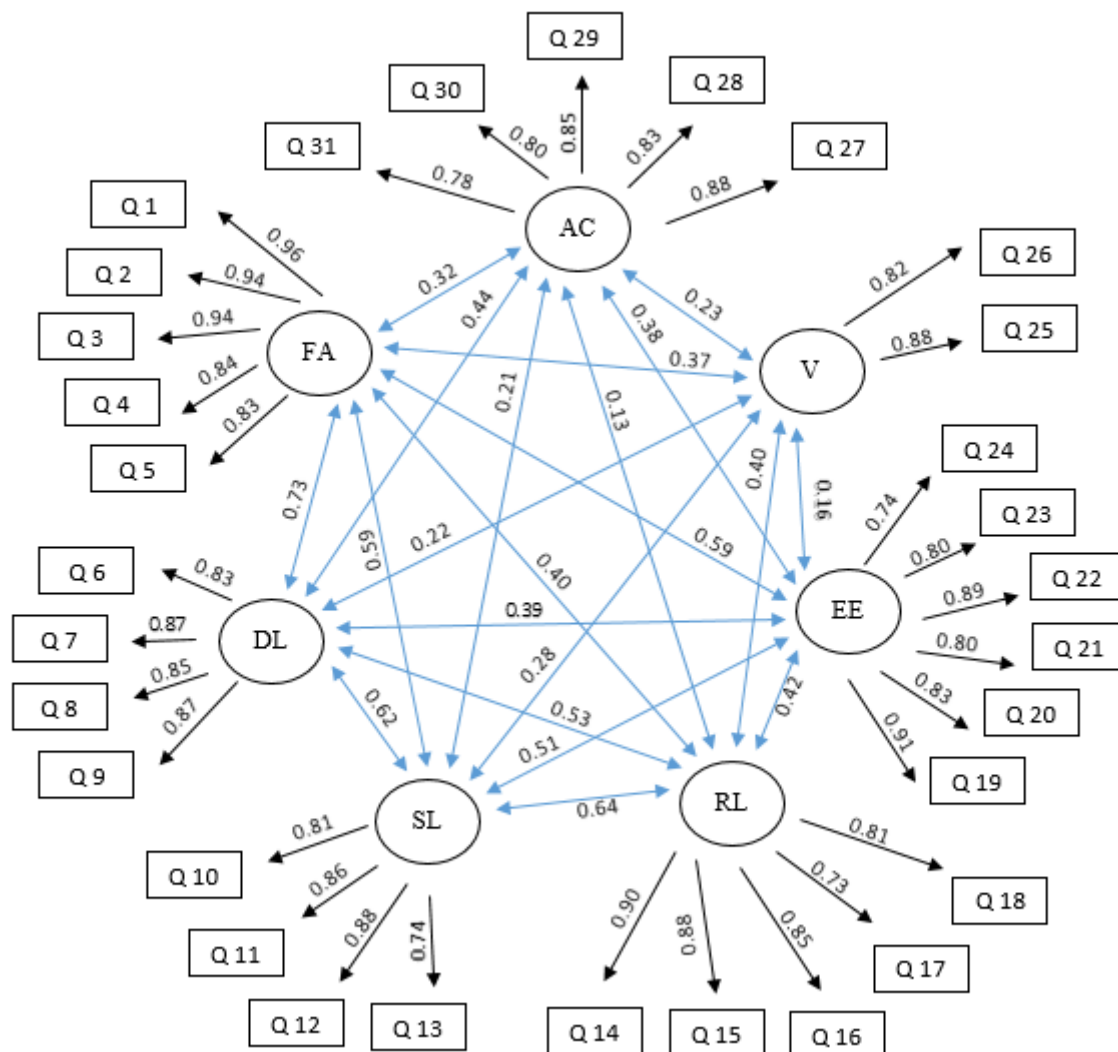
Fig. 2. Diagram showing factor loadings and correlation coefficients estimated by confirmatory factor analysis of the Dutch Musculoskeletal Questionnaire. Note: FA (Force applied), DL (Dynamic loads), SL (Static loads), RL (Repetitive loads), EE (Ergonomic environment), V (Vibration), AC (Atmospheric conditions).

sian version of the DMQ has a good translation and cultural adaptation of the Iranian population.

The internal consistency of the factors was confirmed by measuring Kuder-Richardson-20. Kuder-Richardson-
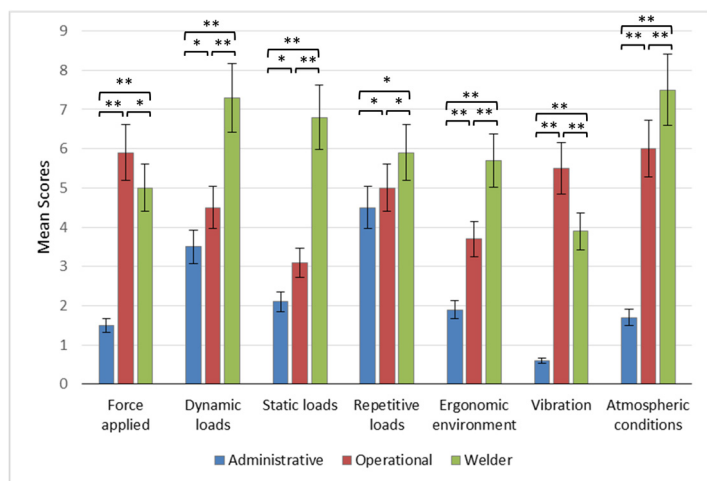
Fig. 1. Standardized mean scores of self-reported exposure summarized in 7 dimensions in 3 groups of the study
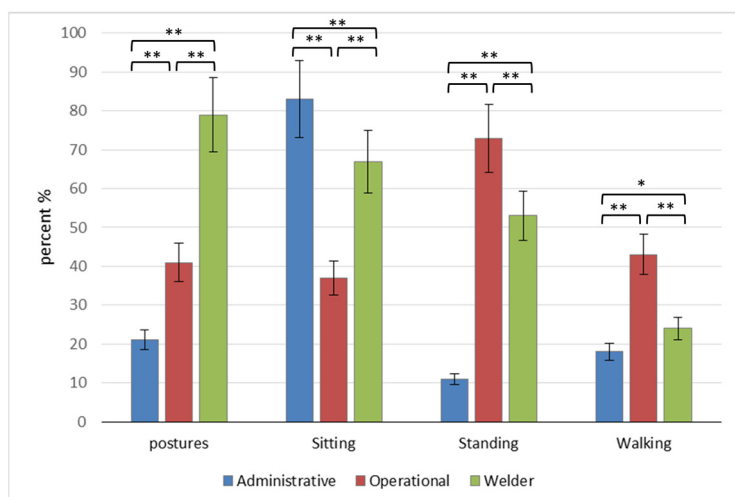
Fig. 3. The mean of self-reported exposure, to uncomfortable postures, sitting, standing and walking in three groups of study. Significant level was set at <0.05 (*) and <0.001 (**).

20 coefficient of the Persian version of the DMQ was greater than 0.83 for all dimensions. The high correlation coefficients between items with a dimension indicated the adequacy of their placement in the dimension and further supported the homogeneity of the dimension (30, 31). Also, internal consistency evaluation of items showed that all factors had good internal consistency. ICC scores between 0.84 to 1 related to retest, which was repeated after 2 weeks, indicated appropriate reliability of the questionnaire.

Confirmatory factor analysis was selected for verifying the predefined structure of the questionnaire. The findings indicate that the Persian version of the DMQ has a good structural validity. The result of the CFA supported the multidimensional nature of risk factors for musculoskeletal disorders (32, 33) and approved all dimensions of the Dutch version of the questionnaire. Correlation between the dimensions of the questionnaire showed a strong, positive, and significant correlation between all dimensions. Therefore, all aspects of DMQ have a close relationship with each other and a change in one of them will affect the others. Moreover, studies conducted on musculoskeletal disorders also confirmed the correlation between musculoskeletal disorder risk factors (34, 35).

Comparison of dimensions mean scores in the studied groups showed that welders had higher scores than 2 other groups in dynamic loads, static loads, repetitive loads, ergonomic environment, and atmospheric conditions, suggesting their highest exposure to the above risk factors compared to other groups. Operational workers had the most exposure to force and vibration compared to other groups due to working with vibrating instruments. Administrative staff gained lower scores in all dimensions compared to other groups. According to the result, the risk factors for musculoskeletal disorders can be classified among study groups and used to prioritize corrective action to prevent musculoskeletal disorders. In this study, welders had priority in performing corrective actions in the work environment, followed by operational and administrative staff in the next order.

Analysis of data collected from the 3 study groups (administrative, operational, and welder staff) showed that different groups with conflicting workloads are identifiable. One of the main features of this questionnaire was identification of high-risk groups. However, this distinction is always relative (comparing groups and dimensions with each other) and it may not be possible to define a criterion for high or low exposure based on this qualitative data.

To prevent the occurrence of WMSDs and identify groups at risk of musculoskeletal disorders, a tool is needed to address musculoskeletal disorders risk factors at workplace (36). Using this tool, high-risk groups are identified and appropriate interventions can be used to reduce the incidence of WMSDs. Recent systematic reviews provide robust evidence of manual handling, bending, and turning of the trunk, whole body vibration, repetitive work, heavy physical work, inadequate postures, and workplace design as risk factors of WMSDs (12, 37, 38). Accordingly, DMQ questionnaire can be used as an appropriate tool for evaluating the risk of musculoskeletal disorders in ergonomic studies by evaluating 7 different domains.

One of the limitations of this study was small sample size. Since the target population of the present study was limited to a company, it was not possible to examine other worker groups (only 3 groups were examined). Also, one of the advantageous features of this questionnaire is identification of worker groups in terms of exposure to WMSDs risk factors, which is suggested to be used in future studies in different worker groups.

Conclusion
Based on the psychometric properties of the present analysis, the Persian version of the DMQ is a valid and reliable instrument for assessing risk factors for musculoskeletal disorders at workplace. This questionnaire is a useful tool to investigate the physical and environmental risk factors for musculoskeletal disorders at workplace

and can be used to rank different worker groups for exposure to musculoskeletal disorders risk factors. Nevertheless, further research needs to be done in this area on a larger scale.

Conflict of Interests

The authors declare that they have no competing interests.

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Appendix 1. Persian version of the Dutch Musculoskeletal Questionnaire

ابعاد	سؤالات	پاسخ	
سؤالات	آیا شما هنگام کار اغلب :		
بدون بعد	۱- در وضعیت بدنی ناراحت‌کننده کار می‌کنید؟	□ بلی	□ خیر
	۲- برای مدت زمان طولانی در حالت ایستاده قرار دارید؟	□ بلی	□ خیر
	۳- برای مدت زمان طولانی در حالت نشسته قرار دارید؟	□ بلی	□ خیر
	۴- مدت زمان طولانی پیاده‌روی می‌کنید؟	□ بلی	□ خیر
اعمال نیرو	آیا هنگام کار اغلب مجبور به:		
	۵- بلند کردن بارهای سنگین (بیش از ۵ کیلوگرم) هستید؟	□ بلی	□ خیر
	۶- هل دادن یا کشیدن بارهای سنگین (بیش از ۵ کیلوگرم) هستید؟	□ بلی	□ خیر
	۷- حمل بارهای سنگین (بیش از ۵ کیلوگرم) هستید؟	□ بلی	□ خیر
	۸- اعمال نیرو با دست و بازوی خود هستید؟	□ بلی	□ خیر
	۹- اعمال نیروی حداکثری در مدت زمان کوتاه هستید؟	□ بلی	□ خیر
بارهای دینامیک	آیا هنگام کار اغلب:		
	۱۰- تنه خود را کمی خم می‌کنید؟	□ بلی	□ خیر
	۱۱- تنه خود را کمی می‌چرخانید؟	□ بلی	□ خیر
	۱۲- گردن خود را خم می‌کنید؟	□ بلی	□ خیر
	۱۳- مچ دست خود را خم می‌کنید یا می‌چرخانید؟	□ بلی	□ خیر
بارهای استاتیک	آیا هنگام کار اغلب مجبور به:		
	۱۴- کار در حالت خمیده برای مدت زمان طولانی هستید؟	□ بلی	□ خیر
	۱۵- نگه‌داشتن بازوی خود در ارتفاع بالاتر از شانه هستید؟	□ بلی	□ خیر
	۱۶- خم کردن گردن خود برای مدت زمان طولانی هستید؟	□ بلی	□ خیر
	۱۷- خم کردن یا چرخاندن مچ دست خود برای مدت زمان طولانی هستید؟	□ بلی	□ خیر
بارهای تکراری	آیا هنگام کار اغلب مجبورید:		
	۱۸- حرکات ریز و سریع با دستان و انگشتان خود انجام دهید؟	□ بلی	□ خیر
	۱۹- حرکات تکراری با تنه خود انجام دهید؟	□ بلی	□ خیر
	۲۰- حرکات تکراری با بازوهای خود انجام دهید؟	□ بلی	□ خیر
	۲۱- حرکات تکراری با مچ دست خود انجام دهید؟	□ بلی	□ خیر
	۲۲- حرکات تکراری با پاهای خود انجام دهید؟	□ بلی	□ خیر
محیط ارگونومیک	آیا هنگام کار:		
	۲۳- در اطراف شما برای انجام درست‌کار فضای کافی وجود دارد؟	□ بلی	□ خیر
	۲۴- ارتفاع سطح کاری مناسب برای انجام کار بدون خم شدن وجود دارد؟	□ بلی	□ خیر
	۲۵- با مشکل اعمال نیروی کافی به دلیل وضعیت بدنی نامناسب مواجه هستید؟	□ بلی	□ خیر
ابعاد	سؤالات	پاسخ	
محیط ارگونومیک	۲۶- به‌ندرت امکان تکیه دادن در طول کار را دارید؟	□ بلی	□ خیر
	۲۷- مشکل دسترسی به ابزاردستی دارید؟	□ بلی	□ خیر
	۲۸- لیز می‌خورید یا می‌افتید؟	□ بلی	□ خیر
ارتعاش	آیا هنگام کار:		
	۲۹- لرزش یا شوک قابل‌توجه دریافت می‌کنید؟	□ بلی	□ خیر
	۳۰- مجبور به حمل ابزار مرتعش هستید؟	□ بلی	□ خیر
شرایط جوی	آیا هنگام کار:		
	۳۱- وزش باد را تجربه می‌کنید؟	□ بلی	□ خیر
	۳۲- سرما را تجربه می‌کنید؟	□ خیر	□ بلی
	۳۳- گرما را تجربه می‌کنید؟	□ بلی	□ خیر
	۳۴- تغییرات دمای هوا را تجربه می‌کنید؟	□ بلی	□ خیر
	۳۵- هوای مرطوب را تجربه می‌کنید؟	□ بلی	□ خیر